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Latino Migrant Farmworkers in Lowcountry South Carolina: A Demographic Profile and an Examination of Pesticide Risk Perception and Protection in Two Pilot Case Studies

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Migrant and seasonal farmworkers face greater exposure to chemicals applied during the growing, harvesting, transporting, and processing of food than other consumers of produce in the United States since they work directly with agricultural toxins and report difficulty accessing health care and other basic needs. Little is known regarding the life opportunities and challenges faced by the contemporary community of migrant farmworkers in the geographic region of lowcountry South Carolina. This paper, which analyzes two interlocking pilot studies, makes a nascent attempt to fill this knowledge gap by presenting descriptive data that summarizes the unique circumstances faced by lowcountry migrant farmworkers due to cultural, language, transportation, education, healthcare, income, and other demographic characteristics. Our findings also support existing evidence that indicates, first, that migrant farmworkers are not receiving adequate pesticide safety training and, second, that even when they do receive training these programs do not necessarily increase protective measures and behaviors. Finally, we conclude by suggesting that future research be conducted to investigate whether the unique combination of socioeconomic and cultural characteristics of migrant farmworkers may be contributing to the lack of effectiveness of current pesticide training and education programs.

Key words: Latino migrant labor, farmworker health, pesticide safety, South Carolina, risk perception

Introduction

The literature on risk perception and management has increasingly pointed to the need for the incorporation psychological, social, economic, and political variables into governmental decision making regarding the determination of allowable risk, the management of risk, and the design and implementation of training and education policies and programs for the use of protective behaviors and equipment (e.g., Acosta et al. 2005; Johnson and Chess 2003; Lichtenberg and Zimmerman 1999; Peters, Covello, and McCallum 1997; Satterfield, Mertz, and Slovic 2004; Vaughan 1993a, 1993b, 1995a, 1995b; Vaughan and Nordenstam 1991). Our paper contributes to this literature by describing the key demographic characteristics, pesticide risk perceptions, levels of risk training and knowledge, and risk protection behaviors of a largely unstudied community of migrant farmworkers in the geographically unique region of lowcountry South Carolina. It is our hope that identification of the demographic characteristics, such as the socioeconomic status, of this population will aid policy makers and agricultural outreach workers in both setting risk policy and creating risk abatement programs that achieve measurable outcomes. In addition, we contribute to the literature on risk perception by reporting our finding that there is no measurable connection between receipt of training and education and consequent protective behaviors among our sample of migrant farmworkers. We begin the paper with a history of pesticide use in the United States, an examination of pesticide risks with a focus on migrant farmworkers, and a summary of the current subset of environmental risk literature on farmworker risk perceptions and behaviors. In the remainder of the paper we describe the geographic, agricultural, and occupational context of our two cases, present an analysis of our findings, and discuss the implications of our results.

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Pesticides and Occupational Risks for Migrant Farmworkers

Advancements in science and technology, most notably the development and use of many agricultural chemicals, massively changed the character of US agriculture in the middle and later half of the 20th century. Pesticide use has grown substantially since the 1930s and continues to grow at a steady rate. Pesticide utilization mushroomed from one-half billion pounds in the 1930s to 1.5 billion pounds in the 1970s (Aspelin 2003). Homeowners apply almost 10 times more pesticide per hectare than farmers, but at least 60 percent of all pesticide products are applied to agricultural lands (Abrams, Hogan, and Maibach 1991; Bormann, Balmori, and Geballe 1993; Kolpin et al. 2002). Pesticide use continues to grow at a phenomenal rate into the 21st century; by 2002 (the most recent data available to the public) more than 2 billion pounds of pesticides were applied in the United States (US Environmental Protection Agency 2002a). Though these changes have led to measurable increases in crop yields as well as lower prices for consumers, it is often at the cost of farmworker health and safety (McCurdy et al 2003; Variyam and Mishra 2005; Villarejo and Baron 1999).

Agriculture is one of the top three hazardous occupations in the United States (Meyers and Hard 1995; National Institute of Occupational Safety and Health 2005) and continues to hold the second highest fatality rate (National Safety Council 2004; Meyers et al 1997; Schenker 1996). The actual numbers of fatalities and injuries are difficult to assess and many researchers warn that both fatal and nonfatal injuries and symptoms are underreported (Alavanaja et al 1996; Calvert et al 2004).

In addition to working with dangerous machinery and equipment, agricultural workers are also exposed to a wide array of potentially hazardous chemicals which include pesticides (insecticides, herbicides, fungicides, rodenticides, and fumigants), fuels, fertilizers, and ripening agents (Abrams, Hogan, and Maibach 1990; Arcury and Quandt 1998; Blair and Zahm 1991; McCurdy et al. 2003; Moses 1989; Savitz et al.1997; Sharpe, Franco, and de Camargo 1995; Zahm and Blair 1993; Zahm, Ward, and Blair 1997; Blondell 1997; Fera et al. 1998; Kristensen, Anderson, and Irgens 1996). Current estimates indicate that the annual rate of pesticide-related illnesses in the US runs at 18 cases per 100 workers (Calvert et al. 2004). However, poor access to healthcare and other poverty-related factors among farmworkers, the long latency period of poisonings, the migratory nature of much farmwork, the misdiagnosis of symptoms, the confounding effect of genetics and other health factors such as smoking, lack of data utilizing biomarkers and biological monitoring, and wide variations of farmworker exposure levels due to different types of farming, seasons, and geographies create barriers to obtaining an accurate picture of illness rates (Cieseilski, Hall, and Sweeney 1991; Frank et al 2004; Jeyaratnam 1990; London et al. 2002; Moses et al. 1993; Variyam and Mishra 2005).

Though illness rates are difficult to measure, the weight of the evidence points to a consistent relationship between exposure to pesticides and symptom prevalence (Kamel and Hoppin 2004). Some of these symptoms include cancer, birth defects, reproductive dysfunctions, neuropsychological and behavioral problems, mood disturbances, cognitive dysfunction, neuromuscular problems, skin sensitization, respiratory disease, and abnormalities in liver and kidney organ functioning (Alavanja et al 2004; Alavanja, Hoppin and Kamel 2004; Alavanja et al 1996; Anger et al. 2000; Blair and Zahm 1995; Calvert et al 1998; Cole et al. 1997; Farahat et al. 2003; Fenske and Simcox 1995; Fera et al. 1998; Gary et al 1996; Gomes et al. 1998; Hayes and Laws 1991; Kamel et al. 2003; Kamel and Hoppin 2004; Keifer and Mahurin 1997; Kristensen, Anderson, and Irgens 1996; London and Myers 1998; Ohayo-Mitoko et al. 2000; Rohlman et al., 2001; Sharpe, Franco, and de Camargo 1995; Sprince et al 2000; van Wendel de Joode et al. 2001).

Growers and their families, farmworkers and their families, and residents living near farms are all exposed to the chemical byproducts of modern agriculture, but it is the farmworkers who work directly in the fields that face the greatest exposure. In 1996, the National Institute for Occupational Safety and Health (NIOSH) identified farming as one of the ten most stressful occupations and identified several groups of workers (including racial and ethnic minorities and migrant and seasonal farmworkers) as being at highest risk to occupational dangers due to factors such as socioeconomic status and biological characteristics. Since that time, a number of studies have identified migrant and seasonal farmworkers as a special population of agricultural workers that, due to barriers produced by poverty; and social, geographic, and cultural isolation, face especially unique challenges in perceiving and protecting themselves from risks (for a few examples see Arcury et al 2001; Arcury et al. 2002; Ciesielski, Hall, and Sweeney 1991; Dirksen 1997; Frank et al. 2004; Griffith and Kissam, et al. 1995; Hansen and Donohoe, 2003; Hooks et al. 1996; Kilty and Vidal de Haymes, 2000; McCauley et al. 2001; Moses et al. 1993; Rust 1990; Slesinger 1992; Villarejo and Baron 1999; Villarejo 2003). Though this paper is focused on the experiences of migrant and seasonal farmworkers, several other populations of farmworkers also face especially difficult work-related challenges (persons with disabilities, women, African Americans, children, and older farmworkers) (for a summary of the literature on these populations see Frank et al 2004).

Language is one of the most obvious barriers for the farmworking population of which 81 percent are estimated to be foreign born (95 percent of all non-native farmworkers are Mexican born) (USDOL 2000a, USDOL 2000b). Research also points to the lack of transportation, severe poverty, lack of adequate health care, pressure to work quickly, lack of documented status, and fear of reprisal as key factors that put migrant and seasonal farmworkers at greater risk (Moses et al. 1993; Rust 1990; Salazar et al, 2004). For example, the USDOL estimates that of all foreign-born farmworkers in the

United States, 53 percent did not have legal documentation for their immigrant status (USDOL 2000a, USDOL 2000b).

Risk Perceptions, Training and Education, and Use of Protective Behaviors

The reluctance of undocumented workers to speak with government officials and other outsiders, the sporadic availability of seasonal agricultural work, and changing patterns in migration make it difficult to document pesticide exposure and, therefore, to address the needs of the migrant farmworker population. Despite these challenges, a number of studies and governmental policies and programs have begun to address the question of how to decrease the risks associated with chemicals and other toxins in the agricultural workplace.

The Environmental Protection Agency (US EPA 2002a) and the Occupational Safety and Health Administration (US DOL OSHA 1987) regulate pesticide production and application, and both mandate the training and education of workers to mitigate the hazards of occupational exposure to pesticides. The Worker Protection Standard (WPS) is the principle piece of legislation aimed at reducing the risk of pesticide poisonings and injuries among agricultural workers and pesticide handlers (revised by the US EPA in 1992). The WPS contains requirements for pesticide safety training, notification of pesticide applications, use of personal protective equipment, restricted entry intervals following pesticide application, decontamination of supplies, and emergency medical assistance (US EPA 2002b).

While WPS and OSHA training may have increased farmer and farmworker awareness of risks and preventative behaviors (Rao et al. 2004), a number of assessments of the WPS training indicate that it has largely been ineffective in protecting agricultural laborers (Arcury et al. 1999; Larson 2000; Murphey-Greene and Leip 2002). Several studies of the WPS, OSHA, and other training programs reveal that the majority of farmworkers have not been trained, and those that have received formal training often found the training ineffective due to language barriers and brevity of training (Arcury et al. 1999; Larson 2000; Murphey-Greene and Leip 2002).

A number of researchers have similarly documented the low levels of training among farmworkers and have called for more national, state, and regional efforts and programs geared to the training and education needs of this worker population (Arcury et al.1999; Larson 2000; Murphey-Greene and Leip 2002, Vaughan 1993a; USDOL 2000a; USDOL 2000b). Some researchers have bolstered the call for increased training and education by documenting a positive correlation between training and use of protective behaviors among farmworkers. Elaine Vaughan (1993a) found in her study on agricultural work in California that use of self-protective equipment was related to self-reports of having received information about pesticides. A more recent study conducted in North Carolina supported Vaughan's conclusion and reported a significant difference in frequency of use of self-protective methods by whether training was received during the season (Arcury et al. 1999).

Recent literature also suggests that while increased training opportunities would be desirable, they are not sufficient for ensuring increased use of protective behaviors. For instance, while the Vaughan study cited above did show that self-protective behaviors were positively related to the receipt of risk information, her study also showed that those workers who reported greater feelings of control over the work situation had a higher incidence of protective behaviors.

Several studies go further to suggest that even when farmworkers do possess knowledge about agricultural toxins and safe work practices, they are often reluctant to utilize precautionary behaviors and gear. For instance, Lantz and others (1994) conducted a peer group discussion with Latino farmworkers and found that the participants possessed an understanding of the poisonous and sometimes cancer causing properties of pesticides. Regardless, the participants indicated that the need to work was more overwhelming than the need to prevent against sickness. In addition, they indicated that other barriers prevented them from protecting themselves (cost of protective clothing, fear of losing their jobs if they requested the clothing, and so on) (Arcury et al. 2005).

These studies on the impact of the social context on the use protective behaviors among farmworkers draws on a growing literature which examines the relationship between socio-economic conditions and patterns of risk perception, evaluation, communication and mitigation (Brownson et al 1992; Calnan 1989; Peters, Covello and McCallum, 1997; Satterfield, Mertz, and Slovic 2004; Snyder 2004; Vacha and McLaughlin 2004; Vaughan 1993a; Vaughan 1995a, 1995b; Wardle et al 2004). Several studies suggest that socioeconomic conditions and cultural beliefs act to filter how individuals experience, make sense of, and respond to repeated or long-term exposure to dangers (Douglas and Wildavsky 1982; Gerber and Neeley 2005; Sandman 1993; Slovic 1987; Taylor 1989). For instance, Peterson and Stunkard found that low socioeconomic status may lead individuals to perceive occupational risk as involuntary (1989) and therefore out of their control.

A subset of this risk literature examines the impact of socioeconomic factors (along with other factors) on individual and/or communities' experience of locus of control and the relationship of that sense of control to positive behaviors (like risk reduction). This literature documents that one's belief that they can influence a situation is positively related with acting to protect against risk (Green, 2004; Peterson and Stunkard 1989; Wardel et al. 2004). One explanation for investigations that find a weak or no connection between training/education and use of protective behaviors is that a perceived lack of control over work and living conditions contributes to low engagement in protective behaviors (regardless of knowledge about risks and protective behaviors) (Baer and Penzell 1993; Grieshop, Stiles, and Villanueva 1996; Arcury et al. 1998; Arcury and Quandt 1998; Arcury 1995, 1997; Harthorn 1998; Kidd et al. 1997; Perry and Bloom 1998; Thu 1998; Vaughan 1993a, 1993b, 1995a, 1995b).

In other words, "...farmworkers must perceive that they have sufficient control of the work environment to use the safety information" (Arcury and Quandt 1998: 333). In one attempt at explaining the connection between feelings of control and lack of engagement in protective behavior, Vaughan found that low socioeconomic status leads people to deny risk due to the belief that they have no control over the risk or fear that exposing the risk could threaten other resources like job status (Vaughan 1993b). In another attempt at explaining this phenomenon, Grieshop et al (1996) found that *farmworkers* tended to place control over workplace safety outside of themselves (i.e., in God, luck, or supervisors). In contrast, *farmers*, or growers, emphasized their own personal control over safety and therefore made plans to stay safe rather than simply accept danger (Vaughn 1993b). The explanations may be varied, but the literature has fairly clearly established that risk perceptions or "intuitive risk judgments" are important in understanding the best mechanisms for providing risk information (Quandt et al 2004; Salazar et al. 2004; Slovic 1987: 280) and social factors, such as socioeconomic status, filter the way people perceive risks (cited above).

Descriptions of the Two Lowcountry South Carolina Pilot Cases

Our findings contribute to the risk literature (especially the study of farmworkers and pesticide risks) by supporting existing evidence that, first, migrant farmworkers are not receiving adequate pesticide safety training/education and, second, even when they do receive training, these programs do not necessarily increase protective measures and behaviors. Our paper also contributes to the overall study of migrant farm labor by documenting the unique circumstances faced by lowcountry migrant farmworkers due to cultural, language, transportation, education, healthcare, income, and other characteristics. While several studies have examined current demographic trends among farmworker communities in other regions (Massey et al. 1987 cited in Griffith and Kissam 1995; Mull et al. 2001), our pilot studies are the first to be conducted in lowcountry South Carolina.

The Two Pilot Case Studies

The following analysis is based on these two separate pilot studies (conducted in 2002/2003) with two sets of migrant and seasonal farmworkers in Charleston and Colleton Counties of lowcountry South Carolina. One of our pilot studies focused on healthcare access and status ("Healthcare Study"); the other, on perception of pesticide exposure risk ("Perception Study"). Since "pesticide" is a generic term that often refers to a wide range of chemicals that are utilized to eliminate or control plants and pests, we use this term broadly to refer to any of those chemicals. Both studies utilized standardized close-ended questionnaires conducted verbally, in Spanish.

The Healthcare Study (a standardized questionnaire of 19 items) identified the needs and common health problems of farmworkers within Charleston County and documented the existence of barriers that limit access to necessary medical services. Respondents in the Healthcare Study (N=33) worked on a variety of farms throughout Johns Island, Wadmalaw Island, Hollywood and Edisto Island, SC and were sampled based upon prevalence and availability of farmworkers during the study time-frame. Questionnaires were administered in community health centers, farmworker labor camps, or individual private residences. Data collection occurred over a period of two months in 2002 coinciding with the summer harvest season. The questionnaire administration lasted an average of 10 minutes. It contained closed-ended questions regarding demographics, health problems, desired services/information, and barriers to healthcare. Tables 1 and 3 present the findings from the Health Study. While the total number of respondents was 33; some individuals chose not to answer all questions (N is noted for each response).

Respondents in the Perception Study included 76 farmworkers from multiple sampling sites within two main agricultural counties (Colleton and Charleston) in coastal South Carolina (selection was based upon prevalence and availability of farmworkers during the time frame of the questionnaire). Questionnaires were administered in community health centers, farmworker labor camps or individual private residences. Data collection occurred over a period of two months coinciding with the spring planting season in 2003. Administration of the questionnaires lasted an average of 30 minutes. Tables 2, 4, and 5 present the findings from Perception Study. While the total number of respondents was 76; some individuals chose not to answer all questions (N is noted for each response).

Respondents for both studies were selected using the snowball sampling technique—a non-randomized sample that is widely used in situations and field settings where respondents are difficult to locate (Berg, 2000). Access to initial participants was made possible by the fourth author's professional activity as an outreach worker for the migrant health program at a local community health center.

As noted above, the sample sizes of the Healthcare Study and Perception Study were 33 and 76 respectively. While this paper makes a useful contribution to the understanding of farmworker health needs and reports information about a population that has been difficult to study, due to the small sample sizes the results must be viewed as preliminary. Both studies have a low number of female respondents (Healthcare Study, N=12) (Perception Study, N=5). This is not surprising since national statistics indicate that 20 percent of migrant or seasonal farmworkers are women and 80 percent are men in the US (USDOL 2000a, USDOL 2000b).

Note that in several instances the two pilot studies collected and reported similar variables, such as age, in a different manner. Therefore, when comparing similar variables from the two studies we sometimes must report the results in different forms (for instance, the Perception Study collapsed age in ranges while measures of central tendency were available from the Healthcare Study).

Geographic Region and Pilot Study Areas

The lowcountry of South Carolina is depicted in Map 1. This region is characterized by its low-lying areas where much of the land topography is at or just above or below sea level. As illustrated by Map 1, fieldwork for this study was conducted in two of the eight coastal counties in South Carolina. Our migrant or seasonal farmworker respondents are not likely to be included in the census data reported; however, we include the most recent census information (2000) on the Hispanic (census term that includes Latino) population for comparison sake.

Based on 2000 census information, there are close to 100,000 Hispanic individuals living in South Carolina, which has a population of approximately four million individuals; 2.4 percent of the total population is Hispanic. Further, there are 7434 Hispanic individuals (4182 are Mexican) living in Charleston County (total Charleston County population is 309,969) and 551 Hispanic persons (348 are Mexican) living in Colleton County (total Colleton County population is 38,264) (US Census 2000). Our sample population may or may not be within the US Census-based population data due to the inherent difficulties in tracking migratory populations.

According to sources *other* than the US census, Charleston County has the second highest number of migrant and seasonal farmworkers (1500 reported workers in the year 2000) in South Carolina (South Carolina Employment Security Commission 2002). Farmworkers in Charleston County work on numerous farms throughout Johns Island, Edisto Island, Wadmalaw Island and Hollywood. Each farm varies with respect to the size, owner, crops and associated crew leaders and housing camps. Colleton County was estimated to have a population of 300 workers in 2000 (SCES 2002), employed principally on one large family farm. Both counties, especially Colleton, are largely rural (US Census 2000) Please see Map 1.

The respondents in both studies are part of the Eastern stream of migrant farmworkers traveling through Florida on up to Maine for seasonal employment. The other two major streams are the West Coast and Midwest streams (with California and Florida housing almost half of all seasonal farmworkers) (USDOL 1993). While it is generally accepted in the social science literature that these were, historically, the three major streams, Griffith and Kissam (1995) point out that sociopolitical developments (i.e., changes in immigration policies) and technological developments (i.e., changes in cropping and land-use strategies) over the last three and a half decades have changed the demographic characteristics of the migrants themselves as well as their migrating patterns. For instance, the East Coast stream had long been a predominantly African American stream of migrants from Florida up to the Northeast. Now, as our pilot studies as well as numerous other studies show, the East Coast stream is made up primarily of Mexican farmworkers (Griffith and Kissam 1995).

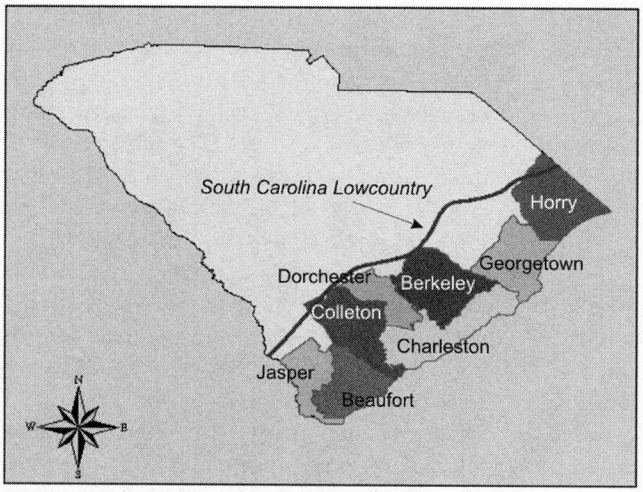
Agriculture and Farmwork Conditions in Lowcountry South Carolina

Tomatoes and the other crops worked by farm employees are significant contributors to the South Carolina economy (crop receipts were $770 million in 2000, and fresh tomatoes brought in over $20 million) (South Carolina Agricultural Statistics Service, 2001). The most common crops worked by the respondents were tomatoes (100 percent). Data on crops is only available from the Pesticide Study. However, informal discussions with farmworkers in the Healthcare study indicate that they work similar crops. Seventy-five of the sampled farmworkers in the Pesticide Study were involved with tomato production; one respondent did not answer questions about the crops they worked. Percentages reflect the responses of the 75 individuals who answered these questions. The next common crops worked were: peppers (68% or 51 respondents), cucumbers (61.3% or 46 respondents), tobacco (48% or 36 respondents) onions (41.3% or 31 respondents), sweet potatoes (38.7% or 29 respondents), squash (28% or 21 respondents), fruit trees (26.7% or 20 respondents), and berries (18.7% or 14 respondents). Most farmworkers were responsible for picking (96%) and packing (70%) the produce, while a limited number (12%) were responsible for the application of pesticides.

Given that all of our respondents (the 75 of 76 that answered our questions about crops) worked with tomatoes, a description of the cultivation and harvesting processes for this fruit provides a good model for understanding the average working conditions of a lowcountry farmworker (also see Sanders 2004). Plastic and stakes are the first and last stages of planting, and are completed in small crews of farmworkers. Some farmworkers pack, pick, and place plastic-stakes while others just pick or pack tomatoes. Once the soil has been prepared, a tractor makes rows where the tomato plants will go, and plastic is laid. Workers walk beside and behind the tractor, unraveling black plastic, and laying it over the beds. During this stage, soil fumigants are commonly added under the plastic. During the staking process, workers tie stakes around the young tomato plants. The tomatoes are then harvested by hand. Once the crops are completely harvested, workers return to fields to remove the stakes and save them for next year, then pull up the old plastic and burn it. According to the informal conversations with respondents, this is highly labor-intensive and is the least favorite task for farmworkers.

Stake removal and many other stages of cultivation and harvesting are most commonly paid by "piece-rate" (most workers in the Perception and Healthcare Studies worked on this system). For older workers, pregnant women, and so-called "lazy" individuals (according to farmers and crew-leaders), hourly rates of $5.15 are sometimes made available, and payment format is at the discretion of the farmer (Respondents, personal communication 2003). Most employed respondents in the Perception and Healthcare Studies earned less than $250.00 per week (earnings depended on their own

Map 1. South Carolina Lowcountry Case Areas



Source: Maps prepared using ESRI's ArcGIS 9.1 at the Santee Cooper GIS Laboratory, College of Charleston

Primary data sets acquired from:
ESRI Data & Maps (2000) CD #6 Southern United States Data. Redlands, CA, www.esri.com
ESRI Data & Maps (2002) CD #6 Southern United States Data. Redlands, CA, www.esri.com
ESRI Data & Maps (2005) CD #6 Southern United States Data. Redlands, CA, www.esri.com
U.S. Census Bureau, 2005. Homepage: http://www.census.gov
U.S. Department of Agriculture. National Agricultural Statistics Service, 2005. Homepage: http://www.nass.usda.gov/census/

Figure 1. The South Carolina Lowcountry and Coastal Counties

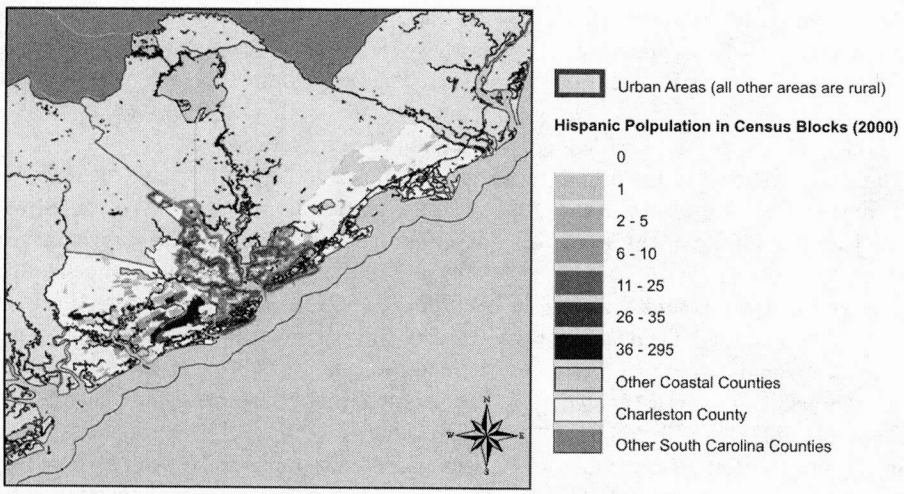


Figure 2. Charleston County Hispanic Population in Census Blocks

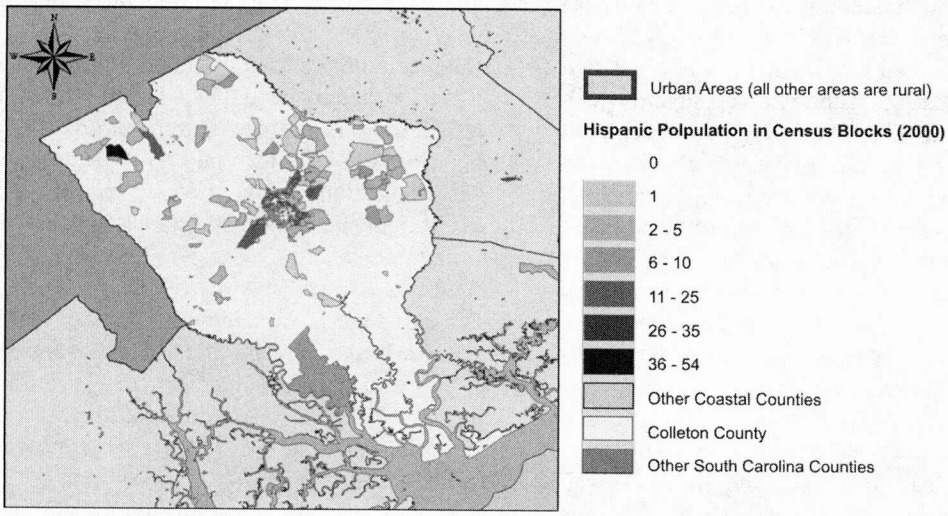


Figure 3. Colleton County Hispanic Population in Census Blocks

physical health and strength, and income was only available when work was available). These wages appear even more meager when it is understood that agricultural laborers often work 12-hour days (or more) (Lantz et al. 1994). In addition, the funds must be stretched for long periods of time as weather and crop conditions can lower the average number of hours worked a year. Simply put, farmworkers in our study labor hard and receive little compensation for their efforts.

Demographic Characteristics of the Lowcountry Migrant Farmworker Community

Our data reflect the findings of other recent scholarship on demographic trends in present-day migrant and seasonal farmworker populations (see Tables 1-2). According to our samples, the majority of the farmworkers in the lowcountry migrate with the crops (80 percent of respondents in the Perception Study reported migrating; in the Heathcare Study, respondents were not asked if they migrated, however 49 percent indicated that they use health services provided for migrating families). Both the Healthcare Study and the Perception Study show that this population of farmworkers is primarily Latino (all respondents who answered this question). The Perception study also indicates that the population is largely Mexican (99 percent). Numerous studies document the increasing Latino/Hispanic presence among the major migratory streams of farm laborers throughout the US (Arcury, Quandt, and Russell, 2002; Griffith and Kissam 1995; Mull et al 2001; Mehta et al. 2000; Quandt, Preisser and Arcury 2002). In addition, most respondents in the Healthcare Study (67.9%) indicated that their native language was Spanish, and 32.1 percent reported their native language to be indigenous (such as Misteco or Zapateco). Only 6.1 percent of the respondents in the Healthcare Study reported speaking or reading English. In the Perception Study, 23.7 percent indicated that they spoke "a little" English, and only 2.6 percent responded that "yes" they did speak English.

The migrant farmworker population tends to fall into two general types. One is made up of "... family units, which often travel as such and...the second group...is made up of young, single, males..." (Frank et al. 2004:28). A number of studies have recently documented that since the 1990s the second type of migrant population is becoming more dominant. The contemporary migrant streams of farmworkers are largely made up of men (e.g., Griffith and Kissam 1995; Mehta et al. 2004; USDOL 2000a; Villarejo and Barron 1999; Villarejo 2003), who are single (Griffith and Kissam 1995; USDA Economic Research Service 2000), and young (Griffith and Kissam 1995; Mehta et al 2000; Mull 2001; Samardick, Gabbard, and Lewis, 2000; Villarejo and Barron 1999; Villarejo 2003; USDA Economic Research Service 2000). As with the prevailing literature, our pilot studies show that the population is largely male, single, and young. Of the 33 migrant farmworkers sampled for the healthcare study, 21 (63.6%) were male and of the 75 farmworkers who responded for the Perception Study, 70 (93.3%) were male. The median age for

Table 1. Healthcare Study: Farmworker Demographic Profile

Characteristic	N*	Percent
Gender		
Male	21	63.6
Female	12	36.4
Marital Status	**33**	
Married	19	57.6
Single	14	42.4
Male	21	
Married	8	38.1
Single	13	61.9
Female	12	
Married	11	91.7
Single	1	8.3
Residing with Family	**33**	
Male	21	
Yes	10	47.6
No	11	52.4
Female	12	
Yes	12	100
No	0	0
Ethnicity	**33**	
Latino	33	100
Median Age		
Male	23 Years	
Female	23 Years	
Educational Attainment Level	**28**	
Elementary	13	46.4
Middle	9	32.1
High School	3	10.7
None	3	10.7
Limited English Proficiency		
Can you speak English?	**33**	
Yes	2	6.1
No	31	93.9
Can you read English?	**30**	
Yes	2	6.7
No	28	93.3
Native Language	**28**	
Spanish	19	67.9
Dialect (e.g., Zapateco)	9	32.1

* Total N is 33; however, some respondents did not answer all questions.

Table 2. Perception Study: Farmworker Demographic Profile

Characteristic	N*	Percent
Gender		
Male	70	93.3
Female	5	6.7
Marital Status	**75**	
Married	32	42.7
Single	40	53.3
Other (Separated or Widowed)	3	4.0
Ethnicity	**75**	
Latino	75	100
Age	**76**	
<21 years	22	28.9
21-25 years	21	27.6
26-30 years	13	17.1
>30 years	20	26.3
Education	**75**	
Elementary	36	48.0
Middle school	29	38.7
High school	6	8.0
No formal education	4	5.3
Limited English Proficiency		
(*Can you speak English?*)	**76**	
Yes	2	2.6
No	56	73.7
A Little	18	23.7
Native Language	**75**	
Spanish	40	53.3
Dialect (e.g., Nahualt)	35	46.7
Farmworker Status	**75**	
Presently Employed Farmworker	66	88
Family Member (Previous farmworker)	9	12
Years Employed in Agriculture	**74**	
< 1 Year	40	54.1
1-5 Years	25	33.8
6-10 Years	8	10.8
> 10 Years	1	1.4
Average Weekly Income	**76**	
<$100 or $100-149	2	2.6
$150-$199	26	34.2
$200-$250	37	48.7
>$250	11	14.5

* Total N is 76; however, some respondents did not answer all questions.

both male and female respondents in the Healthcare Study was 23 years and in the Perception Study most respondents (73.7%) reported that they were less than 31 years of age. In regards to marriage status, both studies showed that a large number of the respondents reported the status of single (42.4% for the Healthcare Study and 53.3% of the Perception Study). This is directly related to the increasing concentration of men in the migrant stream with male migrants much less likely to be married than female migrants. The Healthcare Study shows that while only 38.1 percent of men were married, 91.7 percent of women were married. Not only are the men more likely to be unmarried, but as Griffith and Kissam point out, they are also more likely to be "unaccompanied" by any family members (1995) (also see Mehta et al. 2000). In the Healthcare Study we found, likewise, that all of the women in the Healthcare Study (100%) and 47.6 percent of the men sampled were currently residing with a family member (i.e. spouse, children, parents, in-laws, etc.).

Note that one study on seasonal and migrant farmworkers working in several different states across the country found that the majority (56.7%) were female (Mull et al 2001). An explanation for this higher female presence may be that while the study surveyed both migrant and seasonal farmworkers, most of the respondents (61.5%) were seasonal. In addition, all of the respondents were members of the Association of Farmworker Opportunity Programs (AFOP). Many of the services of the AFOP require that the members be either permanent residents or hold US citizen status. The Mull study aside, it is well documented that the majority of the contemporary migrant farmworkers throughout the nation and the southeast are male.

Given the young age of most farmworkers, it is not surprising that a number of studies report low levels of agricultural experience for most currently working migrant and seasonal farmworkers. Mull et al found that the majority of the participants in their study had worked in agriculture for less than 10 years (2001). Our Perception Study shows an even lower level of agricultural experience among Low-country farmworkers; 54.1 percent indicated that they had been employed for less than a year as farmworkers. Griffith and Kissam (1995) provide one possible explanation for the large composition of the labor force that is made up of 'new to agriculture' workers, in their words: "Farmworkers experience extensive underemployment during the peak harvest seasons and seasonal unemployment, with consequent low annual incomes…underemployment serves to decrease farmworker attachment to the farm labor force and hastens the flight of more productive workers from farmwork. Thus, the farm labor market must be constantly replenished with new, usually foreign workers…" (244-255). Griffith and Kissam's documentation of the underemployment, unemployment, and generally low wages of migrant farmworkers is well documented throughout the literature (e.g., Gabbard et al 1994; Hansen and Donohoe 2003; Mehta et al. 2000) and government documents (e.g., NIOSH 2005) and is echoed in our findings of the work experiences of the lowcountry

population. As noted earlier, for example, the respondents in the Perception Study earned low wages, with most making less than $250.00 per week (earnings depended on their own physical health and strength, and income was only available when work was available). While income was not asked on the Healthcare Study survey, informal conversations with respondents indicate that they also made similar wages to those who participated in the Perception Study.

Finally, the education status of our sample falls in line with the low levels of attainment predicted by the literature (e.g., Mehta et al 2000; Vaughan 1995a, 1995b; USDA Economic Research Service 2000; USDOL 2000a). Approximately 78.6 percent of the Health Care respondents who answered our education question indicated that they had attained only a middle school or lower level of education (10.7 percent had been to high school and 10.7 percent had no schooling). While 86.7 percent of the Perception Study respondents who answered our education question indicated that they had completed middle school education or lower level of education (8 percent had been to high school and 5.3 percent had no schooling).

Health Care Needs Assessment

In addition to contributing to our understanding of the basic demographic characteristics of lowcountry farmworking population, the Healthcare Study specifically surveyed participants about their health experiences and needs (see Table 3).

Examination of the questionnaire results indicates that the majority of respondents had health problems and that there are several barriers for them to gain health services. This fits with previous literature that pinpoints significant and varied health problems experienced by farmworkers (Alavanja et al 2004; Alavanja, Hoppin and Kamel 2004; Alavanja et al 1996; Anger et al. 2000; Blair and Zahm 1995; Calvert et al 1998; Cole et al. 1997; Farahat et al. 2003; Fenske and Simcox 1995; Fera et al. 1998; Gary et al 1996; Gomes et al. 1998; Hayes and Laws 1991; Kamel et al. 2003; Kamel and Hoppin 2004; Keifer and Mahurin 1997; Kristensen, Anderson, and Irgens 1996; London and Myers 1998; Ohayo-Mitoko et al. 2000; Rohlman et al., 2001; Sharpe, Franco, and de Camargo 1995; Sprince et al 2000; van Wendel de Joode et al. 2001). Most respondents reported that they had experienced health problems (58.3% of the 12 women and 57.1% of the 21 men in the sample). The most common health problems for male respondents were dental (23.8%), allergies (14.3%), sexually transmitted diseases (14.3%), and skin irritations (14.3%). Female respondents cited back pain, obstetrics/gynecology, and stomach pains evenly as the principal health problems suffered, each accounting for 16.7 percent of the total health problems recorded. The prevalence of health problems that are specific to pesticide exposure were explored in the Pesticide Study.

Respondents were asked what kinds of health services (i.e. hospitals, migrant health programs, doctors, health departments, pharmacies or home remedies/folk healers) they utilized. The most common provider of health care services was Migrant Health Clinics, such as Sea Island Medical Center, accounting for half of total use, followed by hospitals accounting for a quarter of total use (fourth author, personal communication). Due to the poor health trends migrant farmworkers are targeted nationally and at the state level for health care access. In South Carolina, the system of community health centers and other migrant farmworker assistance programs (the South Carolina Migrant Health Program or SC MHP) serves approximately 1500 individuals annually (SC MHP 2004).

Our results indicate that in most cases, fees for health services were paid for by the individual user. Two-thirds of the sample had utilized one or more health services; of those 74 percent of the 33 respondents reported that they were satisfied with the care they had received.

Our findings support the research that documents migrant farmworker difficulties in obtaining health care (e.g., Arcury et al 2001; Ciesielski, Hall, and Sweeney 1991; Dirksen 1997; Frank et al. 2004; Hansen and Donohoe, 2003; Hooks

Table 3. Healthcare Study: Farmworker Self-Reported Health Problems by Gender*

Health Problem	Men (N=21) Frequency	%	Women (N= 12) Frequency	%
Stomachaches	1	4.8	2	16.7
Colds or Flu	0	0	1	8.3
Swollen Feet	1	4.8	0	0
Breast Pains	0	0	1	8.3
High Blood Pressure	2	9.5	0	0
Gynecological	0	0	2	16.7
Headaches	0	0	1	8.3
Green Tobacco Sickness	0	0	0	0
Sexually Transmitted Diseases	3	14.3	0	0
Bronchitis	0	0	0	0
Tuberculosis	0	0	0	0
Diarrhea	1	4.8	0	0
Dental	5	23.8	0	0
Allergies	3	14.3	1	8.3
Asthma	0	0	0	0
Skin Irritations	3	14.3	0	0
Back Pain	1	4.8	2	16.7
Diabetes	0	0	0	0
Number *of individual respondents* who reported ANY health problem	12	57.1	7	58.3

* N = 33.

Table 4. Perception Study: Farmworker Perceptions, Knowledge and Behavior*

	N	Frequency*	Percent
Have you been exposed to pesticides?	**76**		
Yes		42	55.3
No		34	44.7
Has a family member been exposed to pesticides?	**62**		
Yes		10	16.1
No		52	83.9
Knowledge of Risks	**76**		
Low (0-15.0)		27	35.5
Medium (15.1-20.8)		25	32.9
High (20.9-25)		24	31.6
Have you received training on pesticides?	**75**		
Yes		30	40
No		45	60
Do you use protective equipment?	**73**		
Yes		53	72.6
No		20	27.4
Reasons why equipment is not worn:	**52**		
Not provided		30	57.7
Too expensive		4	7.7
Don't know where to purchase it		2	3.8
Slows down work		8	15.4
Other workers do not use it		8	15.4

* Total N is 76; however, some respondents did not answer all questions.

et al. 1996; Slesinger 1992; Quandt et al. 2004; Villarejo 2003; Villarejo and Baron 1999). Access to healthcare for respondents in our study was limited by transportation, knowledge of services, language, and finances. Three quarters of respondents cited transportation as the number one barrier to accessing health care. When asked about availability of health services, 67 percent reported that they did not know of services, 64 percent reported that language presented a barrier to health care access, and 55 percent reported that they had insufficient financial resources to pay for health care.

Pesticides and Environmental Risk Perception

Since many of the health problems reported through the Healthcare study could be related to pesticide exposure, a perception pilot study was conducted as a broader follow-up to examine pesticide risk perception and farmworker behaviors related to these perceptions. These data, which include information regarding farmworkers' perceptions of pesticide risks, exposure to pesticide training and education, and use of protective behaviors is described below and presented in Tables 4 and 5. A summary and analysis of the Pesticide Study and the Healthcare Study is presented in the final section of this paper titled 'Discussion'.

The perception pilot study explores two main issue areas: 1) farmworkers' perceptions regarding pesticide exposure and their level of knowledge about probable exposure pathways, preventative measures, and potential health problems; and 2) whether a relationship exists between knowledge, risk perception and previous exposure prevention training and the subsequent behaviors and protective measures reported by farmworkers and their families. Results reported below highlight important findings regarding knowledge of pesticides and exposure pathways; and the relationships among training, risk perception, knowledge, and risk reduction.

Respondents were asked a series of four questions to assess their level of knowledge about pesticides. The first question asked respondents to identify the various forms in which pesticides are manufactured such as liquid, dust, granules or gas (59% correctly identified all four forms). The second question asked respondents to identify common pathways to pesticide entry in the human body such as skin, nose, mouth, eyes, and smoking (69% correctly selected all five pathways of pesticide exposure). The third question asked respondents to correctly identify actions that reduce the risk of pesticide exposure such as washing one's hands before eating and taking one's shoes off before entering the house (25% identified three out of eight, 50% identified five out of eight, and 75% identified at least seven out of eight protective measures). The fourth question asked respondents to correctly identify health effects of both chronic and acute exposure to pesticides (for example, cancer, dizziness and sterility) (50% correctly identified four to eight of the possible eight listed symptoms).

A 25-item knowledge index measuring general knowledge of pesticides was created from the sum of correct responses to the four questions. Respondents' index scores ranged from 6-25 with a mean score of 17.25 and a median score of 17. A trichotomous variable (high, moderate, and low) was then created from the knowledge index to classify respondents on pesticide knowledge. Respondents in the low knowledge group scored 0 to 15, the moderate knowledge group scored 15.1 to 20.8 and the high knowledge group scored 20.9 to 25. As noted above, the median score of 17 and the mean score of 17.25 both fall within the range for the moderate knowledge group. Table 4 reports the ranges for each of the knowledge groups.

In order to assess the perception of exposure to pesticides among the farmworkers, each respondent was asked whether they, fellow family members employed in agriculture, or those family members never employed in agriculture, had been exposed to pesticides. Only a little over half of the respondents (55.3%) believed they had been exposed to pesticides and less than a fifth (16.1%) reported family exposure (see Table 4). Some of our 76 respondents choose not to answer some of our questions (in particular if a family member had been

exposed). From the responses provided and considering that this sample is youthful, new to agricultural work, and largely single, it is not surprising that they would report low levels of pesticide exposure to themselves and family members. However, when asked to identify any health problems or symptoms (associated with pesticide exposure), 81 percent reported having experienced at least one health problem. The total number of health problems per respondent ranged from 1-13, with the median response of six. The most frequently cited health problems were fatigue (64.5%), eye irritation (60.5%), profuse sweating (56.6%), severe headaches (50%), muscle cramps (46.1%), rashes (39.5%), nausea (37.3%), vomiting (32.9%), dizziness (30.3%), double vision (26.3%), and fainting (25%).

Workers were asked whether they had received training on methods of protecting themselves from pesticide exposure, what types of materials were used in the training, as well as who conducted the training (i.e. grower, outreach worker). Only forty percent reported that they received training (see Table 4). This falls within the range of figures found in other research on farmworkers and training. For example, researches Murphy-Greene and Leip (2002) found that 53 percent of the farmworkers who participated in their study had received formal pesticide training and Arcury et al (1999) found that only 35 percent of the farmworkers from their study had received training. Trainings, when they did occur for our respondents, were primarily conducted by crew leaders (68%) or by the employer (33%), using a variety of materials including videos (77.8%), pamphlets (27.8%), posters and photos (16.7%) and other unspecified materials.

Workers were asked whether protective equipment designed to minimize contact with pesticides (gloves, boots, masks, respirators, coveralls) were provided by the grower or crewleader and whether they were utilized by the farmworkers. Table 5 reports on the use and provision of protective gear.

In summary, 66.2 percent responded that they been given protective equipment, and 72.2 percent stated that they used protective equipment while working. Gloves were most frequently cited as the type of protective equipment provided and used. The main reason that respondents reported not using equipment is that it was not provided. Respondents also reported that other factors limited their use of protective gear including peer pressure, expense of equipment, and gear slowing work pace (see Table 4). A number of studies have likewise found that protective gear is under-utilized (Arcury et al.1999; Larson 2000; Murphey-Greene and Leip 2002, Vaughan 1993a; USDOL 2000a; USDOL 2000b).

We also examined the relationships between exposure to workplace safety training and farmworker protective behavior. A series of T test and chi-square tests were performed to assess the relationships between training, risk perception and risk reduction behaviors. No significant association was observed between training and perception of exposure to pesticides by the respondents. Likewise, there were

Table 5. Perception Study: Farmworker Protective Equipment Use and Provision*

	Yes		No		
Used by Farmworker	**Frequency**	**Percent**	**Frequency**	**Percent**	**Total***
Coveralls	5	6.9	67	93	72
Boots	14	19.4	58	81	72
Goggles	8	11	65	89	73
Respirators	9	12.5	63	87.5	72
Face Shields	5	6.9	67	93.1	72
Gloves	54	73	20	27	74
Use any Equipment	52	72.2	20	27.8	72
	Yes		**No**		
Provided by Farmer	**Frequency**	**Percent**	**Frequency**	**Percent**	**Total***
Coveralls	4	5.3	71	94.7	75
Boots	10	13.5	64	86.5	74
Goggles	7	9.6	66	90.4	73
Respirators	9	12	66	88	75
Face Shields	4	5.4	70	94.6	74
Gloves	49	65.3	26	34.7	75
Provided any equipment	49	66.2	25	33.8	74

* Total N is 76; however, some respondents did not answer all questions.

no significant associations observed between training and knowledge of risk reduction activities such as hand washing and removing one's shoes before entering the home. Nor was there any significant association between training and use of protective equipment. This directly confirms findings in the literature which document that while farmworkers may receive information and training in regards to the risks associated with agricultural chemicals as well as appropriate protective behaviors, they do not necessarily utilize this information (Arcury 1995, 1997; Arcury and Quandt 1998; Harthorn 1998; Kidd et al. 1997; Lantz et al. 1994; Larson 2000; Murphey-Greene and Leip 2002; Perry and Bloom 1998; Thu 1998; Vaughn 1993b). Note however, that the relationship between training and glove-use did approach statistical significance ($N=74$; $X^2=2.836$; $p=0.092$) suggesting that receiving training increases the likelihood of wearing gloves (please note two respondents did not answer our questions).

Discussion

While national regulations (for instance the Worker Protection Standard and OSHA training requirements) and regional programs (for instance the regional Clemson University Extension Pesticide Information Program, the Southern Region Pesticide Coordinators Extension, and the Environmental Protection Agency's Methyl Bromide Outreach Program) represent commendable attempts to educate farmworkers about pesticides, we found that the majority of the respondents are not being trained.

In addition, though our respondents did appear to be knowledgeable about pesticide risks, over 60 percent of 76 individuals scored in the medium to high ranges on risk knowledge, their level of knowledge was not associated with training. Likewise, training and knowledge did not appear to be related to engagement in protective behavior. Note that in one case the relationship between training and glove-use approached statistical significance ($p=0.092$), however, informal discussions between the interviewer and respondents indicate that gloves are frequently provided to protect the fruit rather than to protect the workers. According to these discussions, many workers were provided with, and utilized protective equipment (usually gloves) not so much to protect themselves from exposure, but rather, to protect either the produce itself from being damaged during the picking and packing processes or themselves from the minor discomforts of working in the field (i.e. against irritating thorns or hairs on the plants, from hands turning green while picking tomatoes). Although it may be argued that protective equipment was at least used, gloves alone, the most common form of self-protective equipment, is not a sufficient form of protection to guard against multiple pathways of exposure (i.e. mouth, nose, eyes, skin). Training, therefore, may increase behaviors that are protective of the fruit but not necessarily the worker.

While we have documented the demographic characteristics of lowcountry farmworkers and the lack of relationship between training, knowledge, and use of protective behaviors among our Perception Study sample, we have conducted only the first step in understanding this unique component of the US workforce. The question now is "why?" Why do migrant farmworkers not respond to training with increased use of protective gear? A number of the demographic variables point to possible explanations that should be explored in future research. First, is there a connection between the low use of protective behaviors and the current trend toward a migrant workforce that is increasingly male, youthful, and single? The sample sizes of our two pilot studies were too small for us to explore this question. However, other research suggests that gender, at least, may be related to how well farmworkers adapt their behaviors to training and new information. Frank, et al. in their review of the literature note, for instance, that many national centers target women in farm situations since they appear to be more adaptable and serve as better change agents (Frank et al. 2004).

Second, is there a relationship between the low socio-economic conditions faced by our respondents and their low engagement in protective behaviors (regardless of knowledge about risks and protective behaviors)? Third, and related, do migrant farmworkers, because of their low socio-economic characteristics (poverty, inadequate access to health care, lack of transportation, language barriers, and low education levels) experience low levels of perceived and/or real control over workplace conditions? These questions are well-grounded in recent developments in the literature. Recall that several studies have documented the relationship between socio-economic conditions and patterns of risk perception, evaluation, communication and mitigation (Brownson et al 1992; Calnan 1989; Peters, Covello and McCallum, 1997; Satterfield, Mertz and Slovic 2004; Snyder 2004; Vacha and McLaughlin 2004; Vaughan 1993a; Vaughan 1995a, 1995b; Wardle et al 2004). Other studies have documented the connection between feelings of control and socioeconomic status, for instance Peterson and Stunkard, found that low socioeconomic status may lead individuals to perceive occupational risk as out of their control (1989). Many more studies propose that a perceived lack of control over work and living conditions contributes to low engagement in protective behaviors (regardless of knowledge about risks and protective behaviors) (Baer and Penzell 1993; Grieshop, Stiles, and Villanueva 1996; Arcury et al. 1998; Arcury and Quandt 1998; Arcury 1995, 1997; Harthorn 1998; Kidd et al. 1997; Perry and Bloom 1998; Thu 1998; Vaughan 1993a, 1993b, 1995a, 1995b). In just one example specific to the topic of farmworkers and risk, a few studies have documented that the low-paying piece-rate system encourages workers to do whatever is necessary to work fast (Sakala 1987) which can lead to increased injuries (McCurdy et al 2003).

In light of the demographic picture we have presented; our finding that there is no relationship between training, knowledge, and use protective behaviors; and the trends cited in the literature above, we recommend that further research be conducted to ascertain the impact of the low socio-economic conditions and other social characteristics (such as gender and

age) of migrant farmworkers on their response to training and education and their use of protective behaviors. We further recommend that the relationship between socio-economic characteristics, feelings of control, and protective behaviors be explored. With such information and knowledge, farmworkers, and farmworker associations and programs will be better positioned to capitalize on the many assets that migrant and seasonal agricultural workers do possess (i.e., political mobilization around farmwork conditions and pay, the flexibility to move to regions where pay and conditions are better, the potential to utilize farmwork as a springboard for upward mobility in other professions) (e.g., Wells and Villarejo 2004). In addition, such information would aid the work of agriculture programs and extension efforts to *successfully* train *all* agricultural workers and, more importantly, increase the *practicality* and *utilization* of that training and education. Until the needs, perceptions, and behaviors of impoverished farmworking communities are better understood (with sensitivity to cultural diversity and other social characteristics), efforts to assist agricultural workers to protect themselves from environmental risk will likely be ineffective.

References

Abrams, K., D.J. Hogan, and H.I. Maibach
1990 Pesticide-related Dermatoses in Agricultural Workers. Occupational Medicine: State of the Art Reviews 6:463-492.

Acosta, M.S.V., P. Chapman, P.L. Bigelow, C. Kennedy, and R.M. Buchan
2005 Measuring Success in a Pesticide Risk Reduction Program Among Migrant Farmworkers in Colorado. American Journal of Industrial Medicine 47(3): 237-245.

Alavanja, M.C.R., D.P. Sandler, S.B. McMaster, S.H. Zahm, C.J. McDonnell, C.F. Lynch, M. Pennybacker, N. Rothman, M. Dosemeci, A.E. Bond, and A. Blair
1996 The Agricultural Health Study. Environmental Health Perspectives 104(4): 362-69.

Alavanja, M.C.R., M. Dosemeci, C. Samanic, J. Lubin, C.F. Lynch, C. Knott, J. Barker, J.A. Hoppin, D.P. Sandler, J. Coble, K. Thomas, and A. Blair
2004 Pesticides and Lung Cancer Risk in the Agricultural Health Study Cohort. American Journal of Epidemiology 160(9): 876-885.

Alavanja, M.C.R., J.A. Hoppin, and F. Kamel
2004 Health Effects of Chronic Pesticide Exposure: Cancer and Neurotoxicity. Annual Review of Public Health 25:155-197.

Alavanja, M.C.R., C. Samanic, M. Dosemeci, J. Lubin, R. Tarone, C.F. Lynch, C. Knott, K. Thomas, J.A. Hoppin, J. Barker, J. Coble, D.P. Sandler, and A. Blair
2003 Use of Agricultural Pesticides and Prostate Cancer Risk in the Agricultural Health Study Cohort. American Journal of Epidemiology 157 (9): 800-814.

Anger, W.K., Y.X. Liang, V. Nell, S.K. Kang, D. Cole, and B. Bazylewicz-Walczak
2000 Lessons Learned-15 Years of the WHO-NCTB: a Review. Neurotoxicology 21: 837-846.

Arcury, T.
1995 Risk Perception of Occupational Hazards among Black Farmers in the Southeastern United States. Journal of Rural Health 11:240-250.

Arcury, T.
1997 Occupational Injury, Prevention Knowledge and Behavior of African-American Farmers. Human Organization 56:167-173.

Arcury, T., C. Austin, R. Saavedra, and S. Quandt
1998 Farmworker and Farmer Perceptions of Farmworker Agricultural Chemical Exposure in North Carolina. Human Organizations 57:350-368.

Arcury, T. and S. Quandt
1998 Occupational and Environmental Health Risks in Farm Labor. Human Organization 57:331-334.

Arcury, T., S. Quandt, D. Austin, J. Preisser, and L. Cabrera
1999 Implementation of EPA's Worker Protection Standard Training for Agricultural Laborers: An Evaluation Using North Carolina Data. Public Health Reports 114:459-468.

Arcury, T.A., S.A. Quandt, A.J. Cravey, R.C. Elmore, G.B. Russell
2001 Farmworker Reports of Pesticide Safety and Sanitation in the Work Environment. American Journal of Industrial Medicine 39: 487-98.

Arcury, T., S. Quandt, P. Rao, A.M. Doran, B.M. Snively, D.B. Barr, J.A. Hoppin, and S.W. Davis
2005 Organophosphate Pesticide Exposure in Farmworker Family Members in Western North Carolina and Virginia: Case Comparisons. Human Organization 64 (1): 40-51.

Arcury, T., S.A. Quandt and G.B. Russell
2002 Pesticide Safety Among Farmworkers: Perceived Risk and Perceived Control as Factors Reflecting Environmental Justice. Environmental Health Perspectives 110 (Supplement 2): 233-240.

Arcury, T.A., S.A. Quandt, D.L. Garcia, J.S. Preisser, D. Norton, P. Rao
2002 A Clinic-based Case-control Comparison of Green Tobacco Sickness Among Minority Farmworkers: Clue for Prevention. Southern Medical Journal: 95(9):1008-11.

Aspelin, A.L.
2003 Pesticide Usage in the United States: Trends During the 20th Century. Raleigh, North Carolina: Center for Integrated Pest Management, North Carolina State University.

Baer, R., and D. Penzell
1993 Susto and Pesticide Poisoning among Florida Farmworkers. Culture, Medicine and Psychiatry 17:321-327.

Berg, B. L.
2000 Qualitative Research Methods for the Social Sciences. Boston: Allyn & Bacon. (Original work published 1989)

Blair, A. and S.H. Zahm
1995 Agricultural Exposures and Cancer. Environmental Health Perspectives 103(Supplement 8):806-113.

Blondell, J.
1997 Epidemiology of Pesticide Poisonings in the United States, with special reference to occupational class. Occupational Medicine: State of the Art Reviews 12:209-220.

Bormann, H., D. Balmori, and G. Geballe
1993 Redesigning the American Lawn: A Search for Environmental Harmony. New Haven, CT: Yale University Press.

Brownson, R.C., J. Jackson-Thompson, J. Wilkerson, J.R. Davis, N.W. Owens and E.B. Fisher
1992 Demographic and Socioeconomic Differences in Beliefs About the Health Effects of Smoking. American Journal of Public Health 82: 99-103.

Calnan, M.
1989 Control over Health and Patterns of Health-Related Behavior. Social Science Medicine 29: 131-136.

Calvert, G.M., C.A. Mueller, J.M. Fajen, D.W. Chrislip, J. Russo, and T. Briggle
1998 Health Effects Associated with Sulfuryl Flouride and Methyl Bromide Exposure Among Fumigation Workers. American Journal of Public Health 88: 1774-1780.

Calvert, G.M., D.K. Plate, R. Das, R. Rosales, O. Shafey, and C. Thomsen
2004 Acute Occupational Pesticide-related illness in the U.S., 1988-1999: Surveillance Findings from the SENSOR-pesticides program. The American Journal of Industrial Medicine 45:14-23.

Ciesielski, S, S.P. Hall and M. Sweeney
1991 Occupational Injuries among North Carolina Farmworkers. The American Journal of Public Health 81: 926-928.

Cole, D.C., F. Carpio, J. Julian, N. Leon, R. Carbotte, and H. Almeida
1997 Neurobehavioral Outcomes Among Farm and Nonfarm Rural Ecuadorians. Neurotoxicology and Teratology 19: 277-286.

Dirksen, M. E.
1997 A Qualitative Investigation of Perceptions of Occupational Risk Among Seasonal Farmworkers. Unpublished Master of Nursing Thesis, University of Washington, Seattle, WA.

Douglas, M.D. and A. Wildavsky
1982 Risk and Culture: An Essay on the Selection of Technological and Environmental Dangers. Berkeley: University of California Press.

Farahat, T., G.M. Abdelrasoul, M.M. Amr, M.M. Shebl, F.M. Farahat, and W.K. Anger
2003 Neurobehavioral Effects Among Workers Occupationally Exposed to Organophosphorous Pesticides. Occupational and Environmental Medicine 60:279-286.

Fenske, R. and N. Simcox
1995 Agricultural Workers. In Occupational Health: Recognizing and Preventing Work-Related Disease. B.S. Levy and D.H. Wegman, eds. Pp. 665-683. Boston: Little, Brown, and Company.

Fera, N.T., E. Roman, G. Reeves, and B. Pannett
1998 Childhood Cancer and Paternal Employment in Agriculture: The Role of Pesticides. Br. J. Cancer 77:825-829.

Frank, A.L., R. McKnight, S.R. Kirkhorn, P. Gunderson.
2004 Issues of Agricultural Safety and Health. Annual Review of Public Health 25:225-245.

Gabbard, S., R. Mines, and B. Boccalandro
1993 Migrant Farmworkers: Pursuing Security in an Unstable Labor Market. Washington, DC: US Department of Labor. Office of the Assistant Secretary for Policy.

Gary, V.F., G. Schreinemachers, M.E. Harkins, J. Griffith.
1996 Pesticide Applicators: Biocides and Birth Defects in Rural Minnesota. Environmental Health Perspective 104(4): 394-99.

Gabbard, S., R. Mines, and B. Boccalandro
1993 Migrant Farmworkers: Pursuing Security in an Unstable Labor Market. Washington, DC: US Department of Labor. Office of the Assistant Secretary for Policy.

Gerber, B. and G.W. Neeley
2005 Perceived Risk and Citizen Preferences for Governmental Measurement of Routine Hazards. The Policy Studies Journal 33(3): 395-418.

Gomes, J., O. Lloyd, M.D. Revitt, and M. Basha
1998 Morbidity Among Farmworkers in a Desert Country in Relation to Long-Term Exposure to Pesticides. Scandonavian Journal of Work Environment and Health 24: 213-219.

Grieshop, J., M. Stiles and N. Villanueva
1996 Prevention and Resiliency: A Cross Cultural View of Farmworkers' and Farmers' Beliefs About Work Safety. Human Organization 55: 25-32.

Green, S.F.
2004 Attitudes toward Control in Uncontrollable Situations: the Multidimensional Impact of Health Locus of Control on the Well-Being of Mothers of Children of Disabilities. Sociological Inquiry. 74(1): 20-49.

Griffith, D. and E. Kissam with J. Camposeco, A. Garcia, M. Pfeffer, D. Runsten, and M.V. Pizzini
1995 Working Poor: Farmworkers in the United States. Philadelphia: Temple Press.

Hansen, E. and M. Donohoe
2003 Health Issues of Migrant and Seasonal Farmworkers. Journal of Health Care for Poor and Underserved 14(2): 153-164.

Harthorn, B.
1998 California Farmworkers: Dilemmas in Developing Interventions for Health and Medical Care Concerns. Human Organization 57:369-378.

Hayes, W.J. and E.R. Laws, eds.
1991 Handbook of Pesticide Toxicology, (Vol. 1: General Principles) Pp. 245-360. San Diego: Academic Press.

Hooks, C., C. Ugarte, J. Silsby, R. Brown, J. Weinman et al
1996 Obstacles and Opportunities in Designing Cancer Control Communication Research for Farmworkers on the Delmarva Peninsula. Journal of Rural Health 12(4 Supplemental):332-42.

Jeyaratnam, J.
1990 Acute Pesticide Poisoning: A Major Global Health Problem. World Health Statistics Quarterly 43:139-144.

Johnson, B.B. and C. Chess
2003 Communicating Worst-Case Scenario: Neighbors' Views of Industrial Accident Management. Risk Analysis 23(4): 829-840.

Kamel, F., A. Rowland, L. Park, W. Anger, D. Baird, and B. Gladen
2003 Neurobehavioral Performance and Work Experience in Florida Farmworkers. Environmental Health Perspectives 111: 1765-1772.

Kamel, F. and J. Hoppin
2004 Association of Pesticide Exposure with Neurologic Dysfunction and Disease. Environment Health Perspectives 112, 9: 950-958.

Keifer, M., R. Mahurin
1997 Chronic Neurologica Effects of Pesticide Overexposure. Occupational Medicine 12: 291-304.

Kidd, P., K. Townley, H. Cole, R. McKnight, and L. Piercy
1997 The Process of Chore Teaching: Implications for Farm Youth Injury. Family and Community Health 19: 78-89.

Kilty, K. and M. Vidal de Haymes
2000 Racism, Nativism, and Exclusion: Public Policy, Immigration, and the Latino Experience in the United States. Journal of Poverty 4(1-2): 1-25.

Kolpin, D., E. Furlong, M. Meyer, E. Thurman, S. Zaugg, L. Barber, and H. Buxton
2002 Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in US Streams, 1999-2000: A National Reconnaissance. Environmental Science and Technology 36:1202-1211.

Kristensen, P., A. Anderson, and L.M. Irgens
1996 Cancer in offspring of parent engaged in agricultural activities in Norway: Incidence and risk factors in the farm environment. International Journal of Cancer 65:39-50.

Lantz, P., L. Dupuis, D. Reding, M. Kauska, and K. Lappe
1994 Peer Discussions of Cancer Among Latino Farmworkers. Public Health Reports 109:512-520.

Larson, A.
2000 An Assessment of Worker Training Under the Worker Protection Standard. Washington, DC: EPA, Office of Pesticide Programs.

Lichtenberg, E. and R. Zimmerman
1999 Adverse Health Experiences, Environmental Attitudes, and Pesticide Usage Behavior of Farm Operators. Risk Analysis 19(2): 283-295.

London, L. and J.E. Myers
1998 Use of a Crop and Job Specific Exposure Matrix for Retrospective Assessment of Long-Term Exposure in Studies of Chronic Neurotoxic Effects of Agrichemicals. Occupational and Environmental Medicine 55: 194-201.

London, L., S. De Grosbois, C. Wesseling, S. Kisting, H. Rother, and D. Mergler
2002 Pesticide Usage and Health Consequences for Women in Developing Countries: Out of Sight, Out of Mind? International Journal of Occupational Health 8: 46-49.

McCauley, L.S., M.R. Lasarev, G. Higgins, J. Rothlein, J. Muniz et al
2001 Work Characteristics and Pesticide Exposure Among Migrant Agricultural Families: A Community-based Research Approach. Environmental Health Perspectives 109(5):533-38.

McCurdy, S.A., S.J. Samuels, D.J. Carroll, J.J. Beaumont, and L.A. Morrin
2003 Agricultural Injury in Carlifornia Migrant Hispanic Farm Workers. American Journal of Industrial Medicine 44(3): 225-235.

Mehta, K., S.M. Gabbard, V. Barrat, M. Lewis, D. Carroll, and R. Mines
2000 Findings from the National Agricultural Workers Survey (NAWS) 1997-1998: A Demographic and Employment Profile of United States Farmworkers. Reseach Report No. 8, U.S. Department of Labor, Office of the Assistant Secretary for Policy, Office of Program Economics.

Moses, M.
1989 Pesticide-related health problems and farmworkers. American Association of Occupational Health Nurses Journal 37:115-130.

Moses, M., E. Johnson, W. Anger, V. Burse, S. Horstman, R. Jackson, R. Lewis, K. Maddy, R. McConnell, W. Meggs, and S. Zahm
1993 Environmental Equity and Pesticide Exposure. Toxicology and Industrial Health 9:913-959.

Mull, L.D., L.S. Engel, B. Outterson, and S.H. Zahm
2001 National Farmworker Database: Establishing a Farmworker Cohort for Epidemiological Research. American Journal of Industrial Medicine 40(5): 612-618.

Murphey-Greene, C. and L. Leip
2002 Assessing the Effectiveness of Executive Order 12898: Environmental Justice for All? Public Administration Review 62: 679-687.

Meyers, J. and D. Hard
1995 Work -related Fatalities in the Agricultural Production and Service Sectors, 1980-1989. American Journal of Industrial Medicine 27:51-63.

Meyers, J.M., J.A. Miles, J. Faucett, I. Janowitz, D. Tejeda, J. Kubashimi
1997 Ergonomics in Agriculture: Workplace Priority Setting in the Nursery Industry. American Industrial Hygiene Association Journal 58(2): 121-126.

National Safety Council (NSC)
2004 About Agriculture. URL:<http: agriculture.about.com cs education1 a 090503.htm> (October 6, 2004).

National Institute for Occupational Safety and Health (NIOSH)
2005 Worker Health Chartbook 2004. URL:<http: www.cdc. gov niosh docs chartbook > (October 11 2005)

Ohayo-Mitoko, G.J., H. Kromhout, J.M. Simwa, J.S. Boleij, and D. Heederik
2000 Self Reported Symptoms and Inhibition of Acetylocholin-esterase Activity Among Kenyan Agricultural Workers. Occupational and Environmental Medicine 57: 195-200.

Perry, M. and F. Bloom
1998 Perceptions of Pesticide Associated Cancer Risks among Farmers: A Qualitative Assessment. Human Organization 5:342-349.

Peters, R.G., V.T. Covello, and D. B. McCallum
1997 The Determinants of Trust and Credibility in Environmental Risk Communication: An Empirical Study. Risk Analysis 17(1): 43-54.

Peterson, C. and A. J. Stunkard
1989 Personal Control and Health Promotion. Social Science and Medicine 28: 819-828.

Quandt, S.A., A.M. Doran, P. Rao, J.A. Hoppin, B.M. Snively, and T.A. Arcury
2004 Reporting Pesticide Assessment Results to Farmworker Families: Development, Implementation, and Evaluation of a Risk Communication Strategy. Environmental Health Perspectives 112 (5): 636-642.

Quandt, S.A., J.S. Preisser, and T.A. Arcury
2002 Mobility Patterns of Migrant Farmworkers in North Carolina: Implications for Occupational Health Research and Policy. Human Organization 61: 21-29.

Rao, P., T.A. Arcury, S.A. Quandt, and A. Doran
2004 North Carolina Growers and Extension Agents' Perceptions of Latino Farmworker Pesticide Exposure. Human Organization 63 (2): 151-161.

Rohlman, D.S., S.R. Bailey, W.K. Anger, L. McCauley
2001 Assessment of Neurobehavioral Function with Computerized Tests in a Population of Hispanic Adolescents Working in Agriculture. Environmental Research 85(1): 14-24.

Rust, G.
1990 Health Status of Migrant Farmworkers: A Literature Review and Commentary. American Journal of Public Health 80: 213-217.

Sanders, D.C., ed.
2004 Vegetable Crop Guidelines for the Southeastern U.S. Raleigh, North Carolina: North Carolina State University.

Sandman, P.
1993 Responding to Community Outrage: Strategies for Effective Risk Communication. Fairfax, Virginia: American Industrial Hygiene Association.

Samardick, R., S.M. Gabbard, and M.A. Lewis
2000 Youth Employment in Agriculture. In US Bureau of Labor Statistics, Report on the Youth Labor Force: Revised (52-57). Washington, DC: US Department of Labor.

Satterfield, T.A., C.K. Mertz, and P. Slovic
2004 Discrimination, Vulnerability, and Justice in the Face of Risk. Risk Analysis 24(1): 115-129.

Samardick, R., S.M. Gabbard, and M.A. Lewis
2000 Youth Employment in Agriculture. In US Bureau of Labor Statistics, Report on the Youth Labor Force: Revised (52-57). Washington, DC: US Department of Labor.

Salazar, M.K., M. Napolitano, J.A. Scherer, L.A. McCauley
2004 Hispanic Adolescent Farmworkers' Perceptions Associated with Pesticide Exposure. Western Journal of Nursing Research 26(2): 146-166.

Sakala, C.
1987 Migrant and Seasonal Farmworkers in the United States: A Review of Health Hazards, Status, and Policy. International Migration Review 21: 659-687.

Savitz, D., T. Arbuckle, D. Kaczor, and M. Curtis
1997 Male Pesticide Exposure and Pregnancy Outcome. American Journal of Epidemiology 146:1025-36.

Schenker, M.B.
1996 Preventive Medicine and Health Promotion are Overdue in the Agricultural Workplace. Journal of Public Health Policy. 17(3):275-304.

Sharpe, C.R., E.L. Franco, and B. de Camargo
1995 Parental exposures to pesticides and risk of Wilms' tumor in Brazil. American Journal of Epidemiology 141:210-217.

Slesinger, D.
1992 Health Status and Needs of Migrant Farmworkers in the United States: A Literature Review. Journal of Rural Health 8:227-234.

Slovic, P.
1987 Perception of Risk. Science 236: 280-285.

Synder, K.
2004 Risk Perception and Resource Safety for Female Agricultural Workers. Research in Economic Anthropology 23 (271-294).

South Carolina Agricultural Statistics Service
2001 South Carolina Agricultural Statistics. URL:http://cherokee.agecon.clemson.edu/ae491.pdf (October 8, 2004). South Carolina

Employment Security Commission (SCES)
2002 Employment Trends. URL:<http://www.sces.org> (July 22, 2002).

South Carolina Migrant Health Program (MHP)
2004 Migrant Health. URL:<http://www.scdhec.net/omh/migrant.htm> (October7, 2004).

Sprince, N.M., M.Q. Lewis, P.S. Whitten, S.J. Reynolds, C. Zwerling
2000 Respiratory Symptoms: Associations with Pesticides, Silos, and Animal Confinement in the Iowa Farm Family Health and Hard Surveillance Project. American Journal of Industrial Medicine 38(4): 455-62.

Taylor, D.E.
1989 Blacks and the Environment: Towards an Explanation of the Concern and Action Gaps Between Blacks and Whites. Environment and Behavior 21(2): 175-205.

Thu, K.
1998 The Health Consequences of Industrialized Agriculture for Farmers in the United States. Human Organization 57:335-341.

US Department of Agriculture, Economic Research Service.
2000 Almost Half of Hired Farmworkers 25 Years and Older Earn Poverty-Level Wages. Rural Conditions and Trends 11(2); 47-50.

US Department of Labor (USDOL), Bureau of Labor Statistics
1993 US Farmworkers in Post-IRCA Period: Based on Data from the National Agricultural Workers Questionnaire (NAWS) (Research Report No. 4: 1993-342-559-814/84422). Washington, DC: US Department of Labor.
2000a National Agricultural Workers Questionnaire. Washington, DC: US Department of Labor.
2000b Workplace Injuries and Illnesses in 1999. Washington, DC: US Department of Labor

US Department of Labor (USDOL), OSHA
1987 Hazard Communication: Final Rule (29 CFR parts 1910, 1915, 1917, 1918, 1926, and 1928). Washington, DC.: US Department of Labor.

US Environmental Protection Agency (EPA)
2002a Office of Pesticides Annual Report, 2002. URL:<http://www.epa.gov/oppbead1/pestsales/99pestsales/sales1999.html#2_1> (October 22, 2004).

2002b Worker Protection Standards. Office of Pesticide Programs. URL:<http://www.epa.gov/oppfead1/safety/workers/workers.htm> (September 16, 2004).

Vacha, E. and T.F. McLaughlin
2004 Risky Firearms Behavior in Low-Income Families of Elementary School Children: The Impact of Poverty, Fear of Crime, and Crime Victimization on Keeping and Storing Firearms. Journal of Family Violence 19(3): 175-184.

Variyam, J.N. and A. Mishra.
2005 The Well-Being of US Farm Workers: A Look at Health. Review of Agricultural Economics 27(3): 369-376.

Vaughan, E.
1995a The Significance of Socioeconomic and Ethnic Diversity for the Risk Communication Process. Risk Analysis 15(2): 169-180.
1995b The Socioeconomic Context of Exposure and Response to Environmental Risk. Environment and Behavior 27(4): 454-489.
1993a Chronic Exposure to an Environmental Hazard: Risk Perceptions and Self-protective Behavior. Health Psychology 12:75-85.
1993b Individual and Cultural Differences in Adaptation to Environmental Risk. American Psychologist 48:673-680.

Vaughan, Elaine and Brenda Nordenstam.
1991 The Perception of Environmental Risks Among Ethnically Diverse Groups. Journal of Cross-Cultural Psychology 22:29-60.

van Wendel de Joode, B., C. Wesseling, H. Kromhout, P. Monge, M. Garcia, and D. Mergler
2001 Chronic Nervous System Effects of Long-Term Occupational Exposure to DDT. Lancet 357: 1014-1016.

Villarejo, D.
2003 The Health of US Hired Farm Workers. Annual Review of Public Health 24: 175-193.

Villarejo, D. and S.L. Baron
1999 The Occupational Health Status of Hired Farm Workers. Occupational Medicine 14(3): 613-635.

Wardle, J. K. McCafferty, M. Nadel, and W. Atkin
2004 Socioeconomic Differences in Cancer Screening Participation: Comparing Cognitive and Psychosocial Explanations. Social Science and Medicine 59(2): 249-261.

Wells, M.J. and Villarejo, D.
2004 State Structures and Social Movement Strategies: The Shaping of Farm Labor Protections in California Politics and Society 32(3): 2291-326.

Zahm, S. and A. Blair
1993 Cancer Among Migrant and Seasonal Farmworkers: An Epidemiologic Review and Research Agenda. American Journal of Industrial Medicine 24:753-766.

Zahm, S., M. Ward, and A. Blair
1997 Pesticides and Cancer. Occupational Medicine: State of the Art Reviews 12:269-289.