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Pesticide Knowledge, Attitudes, and Practices Among Small-Scale Hmong Farmers in the San Joaquin Valley of California

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Abstract

A survey was conducted to assess the pesticide knowledge, attitudes, and practices of small-scale Hmong farmers in the Fresno area of the San Joaquin Valley of California. Hmong farmers in this region were found to cultivate 35 crops, most of which were Asian specialty crops with economic significance. The majority of farmers used pesticides on their farms, primarily to control diseases and insects. Long beans and sweet peas were perceived to require more pesticides than other crops. Participants were aware of pesticide-related health risks, yet 71% had no formal education. Most participants used proper personal protection equipment (PPE) and followed safe application practices, yet 84% reported that they wear work clothing from the farm into their home, which could contribute to the take home pesticide exposure pathway. Seventy-five percent of participants were not familiar with the concept of integrated pest management (IPM) as a formal pest management practice; however, many participants were using some components of IPM such as crop rotation. Nearly all participants (96%) requested more pesticide safety training be made available in Hmong. This study contributes to the understanding of potential pesticide exposure and health risks of Hmong farmers in the San Joaquin Valley of California, and the need for additional pest management training for the community.

Key words: occupational exposure, take-home pesticide exposure pathway, personal protective equipment, integrated pest management, limited resource farmer

Pesticide knowledge, attitudes, and practices among small-scale minority farmers including Hmong American farmers in the United States are largely unexplored. Understanding these factors is critical to ensure safe and productive farming practices in agricultural regions such as the San Joaquin Valley of California. The San Joaquin Valley is part of the Central Valley of California, a largely agricultural region, which produces over 50% of the nation's fruits and vegetables (CDPR 2006, Calvert et al. 2008). Pesticides are often used to reduce insect pests and plant pathogens, but overuse can lead to insecticide resistance and secondary pest outbreaks, while misuse can harm the environment and human health (Tilman et al. 2002, Alavanja et al. 2004, Frank 2004, Guzzella et al. 2006, Ntow et al. 2006, Damalas and Koutroubas 2016). Pesticides are one component of the practice of integrated pest management (IPM), which uses biological, cultural, and chemical methods to manage pests in an environmentally compatible and economically feasible manner (Stern et al. 1959, Flint and van den Bosch 1981). The practices of IPM can directly reduce pesticide use and exposure to farmers and the local community (Flint and Van den Bosch 1981).

Small-scale farms in the Central Valley of California are often run by limited resource, ethnic minority farmers. According to the U.S. Department of Agriculture (USDA), small farms are individual farms that grow and sell between $1,000 and $250,000 per year in agricultural products (USDA-NASS 2009). The USDA-NRCS (1991) also categorizes limited resource farms as those which are smaller than the average size, have education levels below the county average, and those which have minimum awareness of USDA programs due to social, cultural, or language barriers. Most small-scale farming operations are labor-intensive structures that focus on growing a diverse crop supply that is economically and environmentally sustainable to the local community. Small-scale farms can conserve agricultural biodiversity and preserve culturally important cultivars, and contribute to farmer's markets and community supported agriculture programs (Grasswitz 2019). Small-scale farmers are often limited resource farmers and underserved, facing barriers to obtaining financial resources and information needed to improve farms (NRCS 1991, McCauley et al. 2006, De Castro et al. 2014). In addition, IPM programs are often for large-scale farms and individual crops (Grasswitz 2019). Hmong American farmers in the United States are typically small-scale, limited resource farmers.

The Hmong originate from agricultural communities in the highlands of China (Lee 2005). Due to years of wars and persecution by the Chinese, Hmong migrated to surrounding countries including Vietnam, Laos, Myanmar, and Thailand (Lee 2005). In Laos, the Hmong settled predominately in the mountains and were subsistence farmers. After the Vietnam War, Hmong began migrating from Laos to the United States in 1975 as refugees and brought their traditional farming practices with them. The U.S. 2010 Census reported 91,224 Hmong living in California, with the largest population (31,771) in the Central California county of Fresno (U.S. Census Bureau 2010). According to the University of California Agriculture and Natural Resources Cooperative Extension (UCCE), approximately 900 out of the 1,300 Southeast Asian farms in Fresno County are run by Hmong farmers (Molinar et al. 2007).

Hmong farms in the Fresno area focus on seasonal specialty crops such as Asian vegetables and herbs, and strawberries (Stumbos 1993, Molinar 2012). Community farms are often on rented land and shared with family members and products are sold at farmers' markets and local restaurants. The Hmong are a close knit community, with a history of oral communication and a low literacy level (Pfeifer et al. 2012). Many pest management and pesticide-related resources are available only in English, while a number are available in Spanish and a limited number in other languages. In California, pesticide handlers and farm workers are required to have training on pesticide safety, and the laws require any individual purchasing restricted-use pesticides to have a Qualified Applicator License (QAL); an individual with a QAL can supervise pesticide use by other individuals on the farm (CDPR 2016).

Research addressing pesticide knowledge and practices, and familiarity with the concept of IPM in small-scale minority farmers in the United States has been addressed in a number of studies; some examples include studies of African American farmers in the south, Amish and Mennonites in the Midwest, and Hispanic farmers in Michigan and the Pacific Northwest. Knowledge of IPM in African American and white small-scale farmers in southern states found that about half of those surveyed were familiar with the IPM concept, with slightly fewer African American farmers using IPM (Molnar et al. 2001). Reasons for not adopting IPM included that farmers needed more information about using techniques, practices required more time than conventional approaches, or that IPM had not worked previously. Farmers with higher education levels adopted more IPM measures; farm sales as a percent of total income also predicted the use of IPM. A small number of farmers reported implementing pesticide application practices such as calibrating equipment and using pesticides less harmful to beneficial insects (Molnar et al. 2001). In Missouri, cultural practices of small-scale Plain farmers (Amish and Mennonite) influenced their adoption of IPM (Piñero et al. 2015). Cultural beliefs in these groups do not permit use of modern technologies, so pest management advice was sought out through extension events such as farm visits, tours or in-person events (Piñero et al. 2015); 75% of respondents in this population had a moderate level of knowledge of IPM. In Michigan, Latino blueberry farmers' knowledge and practices of pesticide use and IPM were assessed (Santos 2015). These farmers were new to blueberry production and had limited English and low education levels. Pesticide use and IPM practices were assessed before and after trainings. Before training, 35% could recognize beneficial insects, and this increased to 85% after trainings (Santos 2015). Numerous studies investigating barriers to accessing pesticide safety information in limited resource farmers have also been conducted outside the United States, and these studies provide additional insight into needs of limited resource, minority farmers. They stress the importance of developing more pesticide safety training for farmers with limited educational backgrounds or with low literacy levels, arguing that without adequate education and instruction, farmers are unaware of long-term adverse health impacts (Yassin et al. 2002, Ntow et al. 2006).

Limited research has focused on Hmong farming practices in the United States. In Washington state, risk factors for Hmong farmers were found to include respiratory exposure, ineffective pest management activities, and lack of information published in Hmong (De Castro et al. 2014). An additional study by Neitzel et al. (2014) found that Hmong farmers were not wearing PPE during mechanical operations. Developing culturally appropriate interventions was suggested to reduce occupational injuries and exposure, as was further research to better understand the health needs of the Hmong farming community (Neitzel et al. 2014, Sowerwine et al. 2015).

To date, pesticide knowledge, attitudes, and practices, including familiarity with the concept and practices of IPM, have been largely unexplored among Hmong American farmers. Understanding these factors is key to meeting the training needs for this community. The goal of this study was to investigate the pesticide knowledge, attitudes, and practices among Hmong American farmers living in the Fresno area of the San Joaquin Valley of California. The study addressed the following objectives: 1) to determine the crops cultivated by Hmong American small-scale farmers, and to learn which crops were perceived to require more pesticide use, 2) to examine Hmong farmers' knowledge and perception about pesticide danger levels, 3) to assess the use of PPE and safe practices during pesticide use, and 4) to evaluate farmers' familiarity with the concept of IPM and associated practices, and assess farmers' interest in future pesticide safety trainings.

Methods

A cross-sectional study was conducted of Hmong farmers in the Fresno area of the San Joaquin Valley of California. A standardized questionnaire was administered to assess a wide range of pesticide knowledge, attitudes, and practices. Participants were recruited through snowball sampling (Biernacki and Waldorf 1981). Snowball sampling is a method which recruits participants by referrals made among people who share or know of others who possess similar characteristics that are of research interest (Biernacki and Waldorf 1981). This method was used because the Hmong farming community is a close-knit community of individuals who are hard to reach due to a variety of personal and sociodemographic characteristics. The questionnaire used was adapted with permission from a survey validated by Dr. Neitzel and colleagues at the University of Michigan (Neitzel et al. 2014). The final survey consisted of 36 questions. The cultural equivalency model for translating and adapting instruments was used to translate the English survey into the Hmong written language (Chavez and Canino 2005). The survey was approved by the Institutional Review Board at the University of California Merced. Data collection took place in Fresno, California in January to February 2018.

The first section of the instrument asked respondents to provide demographic information about the farm household. The second part asked about crops grown on the farm and their significance. The third section asked about pesticide use on their farm. These questions included whether the farmer uses pesticides, whether they were organic or nonorganic, and application methods. The participant's perceived risk of exposure was measured on a scale from 1 to 5, with 1 being no risk at all, and 5 representing dangerous and toxic risks. Additional questions on types of PPE used during pesticide application, safe application practices, and the participant's ability to recognize pesticide signal words were included. Finally, the participants were asked whether they were familiar with alternative pest management approaches such as IPM. Since there is no equivalent for IPM in Hmong, the concept was translated in Hmong as Lwm hom kev siv tshuaj los tua kab, which means other ways (alternatives) to use less pesticides to control pests. Questions were also included about which IPM practices the farmer was familiar with, if the participant was familiar with beneficial insects, and which IPM practices were used. Finally, participants were asked about their interest in future pesticide safety trainings.

The survey was written in Hmong and read to participants in Hmong. Each participant was surveyed on an individual basis. Participants were asked to provide consent to participate. Each survey took approximately 1 h to administer. Data were entered into Excel and imported into Stata version 14.2 for analysis. Descriptive data were produced for demographic variables. Open response questions asked the farmer which crops were grown the previous year on the farm, and their significance to the farmer; crops perceived to require the most pesticide use were also listed as well. Whether or not PPE was worn, and if safe pesticide application processes were followed, were evaluated with a binomial test to determine whether responses for the group varied from the expectation of an equal likelihood. Finally, interest in future trainings and in learning pest management practices through IPM were assessed as well.

Results

Demographics

By a series of chain-referrals, a total of 30 farmers were approached for this study, and 28 farmers from different farms completed the survey. The survey participants were 64% female and 36% male. Forty-three percent of the participants were over the age of 60, and 43% were age 40–60 (Table 1). The primary language spoken at home was Hmong (93%). The majority of the participants had no formal education (71%), while 18% had completed college (Table 1). The size of the farms was relatively small, with a mean farm size of 2.02 hectares (~5 acres). The mean number of years farming in the United States was 11.6 ± 1.48. Among the farmers surveyed, 7% owned the land, 82% rented land, and 11% of respondents farmed under other conditions, which was sharing a farm with a relative who rented land.

Table 1. Demographic characteristics of Hmong famers (*n* = 28)

Variable	Percent
Gender	
Female	64.3
Male	35.7
Age	
20–30	7.1
31–40	7.1
41–50	21.4
51–60	21.4
>60	42.9
Language Spoken at Home	
English	7.1
Hmong	92.9
Education	
No School	71.4
Primary School	3.6
Middle School	3.6
High School	3.6
College	17.9

Hmong Farm Crop Characteristics

A total of 31 crop varieties were reported grown in the previous year (Table 2, Supp Table S1 [online only]). Among these crops, long beans and lemongrass were both grown by nearly half the respondents (43%, 12/28), followed closely by bok choy and Chinese broccoli (39%; 11/28). Cherry tomato, Thai pepper, and eggplant (25%; 7/28) were grown by a quarter of participants, and a variety of crops were reported at low frequency (Table 2).

Farmers were asked which four crops they cultivated were most important or meaningful to them, and the significance of the crop to the farmer. There were 22 different crops reported. The six most frequently mentioned by respondents were lemongrass (21% 6/28) and Hmong vegetables (18%, 5/28), followed by Asian rice, cherry tomato, cilantro, and sweet pea (11% each, [3/28], respectively). The reason for significance of each crop varied (Table 3), but crops were typically identified as having significance for their commercial value, home use, or for well-being; well-being included responses of nutritional value and health, and brings good memories. For example, lemongrass was important because it was easy to maintain and had economic value, while Hmong vegetables and cilantro were important for home consumption, and Asian rice contributed to well-being.

Pesticide Practices

A majority of farmers (89%, 25/28) indicated that they had used pesticides on their farms. Among those reported to use pesticides, 84% (21/ 25) used nonorganic pesticides, compared with only 16%

Table 2. Crops grown in the previous year among the Hmong farmers surveyed. Percent of respondents reporting a crop (*n* = 28)

Name of crop	Frequency	%
Long beans	12	42.86
Lemongrass	12	42.86
Bok choy	11	39.29
Chinese broccoli	11	39.29
Cherry tomato	7	25.00
Thai pepper	7	25.00
Eggplant	7	25.00
Sweet Peas	6	21.43
Yo Choy	5	17.89
Asian Rice	5	17.89
Onion	4	14.29
Asian Cucumber	4	14.29
Bittermelon	3	10.71
Cilantro	3	10.71
Singua	3	10.71
Okra	2	7.14
Cabbage	2	7.14
Grape tomato	2	7.14
Zucchini	1	3.57
Asian sweet potato	1	3.57
Daikon	1	3.57
Asian corn	1	3.57
Strawberry	1	3.57
Totsoi	1	3.57
Green beans	1	3.57
Potato	1	3.57
Basil	1	3.57
Cauliflower	1	3.57
Herbs	1	3.57
American broccoli	1	3.57
Bell pepper	1	3.57

Table 3. Six crops most frequently noted as important to Hmong farmers, and their significance

Crop	Significance
Lemongrass	Economic value, easy to grow
Hmong vegetables	Home use
Asian rice	Well-being, easy to grow
Cherry tomatoes	Economic
Sweet peas	Economic
Cilantro	Home use

Table 4. Crops with most perceived pesticide use

Crops	Percent
Long beans	24%
Sweet peas	16%
Chinese broccoli	8%
Thai pepper	8%
Bok choy	4%
Asian Cucumber	4%
Hmong vegetables	4%
Okra	4%
Singua	4%
Bittermelon	4%
Eggplant	4%
Herbs	4%
Spinach	4%

(4/25) who used organic products. Fourteen crops were perceived to require the most use of pesticides (Table 4) (Supp Table S1 [online only]). The crops which farmers felt required the most pesticide use were long beans and sweet peas (24% [6/25], and 16% [4/25], respectively), while Chinese broccoli and Thai pepper were reported by 8% (2/25) (Table 4). Furthermore, 64% (16/25) of Hmong farmers reported that pesticides used were for disease and pest management.

Most farmers 72% (18/25) were occasional pesticide users, while 28% (7/25) were frequent users of pesticides. Occasional users indicated that pesticides were used several times during a growing season, while frequent users applied pesticides from once a week to several times per month. The pesticide formulations used were investigated as well. The most common type of formulation used by most farmers was liquid (93%, 23/25), followed by powders (52%, 13/25), and a small portion of farmers used granular pesticides (20%, 5/25). Additionally, the three most frequent pesticide application methods were spraying (68%, 17/25), followed by hand-thrown (16%, 4/25) and mechanical methods (16%, 4/25). With respect to mixing pesticides, 76% (19/25) reported occasionally mixing pesticides, 12% (3/25) were frequently mixing, and another 12% (3/25) did not mix pesticides. Similarly, 76% occasionally cleaned mixing equipment, while 24% frequently cleaned it. Fortunately, 96% (24/25) had hand-washing stations at the farm, and one farmer brought water to the farm site for cleaning up after applications. Despite taking these precautions, most (84%, 21/25) participants indicated at least occasionally wearing their field clothes home.

Pesticide Knowledge

Among all 28 participants, 39% (11/28) felt they were exposed to dangerous and toxic risks, 39% perceived a large and significant amount of risk, and 18% (5/28) responded that potential exposure represented a moderate amount of risk. There were 86% (24/28) who correctly identified that the image of the skull and crossbones represented the most dangerous pesticide category. Forty percent (10/25) of pesticide users reported that they understand pesticide labels signal words compared with 60% (15/25) who did not. Over half of the Hmong farmers reported they would like to have a better understanding of the pesticide label information provided on the pesticide products.

Prevention of Exposure

The majority of study participants appeared to take numerous precautionary measures when utilizing pesticides. For responses regarding the use of PPE, the overwhelming majority reported wearing closed-toe shoes, boots, hat/head cover, glasses/eye protection, face masks, long sleeve shirts and long trousers, and protective gloves while applying pesticides. For instance, 100% (25/25) reported that they wore hand gloves, long sleeves, and pants, hats or head covers, 95% (24/25) wore safety glasses or eye shields, and 92% (23/25) used face masks (all $P < 0.001$; Table 5). Similarly, 92% (23/25) reported that they do not eat, drink, or smoke while spraying pesticides, 84% (21/25) do not spray in windy weather, and 88% (22/25) reported that they followed the re-entry interval (all $P < 0.001$; Table 5). Despite all these precautions when using pesticides, 80% (20/25) of farmers reported to have had a direct body contact with pesticides, with hand contact being the most common response (90%, 18/20). Additionally, while 68% (17/25, $P = 0.042$) change clothes soon after spraying pesticides, 48% (12/25) did not shower immediately after a pesticide application ($P = 0.50$, Table 5).

Knowledge and Training

Of the 28 participants, 60% (17/28) were not familiar with any alternative pest control methods, 75% were unfamiliar with the term IPM, and 61% are unaware of beneficial bugs. Only 42% had attempted to practice an alternative technique for pest management, and these included crop rotation (4%, 1/28), physical/mechanical methods (14%, 4/28), and organic methods (18%, 5/28). One barrier to using more IPM practices was the need for more information (46%), while others felt that using conventional pesticides were more economical than IPM (38%). Lastly, 96% (27/28) expressed an interest in additional training, and that pesticide training should be made available in Hmong.

Discussion

This is the first study to investigate the pesticide knowledge, attitudes, and practices of Hmong farmers in the San Joaquin Valley of California, which is home to the largest Hmong farming population in the United States. The average size of Hmong farms was similar to the size previously reported for Hmong farmers (2.02 hectares, 5 acres) in the Fresno area (Molinar et al. 2007). Hmong farms are much smaller than other small-scale farms in the Central Valley area of Fresno, which average 20.23 hectares (~50 acres) (CDFA 2016). Our study found that the vast majority of the participants did not own the land they farmed. Hmong farmers in the San Joaquin Valley often have limited resources, as has been found for other small-scale farmers (Rasmussen et al. 2003, Sowerwine et al. 2015, UCCE 2015).

Findings of this study include the reporting of a wide variety of Asian specialty crops, perception of pesticide use and exposure, and pesticide and pest management training needs. Reasons that Hmong farmers are involved in farming included economic gain, well-being and home use of farm products, findings consistent with Miyares (1997) and Rasmussen et al. (2003). The types of crops reported in this study include long beans in the summer, bok choy during winter, and lemongrass, which is grown year round; these were crops also reported grown by Hmong in the Central Valley (Molinar 2012).

Table 5. Hmong farmers use of personal protective equipment and application practices

Variable	*N*	Observed *k*	Observed *P*	*P* value*
PPE-Facemask	25	23	0.92	<0.001
PPE-Full-coverall trouser	25	25	1.00	<0.001
PPE-Gloves	25	25	1.00	<0.001
PPE-Boots	25	25	1.00	<0.001
PPE-Glasses or face shield	25	24	0.96	<0.001
PPP-Hat/head cover	25	25	1.00	<0.001
PPE-Full length sleeves	25	25	1.00	<0.001
When mixing, wear gloves and safety glasses	25	25	1.00	<0.001
Not spraying in windy weather	25	21	0.84	<0.001
Not eating, smoking or drinking while spraying	25	23	0.92	<0.001
Follow re-entry interval after spray	25	22	0.88	<0.001
Take shower immediately	25	12	0.48	0.50
Changes clothes immediately after application	25	17	0.68	0.042

**P* value for a two-tailed test. Expected *P* for all tests was 0.50.

Hmong farmers in the Fresno area reported the use of pesticides to reduce insect pests and plant diseases, as did Hmong farmers in Washington and Thailand (Kunstadter et al. 2013, De Castro et al. 2014, Neitzel et al. 2014). In this study, long beans, sweet peas, and other Asian specialty vegetables were perceived to require more pesticides than other crops to manage insect pests and diseases. An additional study of the pest management practices surrounding these crops could be valuable.

The vast majority of farmers in this study reported using proper PPE, which contrasts with some previous studies that found PPE was not used among limited resource, low-literacy farmers due to language barriers, limited pesticide training, and lack of resources (Yassin et al. 2002, Ntow et al. 2006, Kunstadter 2013, Neitzel et al. 2014, Santos 2015, Negatu et al. 2016). Language and education barriers have been recognized as major contributors to limited pesticide knowledge among farmers and farmworkers with low literacy (McCauley et al. 2006, Santos 2015). The majority of the Hmong participants in this study had little formal education, as found in similar studies of small-scale farmers (Neitzel et al. 2014, Santos 2015). Nevertheless, 85% were knowledgeable about the risk of exposures while using pesticides on their farms. Farmers in this study took precautions, such as waiting to re-enter the field after applying pesticides, and not eating, drinking or smoking during application. We did not inquire about the sources of the participant's pesticide and pest management training. However, farmers in this study are required to have had training to apply pesticides, or to work with pesticides under supervision of a qualified pesticide applicator. According to participants' responses, pesticide applications were being conducted in an appropriate manner.

Another finding from this study is that participants waited some time to change out of work clothes, or did not shower immediately after working. For instance, 60% reported wearing their field clothes into their home; this is reported in studies of farm workers as well (Salameh et al. 2004). The movement of pesticide residue into the home via contaminated work clothing has been called the take home pesticide exposure pathway (Fenske et al. 2013). Farmworkers' homes were more likely to have higher concentrations of pesticide residues compared to nonfarm workers' homes (Fenske et al. 2013). In addition, many participants in this study reported previous exposure to pesticides, particularly via the hands, but participants were not asked when this previous exposure may have occurred.

Over 70% of participants were not familiar with the concept of IPM, although some farmers were implementing practices which are components of IPM programs, such as crop rotations and physical and mechanical pest control methods. Cultural practices such as intercropping and crop rotation were mentioned by Hmong farmers, but they were not mentioned as practices which were used for pest management. Research has demonstrated that these cultural practices reduce the incidence of crop pests. The diversity of crops grown by Hmong farmers also promotes conservation biological control by providing habitat and food sources for existing native beneficial insects such as predators and parasitoids. On Hmong farms, cultural and biological control methods associated with IPM appear to be practiced.

Hmong farmers were interested to learn more about IPM practices and needed more information to do so. Numerous Asian specialty crops are grown by these farmers. One approach to begin an IPM program would be to conduct an inventory of pest and beneficial insects, and plant pathogens, for crops perceived to require the most pesticide use (e.g., long beans). Insects and plant pathogens could be associated with crop damage, and key pests identified. IPM for a crop would include sampling these pests to determine a threshold which justified the use of a pesticide application. Outreach to farmers could discuss sampling and economic thresholds, as well as how existing Hmong farming practices such as crop rotation naturally contribute to IPM and reducing pests. The Hmong community would benefit from more in-person outreach activities conducted in Hmong, since this cultural more commonly practices an oral tradition than a written one.

This study advances our understanding of the Hmong farming community in the San Joaquin Valley of California, but it also has limitations. The study consists of 28 small-scale Hmong farmers in Fresno County; a future study could expand by including a larger sample size and include more counties in the San Joaquin Valley. Future methodology could consider using oral histories and in-depth interviews with farmers as well as surveys, to gain insight into the relationship between traditional farming practices and their role in pest management. Hmong extension personnel are particularly valuable to help understand cultural barriers, to promote safe and effective pesticide use, and to translate the ideas of IPM into practice. It should be noted that Hmong farmers, as a community, are traditionalists in terms of their farming practices; they orally pass farming practices to the next generation.

The Hmong farmers participating in this study had limited educational backgrounds and low literacy. Farmers were interested in more knowledge to safely use pesticides and more information about IPM, and the majority of participants (96%) voiced a preference for trainings to be taught in Hmong. This is a helpful recommendation for future intervention programs because language could be a barrier to providing effective training in this community (Yassin et al. 2002, Salameh et al. 2004, Ntow et al. 2006, Kunstadter 2013, Neitzel et al. 2014, Santos 2015, Negatu et al. 2016). Future work might investigate which pesticides are used to protect the crops that were perceived to require the most pesticide use, in order to better understand the health risks of exposure to these products.

Safety training could emphasize PPE selection to provide the best protection for working with liquid pesticides; the majority of farmers applied liquid pesticides and had recorded a previous exposure, particularly of the hands. Finally, educational outreach should emphasize the hazards of wearing contaminated work clothing into the home. Removing work clothes at the farm would help prevent contamination of cars and homes, and reduce exposure to other family members as well as the farmers. All would benefit from changing work clothes before leaving the farm, as in custom place in many occupations.

Conclusions

This is the first study to explore pesticide knowledge, attitudes, and practices among small-scale Hmong farms in the Fresno area of the San Joaquin Valley of California. The Hmong American population is substantial in size and actively engaged in family farming. Understanding their work practices and needs will inform relevant future pest management trainings.

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