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Working Paper No. 55

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Abstract

A survey of residents of farm labor camps in Michigan shows that they bring different kinds of knowledge to bear on issues of pesticide safety. A survey of 188 migrant agricultural workers shows that those who are the most knowledgeable are specialists in farm work, favor Spanish over English, and participate in out-of-state migration to jobs in Florida and Texas. Those who know less about pesticide safety had worked outside agriculture as well as on farms in Michigan. Education and gender were not related to knowledge of pesticide safety, but they were dimensions of variation in different parts of the migrant stream. Statistical analysis and ethnographic information suggest that both formal and practical knowledge create the differences among workers in their levels of knowledge of pesticide safety.

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Pesticide Safety Knowledge among Michigan Migrant Farmworkers

Introduction

This study analyzes pesticide safety knowledge among 188 farmworkers living in farm labor camps in Michigan during 1995. We found that knowledge among participants in the study varied strikingly. Generally, knowledge was strongest in the area of avoiding pesticides and minimizing contact with them. For example, workers reported routinely washing and changing clothes after working in areas where pesticides had been applied. On the other hand, their knowledge was relatively weak on how to respond to pesticide exposure. When presented with various scenarios involving pesticide exposure, they responded with little awareness of pesticide safety issues.

Levels of knowledge about pesticide safety varied considerably among farmworkers. The factors related to levels of knowledge about pesticide safety included training, exposure to pesticides, and sociocultural aspects of farmworkers' relationship to their work. We had expected that fluency in English would relate to greater knowledge of pesticide safety because of the wide availability of information about pesticides in English in the United States. The farmworkers who knew the most, however, were those who were least adept at understanding and speaking English; they had attended school in Mexico and chose Spanish as the questionnaire language. Workers who participated in the Florida-Michigan migrant stream, and in general those who had migrated among states for agricultural work, also had greater knowledge.

We developed a questionnaire that included closed- and open-ended questions on pesticide safety, work history and socio-demographic characteristics, such as education and household composition. More than a quarter of respondents had not received training in pesticide safety at the time we interviewed them in 1995 (29%). Virtually all participants in our survey were Latinos (99.5%), and most chose to answer questions in Spanish (79.8%), facts which underline the importance of Spanish for pesticide safety instruction.

Statistical analyses showed that participants who had pesticide safety training, who had experienced accidental pesticide exposure, who favored Spanish, who had attended school in Mexico, and who had done farm work in at least one other state besides Michigan, tended to know more about pesticide safety. These findings suggest that those workers who are limited to farm labor and are fluent in Spanish may have greater access to information about pesticide safety than those who do not specialize in agricultural work and prefer to communicate in English.

On the basis of this and other findings reported here, we conclude that a combination of formal training and informal exchange of information is responsible for most workers' learning about pesticide safety. A large social network of Spanish speaking farm laborers appears to be a more effective source of information for its members than are English sources of information for English speakers. In general, we find that although people who specialize in migrant farm work face many disadvantages — low wages, poor living conditions, and unsteady work — they do possess greater knowledge of pesticide safety (in terms of Environmental Protection Agency materials) compared with those who work both in agriculture and other sectors of the economy.

Background

Theoretical Perspectives

This study draws from the works of Giddens (1983) and Bourdieu (1990) considering knowledge and practice and from the works of Chavez (1998) and Paredes (1993) concerning the identity of Latino migrant workers. In laying out his theory of structuration, Giddens discusses the importance of human agents as constructing social institutions through recurrent practices (1983: 8-9). He analyzes human agents as operating with different levels of consciousness including "discursive consciousness," defined as "holding something in mind in a

conscious way" (1983:9). We take this level to include the kind of learning done in a classroom or in formal pesticide safety education.

Another level of consciousness, according to Giddens, is "practical consciousness," involving "tacit modes of knowing how to 'go on' in social life" (idem.). We take this level to involve the general framework and concepts for dealing with daily life inherent in a culture and social class. That is, the mental activity that is at play in "practical consciousness" involves unquestioned assumptions and patterns of behavior into which a person has already been socialized, allowing one to proceed to act without really thinking about what to do. We take this kind of consciousness to be that involved in what has been termed "the household production of health," in which people use home remedies and rely on widespread notions about how to deal with health conditions that often contrast with biomedical understandings. Regarding pesticide safety, when people act on what they consider common sense, they tend to be operating at the level of practical consciousness.

Like Giddens, Bourdieu emphasizes the recursive nature of human action in his concept of "habitus" as it characterizes individuals and constitutes social institutions (1990:57). Habitus is related to "social conditionings" that cause "practices and works to be immediately intelligible..., and hence taken for granted. The habitus makes questions of intention superfluous..." (ibid.:58). Bourdieu has thus developed a concept similar to Giddens' practical consciousness. Bourdieu also speaks of "practical sense," which is a notion of how to "play the game" in social interaction (ibid.:80-81). The approaches of Giddens and Bourdieu lead us to expect that the effort to extend pesticide safety education to migrant workers will be affected by the cultural and class contexts of educator, worker, and the form of education. The most effective form of pesticide safety education might be seen as one that extends the lessons learned at the level of discursive consciousness to that of practical consciousness; however, there is little evidence of such a transition in our study.

In studying migrants from Mexico to California, Chavez (1991, 1998) compares their transition into the agricultural labor force and life in the U.S. as resembling Van Gennep's analysis of rituals (1960). First, they undergo isolation from their home community as they cross the border; then, they enter a liminal state as they begin to accustom themselves to their new context in the U.S. Finally, they go through incorporation into a new way of existence to become members of U.S. communities.

Writing of people in the Rio Grande Valley in Texas, Paredes discusses a process of "transculturation," involving the development of bilingualism and biculturalism plus resistance by Latinos toward the anglo Texan establishment (1993:8). That is, Paredes sees immigrants as learning anglo culture but under conditions of political and economic conflict with the anglo power structure. Similarly, Scott's analysis of the struggle between rich and poor in a village in Malaysia during a "green revolution" points to "everyday forms of peasant resistance" such as "foot dragging," "false compliance," and "feigned ignorance" as the "most significant and most effective over the long run" even though they tend to be little recognized as political actions (1985:xvi). The work of Paredes and Scott lead us to expect of migrant farmworkers resistance to the innovation of pesticide safety education. This study shows, however, that although pesticide safety education is not particularly effective, there is insufficient evidence to conclude that lack of pesticide safety knowledge may be due to resistance on the part of farmworkers.

Agriculture and Occupational Safety

As of Jan. 1, 1995, manual agricultural laborers in the United States are required to have pesticide safety training. More specifically, the Federal Worker Protection Standard forbids producers to send people into fields treated with pesticides unless the workers have training in pesticide safety (EPA, 1993). In Michigan, many farmers have decided to provide pesticide safety education to their workers to ensure that they meet the standard.

Various policies have been designed to protect workers and minimize exposure to pesticide residues. These policies regulate the time of reentry into fields after the application of certain chemicals and rely extensively on workers to engage in self-protective behavior such as wearing protective clothing to minimize their risk of exposure. Worker education programs and safe work practices have been emphasized as key components in the regulatory strategy towards pesticide protection for workers (Stenzel, 1991; Terris, 1990). Sadly few, if any, migrant health clinics are capable, in terms of technology, diagnostic protocols, and logistics, of diagnosing pesticide-related illness (Ciesielski, et al., 1994). Only California requires pesticide poisoning reporting; thus, the medical consequences of patterned pesticide exposure are largely unknown.

Several studies have recognized that pesticide safety education does not prevent much of the serious exposure that causes illness or death; such exposure usually results from working conditions, which are not likely to be under laborers' control (Ciesielski, et al., 1994). In a context where workers have very limited economic resources, the effectiveness of the policies in reducing environmental risks is questionable. Poverty and unstable economic situations are conditions that may predict increased exposures to various environmental hazards (House, Kessler & Herzog, 1990; Williams, 1990). These conditions may be associated with, or influence, personal and group processes that directly modify health or risk behavior.

In 1987, with 1,700 worker-related deaths (52 per 100,000 workers), agriculture became the most hazardous occupation in the U.S. (Department of Labor, 1988:118-119, Table 48). In terms of injury and illness, the Bureau of Labor Statistics estimates that there are 12.7 cases per 100 full-time workers per year. Common hazards include: acute injuries (e.g., falling from heights, farm machinery accidents); chronic low-grade back and joint trauma; lack of toilets and safe drinking water; chronic, acute and occasional pesticide exposures; and occupational dermatoses. In particular, the EPA has ranked chemical exposures of agricultural workers as one of the most significant environmental hazards affecting human health in the U.S. (EPA, 1990:13).

Exposure to pesticide residues can be substantial during an agricultural season; as many as 300,000 seasonal workers may experience pesticide-related illnesses during a given year (EPA, 1992). The few studies that are available on chronic or low-level pesticide exposure suggest that limb-reduction birth defects (Schwartz & LoGerfo, 1988), childhood leukemia (Lowengart & Peters, 1987), brain tumors (Gold & Gordis, 1979), sterility, spontaneous abortion (Moses, 1989), and adult lymphomas and lymphosarcomas (Alavanja, et al., 1986) may be linked to occupational exposure to pesticides. Prolonged low-level exposure to pesticide residues has been associated with an increased risk of various negative health outcomes, including anemia, asthma, Parkinson's disease, neurological disorders, developmental impairment in offspring, chronic dermatitis, and an increased risk for certain cancers (Coye, 1985; Goldsmith, 1989; Rust, 1990; and Sakala, 1987). In particular, exposure to cholinesterase-inhibiting pesticides such as organophosphates and carbamates is considered a major health problem for the 2.5-3 million farmworkers in the United States (Wilk, 1986).

Publicity about the dangers of pesticides led to federal regulations requiring that farmworkers be trained in working safely where pesticides have been applied. The EPA provided training materials that were used at Michigan State University in designing training videos and flip charts in English and Spanish for use by Michigan farmers, migrant clinics, and social service providers. This study examines the relationship of training and other factors to farmworker knowledge of pesticide safety (see also Arcury, et al., 2001a and b; Austin, et al., 2001; Quandt, et al., 2001a and b).

The farmworker population is comprised of an estimated 2.5-3 million individuals and their dependents (Department of Labor, 1991:23-30). The National Agricultural Workers Survey, conducted by the U.S. Department of Labor, surveyed over 2,500 agricultural workers employed in 72 counties in 25 states. In the 1989 NAWS report, researchers found that 38% of the farmworkers interviewed had been born in the United States, and 62%, in other countries.

Of all farmworkers, only 6% were working without legal authorization, comprising 19% of those born outside the United States. About one-third of migrant farmworkers in the United States are younger than 30 years of age; few are older than 60 years (Department of Labor, 1991: 11-21, 31). More than half have less than eight years of education. For over half of the workers, annual income is below poverty level (as defined by federal guidelines). Those who are living with family members and those who are foreign-born are more likely than others to be poor. Approximately two-thirds of the workers are Latino, one-fourth are white, non-Latinos, and 3% are African American.

The number of migrant farmworkers in Michigan is estimated to vary between 20,000 and 45,000 (MCSSA, 1995) depending on the basis for calculating their population. Michigan's hired farm work force can be divided into regular employees (employed 150 or more days in a year) and seasonal workers (employed less than 150 days in a year). In 1992, there were 20,500 regular farm employees in the state and 83,923 seasonal workers, including most migrant laborers (Rochín & Siles, 1994). Rochín and Siles calculated that farm laborers who worked for 150 days that year (eight hours a day) had annual gross earnings of $7,824. For a family of four, this income falls below the poverty level; wages below poverty level are typical of migrant workers around the country.

Torres (1990) described Latinos in the Midwest as having health problems that are characteristic of both "less developed" countries (e.g., high infant mortality rates and high prevalence of infectious disease) and "more developed" countries (e.g., high prevalence of cancer and heart disease). He concluded that the causes of major health problems in the Latino population seem to be at the midpoint in a transition from infectious to chronic disease. A key problem for U.S. farmworkers is their explicit exclusion from coverage by some U.S. labor laws despite the dangerous and difficult working and living conditions that result in many of their health, educational, and social problems. In spite of living and working in the richest country in the world, migrant workers have a marginal social and economic status that effectively excludes them from the "First World."

Methods

Collecting and Coding Data

This study deals with findings from a survey administered in 1995. It is based on a questionnaire that deals with three areas: (1) pesticide safety; (2) basic background information (e.g., age, education, location of schooling, household composition, and location of "home"); and (3) employment characteristics of each respondent (years of farm work in Michigan and during the previous year, other states where the respondent did agricultural labor and other jobs held besides those in agriculture during the same period). The questions on pesticide safety are based on pesticide education materials adapted for use in Michigan from information provided by the EPA. Michigan State University Agricultural Extension staff (Sandy Perry) developed most of the materials used in the state — a video and a flip chart with pictures and a narrative. All materials are available in English and Spanish.

The questions on knowledge of pesticide safety were closed- and open-ended. The closed-ended questions dealt with issues such as familiarity with the term, "pesticide," work as a pesticide handler (e.g., mixing or applying pesticides) and potential means of pesticide exposure (from plants, soil, irrigation water, work clothes, work equipment and during the harvest). All these questions were to be answered "yes" or "no." Other closed-ended questions asked how dangerous it was to work with pesticides and how comfortable the respondent was about the amount of pesticide exposure he or she had, both rated on a five-point scale.

A combination of closed- and open-ended questions asked about personal exposure to pesticides through contact with skin or eyes, breathing, or swallowing them. The questionnaire asked whether the participant had experienced a specific kind of exposure (e.g., to pesticides on the skin). A response of "yes" led to an open-ended question asking what the participant had done as a result of the exposure. The interviewer would continue asking "What else did you do?" until the participant offered no further response.

Other questions asked about lessons from any training the participant had received. They began, "If you have received any pesticide safety training, what did the training recommend you do if you get pesticides on your skin [in your eyes, breathe them in, swallow them]?" Each of these questions was followed by prompting ("What else?") until no more responses were forthcoming. Another open-ended question asked for the symptoms of poisoning from pesticides, and prompting also followed this question until the responses were exhausted.

The questionnaire was most detailed in the area of what actions to take upon being exposed to pesticides. This focus encompassed most of the questions on exposure to pesticides and pesticide safety. The questionnaire asked, "Do you know how to keep from getting pesticides on your skin?" An affirmative response is followed by, "How would you do it?" Another series of questions began, "If a person gets pesticides on their skin, what should they do first?" "When?" "Where?" Interviewers were instructed to continue asking questions on the actions taken in response to exposure until there was no further response. The questionnaire continued with the topics of prevention and response to exposure for getting pesticides in the eyes, breathing them in, and swallowing them.

The last section of the questionnaire dealt with personal items preceded by a reminder that participants did not have to answer if they felt uncomfortable. "Personal items" included age, education, school location, places identified as home, preferred language for posting information about pesticides, and household composition. Finally, each interviewer provided information derived from observation including the participant's gender, ethnicity and choice of English or Spanish for the interview.

Sampling and Field Methods

We recruited people into the study by drawing an opportunity sample from farm labor camps located in central, southern Michigan. The region was chosen because of proximity to project headquarters and budgetary limitations. The counties were Clinton, Gratiot, Ingham, Ionia, Livingston, Montcalm, and Ottawa. The region provided a good range of different kinds of farms in the state according to size and crop, although our sample of farms and farmworkers is not statistically representative.

We worked with an opportunity sample because of the almost insurmountable difficulties of drawing a random sample for a study of this nature. It would be nearly impossible to make a roster of the farmworkers in Michigan, as the population of farm labor camps is in constant flux because of the dynamic nature of migrant agricultural labor in a state such as Michigan with seasonal agricultural production. The problems include weather conditions that determine the timing and amount of hand labor required, conditions on specific farms, farmworkers' family and employment situation, public policies affecting living conditions in farm labor camps and requiring outlays by farmers (who may respond by complying, not complying but trying to avoid any penalties, or closing their labor camps), changes in welfare and other publicly provided benefits that enhance workers' low standard of living, technology (affecting the demand for farmworkers) and market conditions for specific crops. These factors and others shape the number and quality of farm labor camps and the number of residents at a given time.

Farmworkers tend to return to camps where they have done well in the past, but the residents of any one camp cannot be predicted on a yearly, monthly, or weekly basis. Moreover, there is no state register of farmworkers and the list of farm labor camps, updated at the end of the season, makes it a year out of date for sampling purposes. All these obstacles can be overcome to construct a random sample, but at a cost that would have exhausted our budget. In view of these problems, an opportunity sample was the best choice.

Interviews were carried out in the labor camps usually between 6 and 9 p.m., after the residents had returned from the fields. Upon arriving at a camp, team members would each approach a dwelling

(house, trailer, or apartment) to ask for interviews. The interviewers introduced themselves, explained the project, and gave information on the rights of human subjects. They took some time to build rapport and took breaks during the interview if the respondent was getting tired or bored. Upon completing a questionnaire, interviewes gave respondents $5 as tokens of appreciation for their cooperation. We decided to offer money to encourage people to participate, but we made it a small amount to avoid overcoming any serious reluctance. The cost per questionnaire for this study was about $55 including developing, translating, and duplicating the questionnaire, training and fielding interviewers and coding open-ended questions. Thus, the $5 gift was not a significant component. Generally, residents of the camps welcomed the interviewers and were cooperative; a number even expressed reluctance to accept the gift. Finally, interviewers distributed printed copies of pesticide safety materials and a form summarizing the purpose of the questionnaire, including phone numbers in case of further questions or comments.

We pretested the questionnaire three times. Pretests were carried out by members of the research team (Millard and Flores) and by four people working in the fields. During the pretests, we worked to improve the clarity of questions and the adequacy of the Spanish translation, particularly regarding the oral vocabulary used by workers of Mexican descent, who comprise most labor camp residents in this part of the country.

In the data analysis, we dealt with several dimensions of knowledge of pesticide safety and how this knowledge was distributed. The answers to the open-ended questions were all listed, then grouped into categories, and then recorded in the data base. We used factor analysis to identify clusters of migrants regarding social characteristics, and analysis of variance and multiple regression to identify characteristics related to knowledge of pesticide safety.

Participants in the Survey

The interviews were carried out with 188 respondents at 17 farms from Aug. 21 to Sept. 30, 1995. We excluded camp residents under the age of 18 years; the average age of participants was about 32 years of age (Table 1). The proportion of Latinos was 99.5%; 79.8% of participants chose to answer the questionnaire in Spanish. Regarding household composition, 70.2% were living with family members, and the 30.3% of participants who were women all lived with family members.

Nearly all participants considered working by hand in the fields their main job (92.6%). The proportion of pesticide handlers (those who worked mixing or applying pesticides or cleaning equipment used in pesticide application) was 17.6%. We excluded them from most of our analyses because they are required to earn a license by passing a test based on more complex information on pesticide safety than is the focus of this study. Manual agricultural laborers are required to have less specialized pesticide safety training.

Laborers who had worked at the same farm the previous year were 62.2% of participants; the average number of years spent working on farms in Michigan was 5.5 years. Of all participants, 75% had worked in agriculture in 30 other states during the previous year, most often Florida (35.1%) and Texas (23.9%). These patterns relate to the two main "streams" of migrant agricultural workers who come to Michigan: one, with workers wintering mainly in Florida and the other, mainly in Texas. Camp residents who did not leave the state for agricultural work during the previous year accounted for 25% of all participants in the survey; while 35.7% had at least one non-agricultural job in the last year.

Table 2 shows the characteristics of members of the four branches of the "migrant stream" that reaches Michigan: Florida-Michigan, Mexico-Michigan, within Michigan, and Texas-Michigan. This is a rough classification based on asking what places the worker called home. In most cases, we think the worker was returning to the place designated as home annually but not necessarily spending much time there.

Table 1. Description of people drawn in the sample (N = 188)

Characteristic	*Mean + s.d., or [median] and (range) or percentage*
Age (years)	31.7 + 10.5 (18 to 64)
Gender	69.7% men 30.3% women
Education	
Grades completed, those who attended school in:	
United States	9.6 + 3.0
Mexico	5.6 + 3.0
All participants	6.4 + 3.8 *(0-Jr. year in college)*
Where educated[1]	
United States	29.2%
Florida	4.3%
Michigan	3.7%
Texas	20.2%
Mexico	62.2%
Place considered to be home[2]	
Florida	16.5%
Michigan	13.8%
Texas	31.4%
Mexico	31.0%
Ethnicity, Latino	99.5%
Language of questionnaire chosen by participant:	
English	20.2%
Spanish	79.8%
Living with family members when interviewed	70.2%
Work experience in farming	
Working by hand in the fields is main job	92.6%
Pesticide handlers	17.6%
Worked at the current farm previously	62.2%
Number of years worked on Michigan farm	5.5 [4] (0 to 35)
Percent who had worked:	
0 years (it was their first year)	6.9%
1 to 6	62.9%
7 to 35	30.2%
Total	***100.0%***
Farm work in other states:	
Farm work outside Michigan	75.0%
In California	9.6%
In Florida	35.1%
In Texas	23.9%
Total number of states besides Michigan	30 *(0-7 states per worker)*
Work other than farm work, previous year	35.7% *(69/188, 7/9/97)*
Trained in pesticide safety	71%

1 Responses total more than 100% because some attended school in Mexico and the U.S.

2 Responses total more than 100% because 2% mentioned two places as home.

Assessment and Analysis of Knowledge of Pesticide Safety

Most farmworkers had at least some knowledge of pesticides and how exposure can occur in routine field work (Table 3, Questions 1 and 2). They reported nearly universally that they engaged in washing when working in areas where pesticides had been applied. Nearly all reported washing hands before eating, wearing freshly laundered clothes to work, and washing work clothes separately from other clothing (91.3%-98.0%). Fewer reported washing hands before using the toilet (72.7%) and some participants laughed when asked this question, unaware that the skin of reproductive organs is more absorbent of pesticides than skin on much of the rest of the body. Training would be more effective if this point were emphasized.

One reason for the positive responses to washing questions is that Mexican Americans in the migrant stream highly value cleanliness. Pesticide safety training would have complemented all of their patterns of washing except for washing hands before using the toilet. In ethnographic observations, we found that workers always showered and changed clothes at the end of the work day, even in camps with few showers per capita and insufficient hot water. We also know, however, that workers could not always change their work pants from one day to the next because they lacked sufficient clothing and they also tended to eat in the fields without washing their hands for lack of washing facilities. Practical constraints thus interfered with workers' ability to wash as they preferred. Responses to the questions on washing did not always reflect this kind of interference. Therefore the answers tend to overestimate the amount of washing and changing clothes actually done by workers.

A number of farmworkers reported having been exposed to pesticides on the skin (19.4%) or in the eyes (4.5%) or through breathing (33.5%); none reported having swallowed pesticides (Table 3, Question 6 a, c, e and g). We later learned that swallowing pesticides is a widely known way of committing suicide; hence, the question should have been asked differently or perhaps, omitted from the survey. Interviewers asked those who had been

Table 2. Characteristics of Farmworkers in Different Parts of the Migrant Stream

	Mean ± s.d., [median] or percentage			
Characteristic	***Florida (n = 29)***	***Mexico (n = 44)***	***Michigan (n = 21)***	***Texas (n = 52)***
Age (years)	31.0 ± 10.9	28.8 ± 9.2	36.4 ± 11.0	34.2 ± 11.8
Gender				
men	31.0%	95.5%	47.6%	57.7%
women	69.0%	4.5%	52.2%	42.3%
Education				
(grades completed)	5.89 ± 4.1	5.6 ± 2.9	6.2 ± 4.0	7.9 ± 4.0
Language of Questionnaire Chosen by Participant				
English	20.7%	2.3%	14.3%	42.3%
Spanish	79.3%	97.7%	85.7%	57.7%
Living with family members when interviewed	89.7%	29.5%	85.7%	98.1%
Work				
Number of years had worked on farms in Michigan	5.5 [3]	2.8 [1]	6.7 [5]	8.0 [5]
Worked at the current farm in a previous year	51.7%	40.9%	90.5%	82.7%
Work experience in farming in other states, average number of states	1.4 [1]	1.8 [1]	0.7 [0]	1.0 [1]
Pesticide Experience, Training, & Knowledge				
Trained in pesticide safety	72.4%	70.5%	95.2%	78.8%
Exposed to pesticides	48.3%	54.5%	42.9%	23.1%
General knowledge	11.7 ± 2.3	11.6 ± 2.8	11.5 ± 3.5	11.2 ± 2.9

exposed what they did in response, and continued probing until no further answers were offered. The responses were scored by giving points for those that approximated EPA information. As shown in Table 3 (Number 6 b, d, and f), average scores were quite low, ranging from an average of only 0.35 on a 2-point question to 0.83 on a 4-point question. About one-third of the respondents had not been trained in pesticide safety when they responded to our questionnaire. Also, some of the exposures to pesticides could have occurred before pesticide safety training was a legal requirement. The lack of training and any pesticide exposure prior to training may partially explain the low scores on these questions. Nonetheless, the average scores on these questions were very low.

We pursued questions on responding to pesticide exposure with those who had been trained in pesticide safety. We asked them what they learned to do in response to accidents that involve getting pesticides on their skin or in their eyes, breathing, or swallowing pesticides. We scored the answers in the same way as the above questions. Compared with reports on what farmworkers in general had done when exposed to pesticides (Table 3, Question 6 b, d and f), averages on questions about what to do in case of pesticide accidents among trained farmworkers were considerably higher (Table 3, Question 7 a through d). Scores ranged from an average of 0.49 on a 4-point question to 1.37 on a 5-point question. Although these scores are higher than those on the previous survey questions, they still show serious inadequacies in dealing with pesticide accidents.

Table 3. Pesticide safety knowledge, Farmworkers *(N = 155)*

Characteristic	*Responses to Questions* mean ±s.d or %
Familiar with the term, "pesticide"	85.7%
Where can pesticides be found? *(% responding "yes")*	
On plants in the field	92.3%
In the soil	75.5%
On work clothes	81.9%
On work equipment	62.6%
When working in areas where pesticides have been applied	
I often or always:	
wash hands before eating	91.3%
wear freshly laundered clothes to work	98.0%
wash work clothes separately from other clothes	94.0%
wash hands before going to the toilet	72.7%
# of Known Symptoms Known that indicate pesticide poisoning	***1.9 ± 1.4***
*Most listed symptoms**	
Stomach problems	53.5%
Dizziness	32.3%
Headaches	31.6%
Skin irritation	25.2%
Pain	16.8%
Tiredness	9.7%
Trouble breathing	6.4%
Drooling	5.8%
Muscle pains	3.9%
Other (psychological changes, sweating, pupil changes, etc.)	14.2%
In general, how safe is it to work with pesticides?	
Very safe	5.2%
Somewhat safe	9.0%
Somewhat dangerous	36.8%
Very dangerous	38.7%
Don't know	10.3
Had been exposed to pesticides *(n=155 farm workers)*	***40.6%***
on the skin	19.4%
actions taken, ave. of 4 points possible	0.83 ± 0.65
in the eyes	4.5%
actions taken, average of 3 points possible	0.71 ± 0.49
had breathed them in	33.5%
actions taken, average of 2 points possible	0.35 ± 0.48
had swallowed them	0.0%
Among those trained, number of actions to take in case of exposure to pesticides *(n = 110)*	
if on his/her skin (5 points possible)	1.37 ± 0.70
if in his/her eyes (6 points possible)	1.16 ± 0.72
if breathed them in (4 points possible)	0.49 ± 0.55
if swallowed them (5 points possible)	0.57 ± 0.64

** percentage reflects people listing each symptom*

In summary, farmworkers' knowledge about pesticides is strongest regarding where they encountered pesticides in their work (Table 3, Question 2) and routine washing done when they worked where pesticides were applied. These two sets were constructed as closed-ended questions and thus tended to lead respondents to the answer contained in the EPA guidelines. Their knowledge is weakest in the area of actions to be taken in response to accidental exposure to pesticides. The questions on this topic were open-ended; hence, it is not surprising that the scores were lower.

Different Kinds of Knowledge of Pesticide Safety

Our analysis examines two different kinds of knowledge about pesticide safety and their pattern among farmworkers. The kinds of knowledge were (1) general knowledge (formed by questions asked to all participants) and (2) knowledge about dealing with pesticide accidents (questions asked only to those who received some kind of training). We constructed composite variables to measure each kind of knowledge by scoring responses to questions that were grouped for each variable and scored them as shown in Table 4. Next, we examined the relationships of these variables to characteristics of farmworkers to see how knowledge is patterned and to explore how it is created and consolidated.

General Knowledge of Pesticide Safety

We defined "general knowledge of pesticide safety" to include information from questions asked to all participants. The information included responses to Questions 1 through 5 in Table 3 (under A). For example, if someone responded "yes" to the question, "Where can you come in contact with pesticides? …in the soil?" (Question A2, Table 4), a point was added to his or her score for general knowledge of pesticide safety. If the person responded "no" or "I don't know," no points were added. The total number of points for the variable, general knowledge of pesticide safety, was 24; scores of survey participants had an average of 11.5 with a range from 3 to 17 points (Table 5, Number 1).

We examined general knowledge of pesticide safety in relation to the amount of training given to residents of farm labor camps. We grouped labor camp residents into three categories, (1) farmworkers without training, (2) those with training, and (3) pesticide handlers. To qualify as a pesticide handler, a worker is required to obtain a license that depends on passing a pesticide safety test administered by the state. As we had expected that most handlers would be farmers or other permanent Michigan residents, we were surprised to find as many as 33 handlers among the 188 farm labor camp residents. To maintain good rapport, we did not ask to see the licenses of pesticide handlers, and therefore do not know how many were government-licensed pesticide handlers.

Table 4. Construction of the Variables Measuring Knowledge of Pesticides

Variables & Survey Questions	*Possible Points*
General Knowledge of Pesticide Safety	
Are you familiar with the term "pesticide"?	
"Yes" =	*1 point*
Where can you come into contact with pesticides: On plants in the field? In the soil? Harvesting fruits and vegetables? In irrigation water? On work clothes? On work equipment?	
6 questions, each "yes" = 1 point)	*6 points*
Which of the following do you do when working where pesticides have been applied?	
4 questions, each "often" or "always" = 1 point	*4 points*
What are the symptoms of pesticide poisoning?	
12 possible, each "yes" = 1 point	*12 points*
In general, how safe is it to work with pesticides?	
"somewhat dangerous" or "very dangerous" =	*1 point*
TOTAL POSSIBLE	***24 POINTS***
Knowledge about dealing with pesticide accidents What did the training recommend you do if you: Get pesticides on your skin	
5 Actions taught, each one mentioned = 1 point	*5 points*
Get pesticides in your eyes	
6 actions taught, each one mentioned = 1 point	*6 points*
Breathe in pesticides	
4 actions taught, each one mentioned = 1 poin)	*4 points*
Swallow them	
5 actions taught, each one mentioned = 1 point	*5 points*
TOTAL POSSIBLE	***20 POINTS***

Table 5. Composite Variables on Knowledge About Pesticide Safety

Composite Variables	*N, Farmworkers*	*Distribution of Responses to questionnaire items mean ± s.d.*
Variables dealing with knowledge and experience in pesticide safety		
General knowledge of pesticide safety among farm workers (of 24 points total)	**155**	**11.5 + 2.8**
Knowledge about dealing with pesticide accidents among trained workers (of 20 points total)		
Trained farm workers	***110***	***3.6 + 1.6***
Pesticide handlers	***31***	***3.5 + 1.6***

We examined levels of general knowledge in relation to the amount of training workers had been given in a one-way analysis of variance (Table 6). As we hypothesized, untrained farmworkers knew the least about pesticide safety. Trained farmworkers knew more while pesticide handlers knew the most ($F = 9.66$; $p = 0.000$). Our findings indicate that current training programs, especially the training of pesticide handlers, are effective in informing workers of pesticide safety.

Characteristics of Farmworkers in Relation to General Knowledge

Since the focus of our study was pesticide knowledge of farmworkers, we exclude pesticide handlers from the remaining analyses. Among farmworkers, we identified six characteristics significantly related to different levels of general knowledge of pesticide safety (Table 7). First, those who had worked in Florida during the previous year had a higher level of knowledge. Second, in contrast, people who had done farm work only in Michigan had a lower level of pesticide safety knowledge.

Third, having attended school in Mexico rather than the U.S. was related to possessing greater knowledge. Fourth, those who chose Spanish to answer the questionnaire had more knowledge. Fifth, those who had been exposed to pesticides had greater general knowledge of pesticide safety, and finally, those farmworkers who had received some

Table 6. Level of Training & Amount of General Knowledge about Pesticide Safety, All Survey Participants, Analysis of Variance

		General Knowledge of Pesticide Safety	
	N	***mean ± s.d.***	***Range***
Untrained Farmworkers	45	10.4 ± 3.3	(3-16)
Trained Farmworkers	110	11.9 ± 2.4	(4-17)
Pesticide Handlers	33	13.0 ± 2.3*	(9-18)
TOTAL	**188**	**11.8 ± 2.8**	**(3-18)**

***In a one-way analysis of variance, the F = 9.66; Significante = 0.00**

Table 7. General Knowledge about Pesticide Safety & Characteristics of Farmworkers, Analysis of Variance

	General Knowledge of Pesticide Safety (N =155)		
Characteristic	***N***	***mean ± s.d.***	***Range***
*Has worked on farms in Florida in the last year?**			
No	95	11.1 ± 3.0	(3-16)
Yes	60	12.1 ± 2.4	(7-17)
*Has done farm work only in Michigan***			
No	120	11.8 ± 2.5	(3-17)
Yes	35	10.4 ± 3.3	(4-16)
*Attended school in Mexico**			
No	61	10.9 ± 2.9	(3-16)
Yes	94	11.9 ± 2.6	(4-17)
*Language of questionnaire****			
English	32	9.8 ± 3.3	(3-16)
Spanish	123	11.9 ± 2.5	(4-17)
*Exposed to pesticides**			
No	92	11.1 ± 2.7	(4-16)
Yes	63	12.1 ± 2.8	(3-17)
*Trained Farmworkers***			
No	45	10.5 ± 3.1	(3-16)
Yes	110	11.9 ± 2.6	(4-17)
Trained Farmworkers only (N = 110) Exposed to pesticides (n.s.)			
No	65	11.7 ± 2.5	(4-16
Yes	45	12.4 ± 2.2	(4-17)

Differences are statistically significant at the following levels:
n.s. difference not statistically significant

**0.01 < p ≤ 0.05*
***0.0001 < p ≤ 0.01*
****p ≤ 0.0001*

kind of training knew more about pesticide safety than those who were not trained. These findings indicate that some workers were specialists in migrant agricultural work in the sense that they worked year-round on farms and migrated in order to do so. Those who had attended school in Mexico had Spanish as a first language and many may have lacked sufficient fluency in English to secure jobs outside agriculture.

The relationship between exposure to pesticides and knowledge of pesticide safety is complex. Our results show that those who had been exposed also had more knowledge of pesticide safety. Their experience may have motivated them to learn more about pesticide safety when the occasion for doing so arose. On the other hand, exposure to pesticides increases with more time spent working in the fields. Thus, exposure may be unrelated to any cause of the accumulation of general knowledge about pesticide safety. In summary, it is clear that greater experience in agricultural work was linked to more extensive knowledge of pesticide safety. Nevertheless, training seems to have evened out the discrepancy in knowledge between those who had been exposed to pesticides and those who had not (Table 7). This finding suggests training in pesticide safety increased knowledge and ended the significant difference between workers who had been exposed to pesticides and the rest of the sample.

We infer that those remained in farm work seem to be part of a large Spanish-speaking network sharing information of various kinds about farm work, including concepts about working with pesticides. Dependency on Spanish may be an advantage in gaining pesticide knowledge and dependency on English may be an impediment.

Table 8 shows the results of a regression analysis of farmworkers' characteristics in regard to general knowledge of pesticide safety as the dependent variable. The results are consistent with those of the analyses of variance, although they do not contain the same detail. Spanish as the preferred language for the questionnaire was the first variable to enter the stepwise regression, followed by pesticide safety training and, finally, exposure to pesticides.

The three variables were the only ones to enter the equation.

These results imply that information passed among Spanish speaking farmworkers is an important source of pesticide safety information. The high percentage of questionnaires answered in Spanish is consistent with our observations of residents of migrant camps in this part of Michigan during the last decade. Most adults are monolingual in Spanish or have considerable difficulty with English. It thus appears that the migrant stream includes a core of workers whose employment is restricted to agricultural work, partly because of their reliance on Spanish, and that these experienced workers have greater knowledge than others partly because of their familiarity with agricultural work.

Dealing with Pesticide Accidents

Of the 155 farmworkers who participated in this survey, 110 had had training in pesticide safety. To measure knowledge that came from training, we constructed a composite variable reflecting knowledge about dealing with pesticide accidents. The variable included questions that began, "If you have received any pesticide training, what did the training recommend you do if you get pesticides on your skin [in your eyes, breathed them in, swallowed them]?" Responses that resembled instructions published by EPA (1993) each earned one point, and other responses received no points (Table 4).

The farmworkers' characteristics that related to significantly greater knowledge about accidents included: having worked at the same farm the previous year, having worked outside of the agricultural sector in the previous year, living with family members at the time of the survey, and having Texas or the United States as home (Table 9). These findings suggest that workers who knew more about dealing with accidents were different from those with greater general knowledge. Specifically, those who had greater knowledge about dealing with pesticide accidents belonged to the Texas-Michigan migrant stream. They were not solely dependent on employment in agriculture and they also included a very high proportion (71%) of people who call the United States their home.

The workers with Texas as a home state tended to have been educated in Texas. Previous experience in the U.S. educational system may have given Texas-Michigan migrant workers a basis for learning more from training about pesticide safety, as the training probably drew from educational approaches generally used in the United States. Regarding language proficiency, it is possible that fully bilingual workers benefited both from instruction in English and from information diffused through the network of Spanish-speaking migrant workers; however, our survey was not designed to explore this question. In Michigan, many workers are trained by the farmers who employ them (for example, through showing a Spanish-language video on pesticide safety); most Michigan farmers speak little Spanish, however, leaving little possibility for answering questions or discussing safety with most migrant workers.

Table 8. Farmworkers' Characteristics Related to General Knowledge of Pesticide Safety, regression

Variables	*B ± s.e.*	*Beta*	*T*	*Sig T*
Language of Questionnaire *Spanish (+)*	0.399 ± 0.133	0.234	3.007	0.003
Received Training	1.330 ± 0.467	0.219	2.847	0.005
Exposures to Pesticides	0.607 ± 0.269	0.173	2.260	0.025
Constant	8.193 ± 0.734		11.160	0.000

Multiple r = 0.404; r square = 0.163; adjusted r squar = 0.146; F = 9.471; signif. = 0.000

Table 9. Trained Farmworkers' Knowledge about Dealing with Pesticide Accidents, analysis of variance

Knowledge of Training (N = 110)		
Characteristic	***N***	***Mean ± s.d.***
*Worked at the current Farm last year**		
No	40	3.1 ± 1.6
Yes	70	3.9 ± 1.6
*Number of jobs outside farm work in the past year***		
None	72	3.2 ± 1.4
One	32	4.3 ± 1.9
Two	5	4.6 ± 1.1
*Living with family**		
No	27	3.0 ± 1.5
Yes	83	3.8 ± 1.7
Home country is United States		
No	32	3.0 ± 1.4
Yes	78	3.8 ± 1.7
*Home state is Texas***		
No	71	3.3 ± 1.5
Yes	39	4.1 ± 1.8

n.s. results not statistically significant

**** 0.01 < p ≤ 0.05***

***** 0.0001 < p ≤ 0.01***

Discussions and Conclusions

This study assessed and analyzed different kinds of knowledge possessed by farmworkers about pesticide safety. Those who knew most about pesticide safety tended to rely more on Spanish and to be more dependent on the agricultural sector for employment. It makes sense that their greater knowledge about pesticide safety would be related to greater knowledge about farm work in general, which would result from their specialization in that sector. Among farmworkers in general, those in the Florida-Michigan migrant stream knew more. Again, we expect that if specialization in farm work were related to greater knowledge about pesticide safety, those who migrate interstate to work on farms would know more than those who either stay in Michigan, where most farm work stops for the winter, or winter in Texas, where there is little farm work available.

The experience of having been exposed to pesticides was related to greater knowledge about pesticide safety and may have been responsible for motivating farmworkers to learn more about pesticides. This finding suggests knowledge on the level of "practical consciousness" that is part of a specialization in field work, involving knowledge and skill not often recognized in the society at large. This type of knowledge is picked up as part of life in the fields rather than being taught in a formal setting. Several findings in this study suggest that this "practical knowledge" may be an important basis of knowledge about pesticide safety for farmworkers. In addition to having theoretical importance in regard to concepts of different types of knowledge, social networks, and ethnic enclaves, the base of practical knowledge may be worth considering in designing and refining pesticide education programs.

Training in pesticide safety has removed some differences in levels of knowledge. On the other hand, training has benefited workers in the Texas-Michigan migrant stream more than others. Whether this finding results from different kinds of workers belonging to different migrant streams or different kinds of training given to them cannot be established from our data (although we know that the Texas Employment Commission tried to train the agricultural work force in the state).

It is striking that, in general, farmworkers who prefer to communicate in Spanish have greater knowledge of pesticide safety than do other workers. In this analysis, we have attributed the difference to a linking of choice of Spanish with employment only in the agricultural sector; that is, we have attributed the gaining of greater knowledge about pesticide safety to longer and more intense experience in agricultural work. The finding suggests that, in the migrant streams reaching Michigan, there are different kinds of workers. Those migrating to Florida and depending on Spanish may be virtually locked into agricultural work, which would have the consequence of low wages and poor living conditions, while also exposing workers to more information about pesticide safety.

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