UNIVERSITY OF CALIFORNIA, MERCED

Hmong Farmer Narratives of Pesticide Use in the Central Valley, California

A dissertation submitted in partial satisfaction of the requirements

for the degree Doctor of Philosophy

in

Public Health

by

Chia Thao

Committee in charge:

Professor Nancy J. Burke, Chair

Professor Irene H. Yen

Professor Sandie Ha

2021

The Dissertation of Chia Thao is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

Irene H. Yen, PhD, MPH Date

Sandie Ha, PhD, MPH Date

Nancy J. Burke, PhD, Chair Date

University of California, Merced
2021

In loving memory of my baby brother, Neng Thao

"Hakuna Matata"

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Acknowledgments

I am forever indebted to all the Hmong farmers who participated in this study. I appreciate how you opened your homes and farms to me, and I enjoyed learning about your resiliency. Thank you for trusting me with your stories. In addition, I also could not have finished my data collection without the support of various key informants who helped connect and refer me to the Hmong farmer community.

I want to thank my family and friends. To my wonderful husband, loving parents, and amazing brothers for your unconditional love and unwavering support. I am moved beyond words by your sacrifice, patience, and encouragement. We have endured so many hardships together, and there are times that I wanted to give up, but I was able to reach my educational dream because of you. To my children, thank you for entrusting your love with me, despite my absence during the past five years. To my baby brother Neng, I made it! Many thanks to my great friend Kau Vue for working closely with me throughout my educational journey at UC Merced. You are an inspiration for me, and I am happy to know that you will always have my back. And to my sister-in-law, GoaSang Xiong, thank you for being willing to assist and edit my chapters. This dissertation would not have come to fruition without both of your guidance and support.

Last, I would like to thank my mentor Dr. Nancy J. Burke, and dissertation committee, Dr. Irene Yen and Dr. Sandie Ha, for their assistance, support, and mentorship. Thank you for your insightful comments and guidance so that the completion of this dissertation was possible. I can honestly and proudly say that I have the best mentors on my team!

Curriculum Vitae

CHIA THAO, MPH, PhD Candidate

EDUCATION

The University of California, Merced
Merced, CA
Ph.D. Public Heath *August 2016-December 2021*

California State University, Fresno
Fresno, CA
Heath Policy Leadership Certification
May 2012

Master in Public Health, Health Promotion Option
December 2010
American Humanics Nonprofit Management and Leadership Certification
May 2009
Certified Peer Health Educator and Leadership Certification
April 2009

Baccalaureate of Science, Health Science-Community Health
May 2007
Minor in Gerontology

Current Research Interest

My research interests center around improving minority health disparities and promoting wellbeing. My research experience includes diabetes, reproductive health, mental health in the Southeast Asian community, and environmental health. As a Ph.D. candidate at UC Merced, one of my goals is to explore how environmental factors such as pesticide use affect underserved populations in the Central Valley. I recently completed a project on pesticide use and the wellbeing of small-scale farmers in the Central Valley. I assessed small-scale Hmong farmers' attitudes, knowledge, and perception about the use of pesticides using a survey instrument I translated into Hmong. To build on my prior research project, my current dissertation seeks to explore factors that influence pesticide exposure and adverse health impacts among small-scale Hmong farmers, detailing farming practices and the dissemination of pesticide information.

TEACHING EXPERIENCE

Lecturer *August 2012 – Present*
Department of Public Health
Fresno, CA
College of Health and Human Services - California State University, Fresno

- Develop and teach undergraduate public health courses. Specific teaching courses include:
  - Contemporary Health Issue (PH 90)
  - Introduction to Human Sexuality (PH 91)
  - Global & Cultural Issues in Health (PH 104)
  - Alcohol & Alcoholism (PH 111)

- Aging and Health (Gerontology 115)

- Collaborate with other public health professionals to advocate and foster health awareness on campus.
- Establish an instructional plan compatible with the CSUF and system-wide curricular goals focusing on web-enhanced instruction; interact effectively with students to enforce learning in the classroom.
- Currently working with the Fresno County Department of Public Health to develop a COVID-19 contract tracing course in Hmong.

Teaching Assistant *August 2016 – Spring 2018*
Department of Public Health
Merced, CA

- Assist each assigned professor by teaching undergraduate public health courses. Read and evaluate assignments, quizzes, lab reports, and papers. Specific assisting courses include:
  - Insect (PH 137)
  - Environmental Health (PH 110)
  - Research Methods (PH 112)
  - Genetic and Public Health (PH 135)
  - Global Health (PH 105)
  - Health Communication (PH 103)
  - Health Promotion (PH 102)
- Present occasional lectures, hold office hours, proctor exams, host review sessions, maintain student grades, and perform other tasks assigned by the professor.

HEALTHCARE RESEARCH, MANAGEMENT, AND POLICY EXPERIENCE

Graduate Student Researcher *July 2021 – Present*
Health Equality Research Lab
Merced, CA
School of Social Science, Humanities and Art – University of California, Merced

- Assist on an NIH-funded project, "*Getting Asian Americans INFORMED to Facilitate COVID-19 Testing and Vaccination." (Individual and Family Oriented Responsive Messaging and Education).* A research study about Chinese, Vietnamese, and Hmong Americans and their views on COVID-19 testing and vaccinations. The PI for this project is Dr. Janice Tsoh.
- Meeting with community agencies and research teams to coordinate the development of this research project.
- Assist in the translation of materials into Hmong language.
- Assist in the qualitative data collection.

Project Coordinator *August 2018 – Present*
Robert Wood Johnson Foundation
Merced, CA
Interdisciplinary Research Grant

- Coordinate all research activities related to the project.
- Manage meetings, correspond to emails and mails, and research inventories.

- Collaborate with local organizations to conduct research activities and distribute research supplies.
- Organize an intervention bag filled with therapeutic color sheets, journaling books, and informational sheets. An estimated 1000 bags will be distributed to the community once the pandemic is over.

Health Educator Coordinator *October 2008 – December 2009*
University of Health and Psychological Services (UHPS) – California State Fresno, CA
Interdisciplinary Research Grant

- Designed the Family PACT Peer Health Education Program to implement the education and counseling requirements as a part of Family PACT program requirements.
- Collaborated with University Health and Psychological Services (UPHS) Management Team to identify specific responsibilities of the Family PACT program for Peer Health Educators.
- Developed the Peer Health Educators training curricula (in collaboration with UHPS clinical staff and Fresno State professors, other pertinent campus programs such as the Violence Prevention Program, Cultural Heritage Institute, and other off-campus organizations like Planned Parenthood).
- Organized meetings, training, workshops, awards ceremonies, and media events to foster the Family PACT Peer Health Education Program.
- Supervised 11 Peer Health Educators (PHEs) and provided training and on-going support services to PHEs.
- Coordinated and evaluated the Family PACT Peer Health Education Program throughout the program design and implementation process.

Graduate Research January 2009 – December 2009
Master of Public Health Program (MPH)
College of Health and Human Services - California State University, Fresno
Fresno, CA

- Under the guidance of the department chair, I:
  - Assisted and substituted for a Health Promotion and Diseases class and other assigned classes.
  - Created and revised the department flow-charting forms for each major option. Successfully distributed to more than 1,500 students at the Fresno State Graduate Fair; the Public Health Department continues to distribute the forms to their undergraduate students.
  - Facilitated graduate educational workshops for undergraduate students.
  - Coordinated chair's annual meetings.
  - Collaborated with the Health Career Opportunity Program (HCOP) to organize a one-day educational conference for 500 migrant students in the Central Valley.

Community Health Intern *January 2008 – October 2008*
Central California Regional Obesity Prevention Program

College of Health and Human Services – California State University, Fresno
Fresno, CA

- Collaborated with community partners throughout the Central Valley to work on the CX3 research project funded by the State of California. This project aimed to identify barriers that prevented healthy eating in minority communities in terms of cost, quality, accessibility, and environmental factors.

Graduate Assistant *November 2007 – May 2008*
Master of Public Health Program (MPH)
College of Health and Human Services - California State University, Fresno
Fresno, CA

- Responsible for the daily operations and correspondences of the MPH Program by providing student, staff, and faculty quality support where needed.
- Organized outreach events to foster the MPH Program and worked with community members to establish a good working relationship between the Department and the community.
-

Research Assistant *August 2007 – March 2008*
Central Valley Health Policy Institute
Fresno, CA

- Conducted interviews with Hmong breast cancer survivors to determine barriers to care, preventions, and treatments. Translated interview transcripts from Hmong to English to understand barriers.

Health Educator *June 2007 – May 2008*
Economic Opportunities Commission (EOC)
Fresno, CA

- Evaluated and updated the clinical protocol through consulting with the Medical Director for effective and efficient delivery of healthcare services to patients.
- Provided individual education and counseling to patients.
- Follow-up on patient appointments through evaluating patient charts and answering their questions.
- Conducted outreach activities in the community to enhance accessibility of healthcare services to minorities and low-income patients. Worked directly with youth and their parents about health education and sex education. Also provided information to parents regarding EOC healthcare services.
- Supervised student interns and provided support for their projects, as well as provided mentorship to at-risk youth.

Research Scholar *August 2006 – May 2008*
Ronald E. McNair Achievement Fellowship
Fresno, CA

- Under the guidance of Dr. Miguel A. Perez, I developed two research focuses on the Asian communities in the Central Valley. My first research studied the Hmong community and their accessibility to the healthcare system in Fresno County entitled, “Hmong Healthcare

Practices in Fresno County: A Pilot Study." My second research focus was on Asian American College Students' Sexual Health Behaviors.

Research Assistant *February 2006 – September 2007*
Department of Health Science
Fresno, CA

- Worked directly with Dr. Helda Pinzon-Perez to evaluate qualitative and quantitative responses for a Medical Massage Therapy Research Project in the Department of Health Science.
- Utilized the Statistical Package for Social Science (SPSS) and the NVivo software to analyze the Medical Massage Therapy Research Project data.
- Organized and facilitated a Bi-national Conference on campus to educate the community about health education and promotion.

Volunteer Coordinator January 2005 – May 2005
American Cancer Society
Fresno, CA

- Promoted and provided marketing materials about healthy lifestyles to healthcare workers.
- Followed up and evaluated patients' well-being as well as provided additional support for patients. Evaluated patients' support systems for effectiveness and efficiency.

Peer Health Educator *January 2004 – December 2006*
California State University, Fresno Health Center
Fresno, CA

- Actively engaged in the Social Norm's Project by promoting alcohol awareness and prevention.
- Provided assessments on university students' perceptions of health and behaviors. Educated the university community about the findings to counterbalance the myths and stereotypes about university students' drinking behaviors.
- Provided alcohol education and conducted activities with university students to promote safe drinking habits.

NONPROFIT LEADERSHIP EXPERIENCE

Board Chair *January 2016 – Present*
Elder Abuse Services (EASI), Inc.
Fresno, CA

- Chair the board meetings and actively participate in the planning process of EASI's mission by-laws, policies, and programs.
- I am actively seeking grant opportunities, fundraising events, and grant writing. In March 2019 and 2020, I, along with two executive board members, wrote a grant and was awarded $2000 from the Central California Women's Conference (CCWC) grant. Last April 2019, we fundraised over $3,000 for the agency. Annually, from July – September, I collaborate with the executive team on the U.S. Department of Housing and Urban Development (HUD grant proposal.

- Coordinate the Volunteer/Internship Program. Developed and revised a 20-hour course curriculum to teach the volunteers and interns.
- Supervise the interns and monitor interns' activities.
- Collaborate with other aging agencies in the Fresno/Madera region to educate the community about elder abuse, victim advocacy, and coordinated case management services to victims of elder crime and abuse.

Board Member/Consultant *May 2015 – May 2019*
Hmong Cultural Heritage and Museum (HCHM)
Fresno, CA

- Actively participated in the planning process of HCHM's mission, bylaws, policies, and programs.
- Developed and updated the strategic plan and evaluated the implementation plan presented by staff.
- Monitored the organization's performance and ensured adequate and appropriate resources to carry out the organization's mission.
- Evaluated the executive director's performance to provide effective and efficient resources for support.
- Collaborated with local agencies and advocated on behalf of the organization.
- Submitted a grant to Fresno Regional Foundation (February 2016).

Board Chair *August 2008 – December 2013*
Healing Hope, Inc Fresno Board of Directors
Fresno, CA

- Chair of the Healing Hope Board of Directors. I actively participated in the planning process of HealingHope's mission, bylaws, policies, and programs. Developed and updated the developmental process and strategic planning and advocated on behalf of the organization.
- Fundraised over $8,000 for Healing Hope as of May 2010 to fulfill the organization's mission and vision.
- Coordinated Healing Hope Board Leadership meetings and annual retreats.

Board Member *August 2005 – May 2006*
Stone Soup Fresno Board of Directors
Fresno, CA

- Actively participated in the planning process of Stone Soup's mission, bylaws, policies, and programs. Developed and updated the strategic plan and evaluated the implementation plan presented by staff. Monitored the organization's performance and ensured adequate and appropriate resources to carry out the organization's mission. Evaluated the executive director's performance to provide effective and efficient resources for support. Advocated on behalf of the organization.
- Conducted fundraising activities to provide adequate funds to Stone Soup to fulfill the organization's mission and vision.

Evaluator/Team Leader *August 2005 – November 2006*
United Way of Fresno County
Fresno, CA

- Led a 3-member site visit team to conduct extensive interviews with local nonprofit organizations' executive director, board chairman, staff member, and volunteer on personal or professional conflicts of interest, adherence to ethical practices, and meeting all legal regulations and responsibilities as a 501(c) (3) organization.
- Evaluated local nonprofit organizations for effective and efficient operations on the clear and well-defined mission and vision statements and collaboration with UWFC and its endorsed organizations.

Volunteer Coordinator *September 2005 – May 2006*
Sequoia Community Health Centers
Fresno, CA

- Recruited Hmong students attending Fresno State University to be screened, and reviewed Hmong patients' health history in order for Sequoia Health Center to provide high-quality healthcare services to patients.
- Worked as an interpreter for the patients and healthcare providers to avoid confusion and misunderstanding in providing quality healthcare services.

EDITOR/REVIEWER

Madridge Journal of Behavioral and Social Sciences *August 2017-2019*
MJBSS

- As a board editor, I provided valuable feedback and recommendations for revising the manuscript.

California Journal of Health Promotion
CAJHP
October 2015

- Critically reviewed a manuscript on Diabetes Mellitus in the Hmong Community.
- Provided valuable feedback and recommendations for the revision of the manuscript.

PUBLISHED RESEARCH

C Thao. Asian American College Students' Sexual Practices: Findings from the ACHA-NCHA Web-based Data 2009. *California State University, Fresno. Call Number HQ35.2. T43 (2010).*

MA Perez & **C Thao**. Understanding barriers to prevention of ntshav qab zib/ ntshaav qaab zib: A Hmong perspective. *Hmong Studies Journals (2009): 1-23.*

Thao, C., Barrera, I., & Nguyen, U. S. (2019). Let's Face Adverse Childhood Experiences (FACE) It: Parent Education and Empowerment. *Archives of Psychology*, *3*(5).

Thao, C., Burke, N., Ha, S., & Joyce, A. (2019). Pesticide Knowledge, Attitudes, and Practices Among Small-Scale Hmong Farmers in the San Joaquin Valley of California. *Journal of Integrated Pest Management*, *10*(1), 32.

Gharibi, H., Entwistle, M. R., Schweizer, D., Tavallali, P., **Thao, C**., & Cisneros, R. (2019). Methyl-Bromide and asthma emergency department visits in California, USA from 2005 to 2011. *Journal of Asthma*, 1-10.

Thao, C., Perez, M. A., Thao, T., & Vue, K. (2020). Contraceptive Attitudes among Hmong Young Adults in Rural California. *Revista de la Facultad de Medicina Humana*, *20*(2), 1-1.

Angel Santiago Fernandez-Bou* , Jose Pablo Ortiz Partida, Leticia M. Classen-Rodriguez, Chantelise Pells, Kristin B. Dobbin, Vicky Espinoza, José Manuel Rodríguez-Florez, **Chia Thao**, Courtney R. Hammond Wagner, Amanda Fencl, Humberto Flores-Landeros, Mahesh L. Maskey, Spencer A. Cole, Shayda Azamian, Eliseo Gamiño, Alexander Guzman, Ana Grace F. Alvarado, Miriam S. Campos-Martínez, Coreen Weintraub, Espi Sandoval, Ruth Dahlquist-Willard, Leigh A. Bernacchi, Colleen C. Naughton, Robin M. DeLugan and Josue Medellin-Azuara. (2021). 3 challenges, 3 errors, and 3 solutions to integrate frontline communities in climate change policy and research: lessons from California. *Frontiers*.

PRESENTATIONS

Thao C. Pesticide Take-Home Pathways among Hmong Farming in the Central Valley of Fresno, California. American Public Health Association (APHA), Oct 25, 2021. Virtual oral presentation.

Thao C. Pesticide among Hmong Farming in the Central Valley of Fresno, California. UC Merced Farmworker Health Research Conference, April 9, 2021. Virtual oral presentation.

Thao C, Masumoto K, Leon R, and Pacheco-Werner T. How Can We Make Farm Work Healthier? Zocalo Public Square, April 14, 2020. Virtual Oral Discussion.

Thao C, Xiong C & Her C. A Hmong Legacy: Hmong Farmers in the Central Valley of Fresno, California. Hmong Voice Series Events, November 10, 2020. Fresno State Hmong Minor. Virtual Oral Discussion.

Thao C, Xiong S, Vue K, and Xiong C. Critical Hmong Studies, April 19, 2019. Oral presentation. Hmong National Development, Inc. *San Jose, CA*

Thao C, Barrera I, and Nguyen S. Let's Face Adverse Childhood Experiences (FACE) It: Parent Education and Empowerment. American Public Health Association (APHA), Nov 5, 2019. Oral presentation.

Thao C, Vang H, Vue K, and Xiong C. The Remaking of Community: Effects of Neighborhood Location on Hmong Refugees' Social Well-Being. Critical Refugee Studies Collective (CRSC), November 17, 2018. Oral presentation. *UCLA, CA*

H Gharibi, V Ramirez, M. R. Entwistle, C Thao & R Cisneros. Pesticide and Acute Asthma Attacks in California from 2005-2011: A Bidirectional Case Crossover Study. (2018). International Society for Environmental Epidemiology (ISEE), August 28, 2018. Poster presentation. Ottawa, Ontario, Canada.

Thao C, Perez A. P., Vue K., and Thao T. Contraceptive Attitudes among Hmong Young Adults in Rural California. American Public Health Association (APHA), 2018. Poster presentation. *San Diego, CA.*

C Thao. Hmong College Students' Contraceptive Attitudes. College of Health and Human Services Symposium. April 30, 2016. Fresno State.
C Thao. Understanding barriers to prevention of ntshav qab zib/ ntshaav qaab zib: A Hmong perspective. Central California Research Symposium. April 30, 2009.
C. Thao. A Pilot Investigation of Hmong Healthcare Practices in Fresno County. American Public Health Association Conference (APHA), October 18, 2008. Washington D.C.

C. Thao. Asian College Students Sexual Behaviors, Practices and Contraceptive Use. Central California Research Symposium. April 19, 2008. Fresno, Ca.

C. Thao. Hmong Healthcare Practices in Fresno County. Ronald E. McNair Research Symposium. April, 2007. Fresno State.

PROFESSIONAL MEMBERSHIPS

Fresno-Madera Continuum of Care Member *July 2019-Present*
National Institution of Health (NIH) *January 2012-Present*
Administration for Community Living *January 2012-Present*
National Association on Mental Illness (NAMI) *August 2012-Present*
Guttmacher Institute *May 2010-Present*
United States Agency International Development (USAID) *October 2010-Present*
American Public Health Association (APHA) *May 2008-Present*

HONORS/GRANTS

2021 Recipient, Graduate Dean's Dissertation Fellowship
2019 Recipient, Central Valley Graduate Fellowship

2018 Recipient, Critical Refugee Studies Collective (CRSC) Grant
2017 Recipient, Merced Graduate Division's Interdisciplinary Small Grant
2015 Recipient, Provost's Faculty Scholarship Award
2012 Recipient, Central Valley Health Policy Institute Policy Scholar
2009 Recipient, Youth/Peer Educator of the Year Award, Planned Parenthood
2008 Recipient, American Public Health Association PHEP Best Student Research Award
2008 Recipient, Protues Scholarship Award
2008 Recipient, Tokalon Alumnae Association Scholarship Award
2008 Recipient, President Volunteer Services Recognition, CSUF
2007-2008 Scholar, Ronald E. McNair Achievement Fellowship (Graduate), California State University, Fresno
2007-2008 Scholar, California Pre-Doctoral Program/Sally Casanova Pre-Doctoral Scholar
2006-2007 Scholar, Ronald E. McNair Achievement Fellowship (Undergraduate), California State University, Fresno
2006 Recipient, Certification of Appreciation, Sequoia Community Health Centers
2005 & 2006 Recipient, Certificates of Appreciation, California State University, Fresno Social Norm Projects
2004 Recipient, Outstanding Leadership Awards, California State University, Fresno Hmong Student Association
2003 Recipient, Outstanding Certifications, California State University, Fresno College Assistant of Migrant Program

PROFESSIONAL REFERENCES

Available Upon Request

Abstract

Pesticide use has undeniably contributed to greater crop yield. However, concerns about pesticide usage, particularly its impact on the environment and human health, have arisen. Farmers are exposed to pesticides in far greater numbers than the general population. Not surprisingly, studies show that pesticide exposure is associated with adverse health impacts in farming populations, including small-scale minority farmers such as Hmong community farmers in the Central Valley of California. The purpose of this qualitative study was to understand the factors that influence pesticide exposure among small-scale Hmong farmers in the California Central Valley. This research builds upon earlier studies that found Hmong farmers have great difficulty navigating the farming space in the Central Valley due to low literacy, language barriers, and limited in-language pesticide resources. I combined in-depth qualitative interviews and ethnographic observations in the current study. In-depth interviews included (a) narratives of adaptation to new farming practices in a foreign country, (b) explorations of components of pesticide literacy through descriptions of the flows of pesticide education and informal training, and (c) documenting the factors that contribute to the pesticide take-home pathway. Recommendations range from advocating for more culturally and linguistically appropriate pesticide safety training and educational programs be tailored to Hmong farmers, promoting available resources, and providing more services for Hmong community farmers in the United States.

Keywords: Hmong farmers, pesticide exposure, take-home pathways, pesticide safety training

Chapter 1

Introduction

The United States has long been the world leader in agricultural production. An early, intense national commitment to agricultural research and development, mechanization, and innovation resulted in continuous increases in crop yield per acre. One component of this success has been the development and widespread application of chemical pesticides. However, growing concerns have arisen about the possible damage pesticides inflict on the environment and human health, especially among farmers working directly with these chemicals. While exposure to pesticides associated with adverse health consequences can affect all agriculture workers, the potential impact may be most significant among small-scale minority farmers such as the Hmong community farmers, who are the focus of this study. This chapter provides background information regarding the risks associated with pesticide exposure and public health concerns related to agricultural practices.

O'Connor-Marer (2000) defines pesticides as any substance naturally or synthetically designed to destroy, suppress, or alter the life cycle of insects, rodents, nematodes, fungi, weeds, or any other form of life declared to be pests). By the mid-20th century, the U.S. agricultural industry increased its efficiency by adopting a wide array of pesticides to combat pests and increase crop production. Continuous exposure to these chemicals is now associated with adverse health outcomes, particularly for the farming population (Kim et al., 2017; Lee et al., 2007; Ntow et al., 2006; Ntzani et al., 2013; Sabarwal et al., 2018; Vergucht et al., 2006; Yassin et al., 2002).

Numerous studies have shown that exposure during pesticide handling can increase the risks of several acute and chronic health complications (Ntow et al., 2006; Ntzani et al., 2013; Vergucht et al., 2006; Yassin et al., 2002). Maladies associated with pesticide exposure include headache, dizziness, fatigue, insomnia, nausea, chest tightness, and dyspnea. More complex chronic illnesses such as cancer, amyotrophic lateral sclerosis, type 2 diabetes, and Parkinson's disease are also associated with pesticide exposure (Ahmed et al., 2017; Eskenazi et al., 1999; Kamel & Hoppin, 2004; Malek et al., 2012). These revelations have resulted in calls for research to gain a better understanding of the wide range of health impacts caused by pesticide use and exposure (Ahmed et al., 2017; Arcury & Quandt, 2009; Eskenazi et al., 1999; Kamel & Hoppin, 2004; Malek et al. 2012).

The United States Department of Agriculture's (USDA) National Agricultural Statistics Services (NASS) shows that U.S. farmers are becoming more ethnically diverse, and the number of small-scale farms is increasing (NASS, 2018). In the United States, most small-scale farms are family-owned and operated. However, most of the available research analyzing the effects of pesticides on farmers focuses on large, well-established farms owned by non-Hispanic, White farmers (Martin et al., 2002). These findings may not be directly applicable to small-scale farmers due to numerous differences, including farming techniques. For example, large-scale farmers use pesticide sprayer tractors to apply pesticides, while small-scale farmers use hand spray nozzles or smaller devices (Martin et al., 2002; Villarejo, 2003).

Small-scale minority farmers are an understudied population in the literature related to the effect of pesticides on farmers. Research on Hmong American farmers is

even more limited. Understanding small-scale Hmong farmers' exposure to pesticides and associated health risks is crucial to addressing appropriate pesticide safety procedures and preventative measures to reduce pesticide exposure, especially in a region with a high concentration of Hmong farmers such as Fresno County in California's Central Valley.

The following sections describe relevant research related to small-scale farming and pesticide exposure globally and in the United States, emphasizing Hmong farmers in the California Central Valley. I also discuss the policy and legal landscape that small-scale farmers must navigate in their pesticide use, decision-making, and practices. Next, I present a quantitative survey of Hmong farmers in the Central Valley and introduce the empirical Health Literacy model framework to conceptualize my pesticide literacy discussion. Finally, I provide an overview of the dissertation chapters.

Small-Scale Family-Operated Farming in the United States

The 2017 U.S. Census of Agriculture estimated that more than 94% of 570 million farms in the U.S. remain family operations (USDA, 2017). The United States Department of Agriculture (2013) defines small-scale farms as any operation of fewer than 500 acres with profits between $1,000 to $250,000 annually in agricultural products. Similar to the WCA, the USDA estimated that the vast majority of U.S. farms are "small" family-operated farms (see Figure 1 in Appendix A). As of 2017, the USDA National Agricultural Statistics Service estimated that 2.05 million U.S. farms constitute 910 million acres (average size: 444 acres) (see Appendix A) (NASS, 2018). The vast majority of the farms were in rural regions (USDA, 2017), which the U.S. Census Bureau defines as numbering between 2,500 – 50,000 people.

NASS urges more research to understand the characteristics of small-scale farms. NASS statistics have shown an increase in the racial/ethnic diversity of U.S. farmers. For example, the proportion of Asian-operated farms has continued to rise since 2002 (NASS, 2018). In areas such as California's Central Valley, small-scale farms are owned and operated by Hispanic and Asian farmers (Fresno County Agricultural Commissioner's Office [FCAC], 2017; UC Cooperative Extensive, 2008). Many ethnic small-scale farms lack a high level of English fluency (Dahlquist-Willard et al., 2015). Hmong farmers face the same obstacles as other ethnic small-scale farmers. Due to cultural and language barriers, they struggle to navigate available farming resources and services (Dahlquist-Willard et al., 2015; DeSantiago, 2020; Sowerwine et al., 2015; Thao et al., 2019). As a distinctive and cohesive group, the Hmong community farmers provide an attractive research avenue via which a greater understanding of barriers to success afflict many ethnic small farming operations.

Small-scale farmers play a significant role in producing and distributing local foods. In 2015, NASS researchers estimated that U.S. small-scale farmers provide over 8 billion dollars worth of food commodities to consumers, retailers, and institutions. A total of 14,315 U.S. farms made $2.9 billion in sales of fresh produce directly to U.S. consumers, as shown in Figure 2 in Appendix B (NASS, 2018).

Farming contributes significantly to economic development and food accessibility in poor rural regions (Marsden et al., 2000). Research shows that small-scale farmers produce more food per acre of land than large farming operations (Dahlquist-Willard et al., 2015) and small-scale farmers contribute substantially to national food availability and sustainability (Godfray et al., 2010; Marsden et al., 2000). Most small-scale farming

operations in California are labor-intensive and focus on growing a diversity of crops that supply local communities in a socially, economically, and environmentally sustainable way.

Pesticide Use in California's Central Valley

In 2017, the USDA estimated that 86% of all California farms (54,342) were small-scale. As the largest and most diverse agricultural producer in the United States, California uses the greatest volume of pesticides (California Department of Pesticide Regulations [CDPR], 2020). In 2018, farms in California used an estimated 209 million pounds of pesticides (CDPR, 2020).

The Central Valley is an agriculturally rich region with more than 360 different crops under cultivation (U.S. House Natural Resources Committee Press Office, 2014). This region is home to 19 counties, including Butte, Colusa, Glenn, Fresno, Kerns, Kings, Madera, Merced, Placer, San Joaquin, Sacramento, Shasta, Solano, Stanislaus, Sutter, Tehama, Tulare, Yolo, and Yuba (American Museum of Natural History, 2021). The Central Valley lies between the Coast Ranges of mountains to the west and the Sierra Nevada mountains to the east (American Museum of Natural History, 2021). Due to its geographical characteristics, the airflow through the valley can be blocked, trapping most incoming and local pollutants, including pesticide particles (California San Joaquin Valley Unified Air Pollution Control District, 2015). According to the California Department of Pesticide Regulations data, 209 million pounds of active pesticides used for California in 2018 and over 60 million pounds of applied active ingredients are carcinogenic and teratogenic (Proposition 65). The Central Valley is among the regions with the highest concentration of pesticides (CDPR, 2020).

Hmong Farmers in California's Central Valley

Historically, the Hmong were highlanders from agricultural communities in China, Vietnam, Laos, and Thailand (Lee, 2005). Farming primarily dictated their lives. They practiced slash-and-burn farming methods and used hand tools. The Hmong migrated to the United States after the end of the Vietnam War in the late 1970s, and although they initially did not settle in the Central Valley, a second migration led them to the Central Valley's fertile farmland (Lieb 1997). Many Hmong incorporated their experiences from their homelands into their agricultural practices in the United States (Mote, 2004). However, due to their limited English skills, Hmong farmers often experienced difficulty accessing resources available to them (Dahlquist-Willard et al., 2015). Méndez-Barrientos et al. argue that small-scale immigrant farmers, such as the Hmong farmers, have a distinct language, culture, and face land ownership challenges that hinder access to public government resources since land ownership is required to access government loans and other resources (Méndez-Barrientos et al., 2020). As a result, many Hmong farmers could not obtain funding to support their farming.

The Central Valley is home to the largest U.S. population of Hmong farmers. University of California Cooperative Extension (UCCE) (2015) data show that 1,519 farm operators in Fresno County are Asian, with an estimate that more than 900 Asian farms belong to Hmong farmers. Asian farms are generally small-scale operations, averaging 8.8 acres (Sowerwine & Getz, 2013). In 2007, Molinar et al. reported the average Hmong farm to be only 5.8 acres, which corroborates my recent research showing the average farm size to be 5.6 acres (Thao et al., 2019). According to the UCCE

report (2015), Hmong farmers are more likely to be tenants on rented land in peri-urban areas in Fresno and Clovis counties.

Most Hmong farmers in the United States still rely heavily on hand tools, manual labor, and direct sales to local Asian grocery stores, including Hmong grocery stores in the Central Valley (Molinar et al., 2007). According to Ramsussen et al. (2003), Hmong farming practices include hand-planting, thinning, weeding, and hoeing with little utilization of modern farming equipment such as tractors or harvesters. De Castro et al. (2014) reported similar findings in their study of Hmong farming practices in Washington state.

The top commodities of Hmong farms are Asian vegetables and fruits (NASS, 2018; Thao et al., 2019). In the Central Valley, most Hmong farmers grow seasonal Asian specialty crops, including fruits, vegetables, and herbs imported or grown on a limited scale in the United States (University of California, Division of Agriculture & Natural Resources, 2008). According to Molinar (2012), Hmong farmers in the Central Valley predominately grow Asian vegetables and herbs, jujubes, strawberries, and other crops grown for sale locally. My previous research identified 34 varieties of Asian specialty crops grown by Hmong farmers (Thao et al., 2019). Specifically, long beans are the most popular product among the identified crops, followed by lemongrass, bok choy, yo choy, sweet peas, cherry tomatoes, Thai peppers, and eggplant (Thao et al., 2019).

There is limited research on Hmong farmers and their exposure to pesticides. Even so, available research suggests that Hmong farmers may be exposed disproportionately to pesticides (de Castro et al., 2014; Kunstadter et al., 2001). De Castro et al. (2014) conducted a mixed-method study using participatory rural appraisal

and photovoice by 11 participants in Washington state. The study identified Hmong farmers' exposure to pesticides and poor pest management activities as an issue of concern (de Castro et al., 2014). A similar study conducted by Neitzel et al. (2014) reported that Hmong farmers were not using safety measures such as wearing ear or eye protection during mechanical operations. Neitzel et al. (2014) conducted an observational study of nine Hmong-operated farms and made 36 observations. The study also reported that many Hmong farmers they observed failed to wear personal protective equipment (PPE) and were likely exposed during pesticide applications.

More research is needed to understand pesticide use, exposure, and concerns among Hmong farmers in the United States. These findings can inform culturally and linguistically appropriate interventions necessary for this community. In Thailand, a study assessing pesticide exposure among 582 Hmong-Thai farmers found that they use intensive pesticide chemicals to control insects, weeds, and fungi on their farms (Kunstadter et al., 2001). One concern stressed by the investigators was the observation that the Hmong-Thai farmers manually carried the pesticides in backpack sprayers and hand sprayed the pesticides, which increased their risk of direct exposure. The study also found that up to 69% of the 582 Hmong farmers had unsafe levels of a cholinesterase inhibitor, an indicator of exposure to organophosphate and carbamate pesticides, two compounds known to have adverse health effects. Exposure rates were equally high among family members, suggesting exposure may be via a take-home pathway in addition to direct contact associated with the application (Kunstadter et al., 2001). This research demonstrates the critical need for more research to identify factors contributing to pesticide exposure among Hmong farmers. Understanding these factors is essential for

addressing policy change and developing culturally appropriate training for Hmong farmers and other cultural groups in the Central Valley of California.

Pesticide Laws and Regulations

Nearly a century ago, scientists found pesticides could inflict serious injuries to people and harm the environment. As a result, laws and regulations mandate that pesticide handlers follow all state, federal, and local laws when applying pesticides (CDPR, 2020). The U.S. Environmental Protection Agency (EPA) controls all pesticide laws and regulations, including oversight of state pesticide laws and regulations to ensure compliance. The California Department of Pesticide Regulations (CDPR) is responsible for statewide implementation and enforcement of these laws and regulations. As a result, the CDPR receives reports of agricultural pesticide usage. According to the CDPR, the purposes of these laws and regulations are to:

1) Provide for the proper, safe, and effective use of pesticide products and the protection of public health and safety;
2) Protect the environment from harmful pesticides by prohibiting, regulating, or controlling their usages;
3) Assure safety for workers where pesticides are present;
4) Authorize pesticide control and make sure that only competent, responsible licensees and permittees under strict control of the Department of Pesticide Regulation and County Agricultural Commissioners;
5) Assure applicators, consumers, and other users that the pesticides they use are properly labeled and are appropriate for the uses designated on the labeling; and

6) Encourage developing and implementing alternative pesticide methods such as biological and cultural pest control techniques and other integrated pest management systems (CDPR, 2020, p. 3).

The state of California is a pioneer in pesticide regulation due to its intensive pesticide regulatory programs. The laws mandate that all farmers know, understand, and follow federal, state, and local standards of application used on the farm (CDPR, 2020). In all agricultural settings, pesticide handlers and farmworkers undergo required training on pesticide safety. The laws also require anyone using restricted-use pesticides to have a Qualified Applicator License (QAL) and to report the use of any restricted-use pesticide products to the CDPR. Restricted-use pesticides are generally more toxic to human health and the environment (O'Connor-Marer, 2000). These pesticides must be labeled with the words "Danger" and "Poison" and display a skull and crossbones graphic. A few drops of these pesticides absorbed into the human body can be harmful and potentially lethal (O'Connor-Marer, 2000). For farmers, the most common pathways for pesticide exposure are through the skin, mouth, respiratory system, and eyes (O'Connor-Marer, 2000). According to the CDPR (2020), applicants seeking the Qualified Applicator License must demonstrate knowledge competence in pesticide handling and related laws and regulations by passing a state examination test.

Limited pesticide information and training resources available to Hmong farmers pose significant challenges. For instance, the "pesticide label" is a complex legal and scientifically technical document that farmers must read and understand before applying a specific pesticide product onto their crops. Chapter 3 explores the challenges Hmong farmers experience in reading and understanding available pesticide information. In

addition, obtaining a Qualified Applicator License can be difficult for many Hmong farmers for the same reasons. Finally, I provide my narrative of personal experience studying and trying to pass the Qualified Applicator License exam in Chapter 3.

Pesticide Take-Home Pathways

The pesticide "take-home" pathway refers to the pesticide residues a farmer or farmworker carries from the farm into their home via contaminated work clothing, shoes, skin, and vehicles (Fenske et al., 2013). Children of agricultural workers may be particularly affected by pesticide take-home pathway exposure. Studies that analyzed environmental and biological samples of children's exposure to pesticides via the take-home pathway from agricultural homes compared to non-agricultural homes found that children in agricultural homes had higher pesticide levels in their urine and their surrounding environments (Coronado et al., 2004; Thompson et al., 2014). Similarly, Hyland and Laribi's (2017) systematic review concluded that children of farmworkers were more likely to be affected by pesticides via the take-home pathway. López-Gálvez et al. (2019) provided additional evidence of take-home pathway exposure in a meta-analysis, which reviewed and synthesized the results of 39 articles related to the take-home pathway. The study concluded that children in agricultural families have higher pesticide exposure than children living in non-agricultural homes.

Childrens' exposure to pesticides has correlated to many adverse health outcomes. Epidemiological studies have demonstrated that children's exposure to pesticides is associated with adverse neurological development and increased risk of health conditions such as cancer, asthma, and congenital disabilities (Eskenazi et al., 1999; Mostafalou & Abdollahi, 2013; Raanan et al., 2016). Another study, using data from the Center for

Health Assessment of Mothers and Children of Salinas (CHAMACOS), analyzed the association of pesticide exposure among pregnant women and their children. Results indicated that children of mothers with higher pesticide (Organophosphate) concentration in their urine during pregnancy showed increased odds of attention problems and lower attention scores (Marks et al., 2010).

Understanding the effects of take-home pathway exposure is essential to all farmers. Most pesticides are applied in the California Central Valley because this area is among the state's and country's largest agricultural producers (CDFA, 2016). California reported the heaviest pesticide usage in the nation (CDPR, 2020). Given such a heavy reliance on pesticides, understanding the dangers and effects is essential for the State's small farmers.

Lessons Learned from Prior Research: Pesticide Knowledge, Attitudes, and Practices among the Small-Scale Hmong Farmers in the Central Valley

The approach used in this dissertation adopted methodological features used in my second-year research paper, "Pesticide Knowledge, Attitudes, and Practices among the Small-Scale Hmong Farmers in the Central Valley" (Thao et al., 2019). I designed a cross-sectional study to investigate the pesticide knowledge, perceptions, and practices among Hmong American farmers living in Fresno, California. I adapted a standardized questionnaire to assess a wide range of pesticide knowledge, perceptions, and practices (Neitzel et al., 2014). Additionally, I asked questions about farmers' ability to read and understand pesticide labels. A total of 28 farmers from 28 different farms completed the survey (Thao et al., 2019). Most participants (89%) indicated using pesticides on their farms, but 82% had no education in the United States. When asked if participants

understood the information on their pesticide products, most users (60%) reported they did not understand the information on the label. One question asked participants about barriers to understanding pesticide label information. Sixty-eight percent indicated they could not read the label information, and 21% indicated they could not read due to the complex vocabulary. This research documented difficulties Hmong farmers reported in understanding written information on pesticide exposure and the risk of poor health outcomes. The survey failed to capture the depth and complexity of the challenges. To identify and address barriers to understanding pesticide information and pesticide exposure, I employed a qualitative approach to collect and understand Hmong farmers' experiences using pesticides and their relationship to health issues. I was also interested in sources of pesticide education and the processes of communicating and sharing resources among the community.

Methodology

This dissertation explored factors that influence pesticide exposure and adverse health impacts among small-scale Hmong farmers by detailing their farming practices and capturing the information they used regarding pesticides. I conducted in-depth qualitative interviews and recorded ethnographic observations along with a brief demographic questionnaire to understand better the participants' characteristics (see Appendix C).

Purpose of the Study

The overarching aim of this qualitative study was to understand the factors that influence pesticide exposure among small-scale Hmong farmers in the Central Valley of California. Specifically, I explored Hmong farmers' understanding of health risks

associated with pesticide exposure. In addition, I explored the Hmong farmers' interactions with pesticide information and documented their traditional farming practices and how they adapted to current farming practices in the United States. Finally, I explored the pesticide take-home pathway and pesticide exposures among Hmong farmers.

Study Design

My dissertation research combined in-depth qualitative interviews and ethnographic observations. To guide the study, I used the Constructivist Grounded Theory (CGT) approach in each step of my research process (Charmaz, 2014). Even though constructivist grounded theory consists of a systematic structure, the method allows the researcher flexibility when collecting and analyzing qualitative data. The goal is for the researcher to construct theories that arise from the data. According to Charmaz (2014), the process begins with carefully constructing abstract categories through systematic analysis of relevant data. The researcher then invokes an iterative strategy by going back and forth between data and the analysis. The data analysis also includes a comparative approach through actively assessing and interacting with the data. The final step involved constructing a data framework, which constituted an emerging analysis. I then used these principles throughout data collection and analysis.

A Description of the Farm Setting

Hmong farms are defined as "micro-farms" because the average size of Hmong farms is much smaller than the USDA definition of "small family farms" (Molinar et al., 2007; Sowerwine et al., 2015). Previous studies found the average Hmong farm size to be

5.8 acres (Molinar et al., 2007; Thao et al., 2019), with the gross revenue ranging between $5000 to $50,000 annually. Hmong farmers' gross revenue averages are well below the USDA's definition of small family farms (Sowerwine et al., 2015).

Most Hmong farms consist of leased land with short-term contracts, usually between 1 to 5 years. Among Hmong farmers participating in this study, 92% were tenants on rented land; most were on the outskirts of Fresno. I usually drove 30 minutes to 45 minutes before reaching one of my destination farmers. The average short-term contract among study participants was three years. Many farmers needed to relocate to new plots at the end of their short-term lease. As a consequence, few farmers opted to build any permanent farm shelter. Instead, most farmers constructed an open 8 x 10-foot shed with a rented portable bathroom and handwashing station. The typical Hmong farms I visited grew various Asian specialty crops, ranging from lemongrass, mustard greens, green beans, cherry tomatoes, eggplant, bok choy, green onions, and Hmong herbs. Study participants usually reported selling their produce to the local packaging companies, farmers' markets, or Asian grocery stores.

Method and Procedures

Data collection took place in Fresno, California, in Fall 2019 and early Spring 2020. I recruited participants through a method termed "snowball sampling," by which early participants referred the researcher to others who shared similar characteristics (Biernackl & Waldorf, 1981). This method was particularly valuable as Hmong farmers share a close-knit community where introductions from fellow members served as the best way to meet other farmers. As a community member, I understood that most Hmong

farmers mistrusted outsiders, particularly individuals associated with research institutions or governmental agencies, due to incidents the farmers believed exploitive or otherwise adversely affected their farming practices. For instance, a study by Sowerwine et al. (2015) reported that agricultural labor laws, although intended to protect farmworkers, adversely affected Southeast Asian family farmers in the Central Valley. The study found that California Department of Labor Standards Enforcement officials fined many Hmong farms for failing to have workers' compensation insurance and not paying extended family helpers (Sowerwine et al., 2015). Such incidents highlight only one example of why Hmong farmers mistrust such outsiders as local agricultural commissioners who visit the farms to collect information about their farming practices.

To recruit participants, I contacted Hmong farmers who participated in my previous study and networked with the Hmong farming community in Central Valley, California. I developed a telephone script describing my research goals, methodology, and data collection process. Next, I asked farmers I knew for their cooperation in referring me to their peers, farm neighbors, or farm relatives. To establish a natural conversation and ensure that each participant felt comfortable participating in the study, I used my cultural background and knowledge to ask about their family history, lineage, children, and passion. When one meets a new person in the Hmong culture, it is culturally appropriate to first initiate the conversation by asking about their family history and lineage. This practice builds a relationship and facilitates identifying the proper way to address one another, such as an aunt, uncle, grandfather, grandmother, grandmother, or sister/brother. Once a relationship was established, I proceeded to ask questions relevant to my study.

I reassured each participant that the study was only for research purposes and that if they did not feel comfortable taking part, I would completely support their decision. Once a potential study candidate agreed to participate, I followed my two study approaches of interviewing and detailed observation. Participants could limit their study involvement by opting only to the interview or the ethnographic farm observation, which included a brief interview. Once a subject agreed to participate, we established a date and time for a subsequent meeting.

Semi-Structured Interviews

I conducted in-depth qualitative interviews with 25 participants. Each semi-structured in-depth interview lasted approximately 45–60-minutes in a setting most geographically convenient for the participants. On the day of the interview, I brought the participant a consent form, an audio release form, and my interview-guided questions (see Appendix C). I made every effort to make the meeting as natural and comfortable as possible. I verbally reviewed the consent form with each participant, stressed that the participants could withdraw from the study at any time, and emphasized that they could skip any questions or topics that they did not feel comfortable discussing. Each participant signed a consent form (either in Hmong or English) and received a copy of the signed document before proceeding to the conversation.

Given the farmers' history of legal concerns related to pesticide laws and regulations, I emphasized that they could deny my request to record the interview. All participants had a choice of being interviewed in English, Hmong, or Hmong and English. I interviewed 25 participants in Hmong; all (N=25) agreed to be recorded.

Ethnographic Observations

Eleven farmers verbally consented to permit me to shadow them for a day at their farm to collect ethnographic observations. I documented farm size, geographical layout, vegetables grown, farm leadership and workforce, harvesting and planting practices, pesticide use and storage, and pesticide take-home pathways in detailed field notes. The farm observations contain both interviews and fieldwork notes. I collected 13 farm observations; an earlier study provided two observations. I completed 10 interviews with farmers while conducting observations. One of the participants preferred not to be interviewed or recorded. However, with consent, I documented our conversation in detailed field notes.

I brought tools to assist each farmer with their work during the day. I grew up farming with my parents and understand the role of a farm helper. As a farm observer, I wanted to be as helpful as possible while being at the farm with them. Therefore, the night before my appointment with the farmer, I asked them what crops they [we] would be harvesting during my visit and brought the proper tools needed to assist the farmer. As a Hmong daughter, I knew the standard tools Hmong farmers needed to harvest their crops. I also brought all required documents for my data collection, including the consent and audio release forms and an outline of my interview-guided questions. I also brought food for my lunch, protective clothes to farm, boots, and a hoe and sickle. These two tools were the most commonly used during my farm observation days. Farmers also provided tools for my use.

Each farm observation lasted 8 to 12 hours and included the transition from farm to home. Given that I worked alongside the farmers, I usually only recorded notes during

breaks, at lunchtime, and at the end of the day. As soon as I arrived home, I entered the handwritten notes, taken throughout the observation, electronically into a password-protected document. This process permitted me to expand the notes and capture my reflections for that day. My analysis of these observations emerged as themes derived from participants' narratives and my field notes of ethnographic observations.

Data Analysis

Through a series of chain referrals, I approached 35 farmers for this study. Twenty-five agreed to participate. According to Goodson (2013), life history interviews allow the interviewer to understand how the interviewee makes sense of their life experiences during different periods. I adopted a life history approach for the interviews. This approach fostered a natural conversation that allowed each participant to talk about their lives before discussing farming experiences in their home countries of Laos and Thailand and the United States. After listening to the farmer's experiences, I asked specific follow-up questions based on what they shared. As I progressed through the interviews, if the farmer did not initially discuss issues related to my research questions, I referred to the research guide questions and asked if they could share a specific related experience. My interview guide included questions regarding Hmong farmers' traditional practices versus practices adopted in the United States, pesticide application, and understanding any association between pesticide exposure and poor health outcomes. I also asked questions about where they obtained pesticide information, resources, and pesticide education. I also included questions about pesticide take-home pathways and farming equipment such as farming tools that they brought home from their farms.

To analyze my data, I first listened to each recorded audio in its entirety to understand the overarching narrative. All interviews were conducted in Hmong and translated into English. I transcribed each of the recorded interviews and assigned a pseudonym to the speakers as I was transcribing them. Once transcribed, I used a microanalysis approach to analyze the results. Such analysis consists of reading and coding the data line-by-line and carefully examining and interpreting the data (Strauss & Corbin, 1998). According to Strauss and Corbin (1998), microanalysis allows the "analyst to listen closely to what the interviewees are saying and how they are saying it" (p. 65). I organized the data into three categories and merged the farm observations, including detailed fieldwork notes, into the analysis.

Health Literacy as a Framework to Understand Pesticide Education

Achieving literacy in a population is vital as it can produce great public health benefits (Nutbeam, 2009). A popular means to address literacy is the Health Literacy Model. The Centers for Disease Control and Prevention (CDC) addresses personal health literacy and organization health literacy as:

1. Personal health literacy is the degree to which individuals have the ability to find, understand, and use information and services to inform health-related decisions and actions for themselves and others (Santana et al., 2021, p. 4).
2. Organizational health literacy is the degree to which organizations equitably enable individuals to find, understand, and use information and services to inform health-related decisions and actions for themselves and others (Santana et al., 2021, p. 4).

Health literacy is complex. For instance, Nutbeam in 2000 introduced three fundamental types of health literacy and suggested that different types of health literacy require distinct measurement tools and interventions. The first type is basic/functional literacy, which includes having "sufficient basic skills in reading and writing to function effectively in everyday situations" (Nutbeam, 2000, p. 263). The second is communicative/interactive literacy, which includes advanced cognitive and literacy skills and social skills. According to Nutbeam (2000), communicative/interactive literacy "can be used to actively participate in everyday activities, to extract information and derive meaning from different forms of communication, and to apply new information to changing circumstances" (p. 264). Nutbeam termed his third type as critical literacy, defined as "more advanced cognitive skills which, together with social skills, can be applied to critically analyze information and to use this information to exert greater control over life events and situations" (Nutbeam, 2000, p. 264).

Nutbeam's communicative/interactive literacy supports the importance of exploring the content and context in which pesticide information is shared and implemented in the Hmong farmers' community. This model emphasizes the importance of community assets such as utilizing "social skills" to disseminate "new information to changing circumstances." Additionally, the Hmong farmers' community has a collective orientation (Lee, 2005) and family structure plays a critical role on many farms. The Hmong population is primarily an oral community and relies on verbal communication to deliver and receive knowledge (Thao, 2006). The transmission of knowledge is dependent on social networks for support and information sharing. For example, one typically receives knowledge from a credible source within the Hmong community, who

passes it on to their family and friends. This practice of Hmong social networks and communication processes is essential to understanding Hmong farmers' gatekeeper role in disseminating pesticide information in the community.

Brief Overview of Dissertation

This dissertation uses in-depth interviews and ethnographic observations to understand pesticide knowledge and associated health risks among small-scale Hmong farmers in the California Central Valley. I used qualitative semi-structured interviews and field observations to gain insight into the specific context of local farming practices among Hmong farmers in the Central Valley.

In Chapter 2, I present documentation of the small-scale Hmong farmers' agricultural experiences in the United States compared to their home country of Laos. This chapter chronicles Hmong farming narratives about their native lands, then presents how they adapted farming practices in the United States, including their use of pesticides, and assesses their understanding of pesticide exposure and health risks.

Chapter 3 presents how I traced the flow of pesticide information in the Hmong farming community. I documented their oral communication pathways and navigated the flow of pesticide education among the community. This chapter also documents the numerous ways citizens of the community share information and provides the foundation from which I describe components of pesticide literacy.

Chapter 4 assesses the extent of the potential pesticide take-home pathway through analysis of fieldwork observations from farms and corresponding homes. I described daily challenges and the numerous ways that pesticide particles may be introduced into farmers' homes. Given the paucity of research about Hmong farmers, I

anticipated that the study's findings might significantly impact the community. Chapter 5 summarizes the study's major findings and presents policy recommendations.

Chapter 2

Hmong Farmers' Use of Traditional Farming Practices, Pesticide Application, and Understanding Pesticide Exposure and Health Risk

This chapter explores factors that influenced the degree of pesticide exposure and its negative health impacts across small-scale Hmong farmers in the Central Valley of California. The Hmong ethnic group has existed for many thousands of years. The only known origin of the Hmong people is that they lived in China before moving to Indochina: Vietnam, Laos, and Thailand. Due to the Hmong not having a written language or historical evidence, their origins are unknown (Lee, 2005; Yang, 2010). The majority of Hmong still reside in China, followed by populations in Vietnam and Laos. The estimated U.S. Hmong population is estimated to be greater than 300,000, concentrated primarily in California, Minnesota, and Wisconsin (Pfeifer et al., 2012). Hmong in the United States came mainly from Laos. In 1959, the U.S. Central Intelligence Agency recruited members of the Hmong community in Laos to fight alongside U.S. soldiers during the Vietnam War. Once the war ended, communist Pathet Lao insurgents began persecuting the Hmong (Hamilton-Merritt, 1993). Many Hmong sought political refugee asylum in Thailand and subsequently resettled in various Western countries. The majority of the refugees found a haven in the United States (Hamilton-Merritt, 1993). Although the refugees initially did not settle in the California Central Valley, many, in search of fertile land to farm, gravitated to the Central Valley in a second migration (Lieb, 1997). Once on fertile land, many Hmong drew upon their native farming experiences as they adapted to U.S. agricultural practices (Mote, 2004). To understand Hmong farmers' use of traditional farming practices, pesticide use, and

health risk, I present a discussion of small-scale Hmong farmers' agricultural experiences in the United States and in their home country of Laos.

Despite the growing community of small Hmong farms in the United States, published research about this community is limited (de Castro et al., 2014; Fenske et al., 2013; Martin et al., 2002). Unlike large, well-established farms with fully equipped resources, studies of small-scale farming among Hmong citizens have found they are more likely to hand mix and spray pesticides (Dahlquist-Willard et al., 2015; Fenske et al., 2013; Martin et al., 2002) due to the lack of farm equipment such as pesticide tractors. Direct contact with pesticides may introduce small farm operators to greater pesticide exposure. As a result, there is a need to understand the relationship between small-scale farming practices and pesticide exposure risk. I want to identify small-scale farmers' challenges in applying pesticides to their crops. Additionally, I am interested in learning about relevant gatekeepers and actors involved in pesticide decisions among the Hmong farming community. Most available research analyzing the effects of pesticides on farmers focuses on large, well-established farms owned by non-Hispanic, White farmers rather than the farming practices of small-scale minority farmers, such as the Hmong.

The present chapter addresses the challenges Hmong farmers in Fresno County, California, face in their daily farming practices. This study used a qualitative approach, combining in-depth interviews and ethnographic observations. To recruit study participants, I used a "snowball sampling" technique (see Biernacki & Waldorf, 1981) and chain referrals within the Hmong farming community. In addition, I leveraged my familiarity within the ethnic community, where I spent two years attending pesticide

education training and community and family events. I recruited 25 Hmong farmers. All interviews were conducted in the Hmong language and transcribed into English for analysis (see Chapter 1). I employed Constructivist Grounded Theory (Charmaz, 2014) in my analysis to illustrate how Hmong farmers make sense of their farming experiences in the Central Valley. To protect the confidentiality of the farmers, I assigned a pseudonym to each participant.

Demographics

The demographic data was obtained through my brief questionnaire. Twenty-five farmers from small-scale family-operated farms provided the data for this study. The majority of participants were female (63%); males comprised 37% of participants. The median participant age was 58 years (see Table 1). The primary preferred language was Hmong (96%). The majority (75%) of participants had no formal education; 13% had completed college. All of the farms represented in the study were relatively small, with a mean farm size of 7.08 acres. The average farming experience was 10.8 years (see Table 1). Hmong farmers reported a large family household, with 71% having five or more family members currently residing in their homes. Only 8% owned the land they farmed compared to 92%, who leased their farmland. Additionally, 50% of the participants reported farming full-time; 62% of spouses were co-operators of the farms.

Table 1

Participants' Demographic Characteristics (N=25)

Variable	Percent	Mean	Std. Dev.
Years of Farming		16.5	10.88
Size of Farm		7.08	9.13
Gender			
Female	63		
Male	37		
Age			
20 – 40	0		
41-50	25		
51-60	38		
61-70	20		
Over 70	17		
Language Spoke at Home			
English	7		
Hmong	93		
Marital Status			
Married	83		
Divorced	4		
Widowed	13		
Education in the US			
No School	75		
Primary School (1-8 grades)	8		
High School	4		
BS or Higher	13		
Ownership			
Rent	92		
Owner	8		
N	25		

Findings

Among the 25 participants, 92% indicated the use of pesticides on their farms. Only 33% reported having a legal pesticide permit; 67% reported no permit. Having a pesticide applicator license is crucial for the prosperity of their farms as this license is

required to purchase any restricted-use pesticides; however, 79% had no pesticide applicator license. Among those who reported using pesticides, 17% answered they were unaware of any pesticide training conducted in Hmong, and 42% reported "limited" Hmong language pesticide resources. Interestingly, only 8% reported awareness of resources translated into Hmong, while 50% were "not sure" about any printed resources in their native language.

In the following discussion, I outline themes identified during my analysis supported by illustrative quotations from study participants. The three primary themes included: differences between farming experiences in the United States and home country; economic factors influencing the use of pesticides on the farm; and understanding of pesticide utilization and associated health risks.

Farming Experiences in the United States and Home Country (Laos)

"I farmed back in Laos, and after moving to the United States, I wanted to farm, so I moved to the Central Valley." – Mai

Participants described farming as an opportunity to use familiar skills in cultivation to connect them to the U.S. economy. They described using farming skills practiced in their home country in California's Central Valley. Mai, a first-generation Hmong small-scale farmer, shared that her farming experiences in Laos and then in the United States were vastly different. In Laos, she farmed with her dad's handmade hoes, axes, and curved blade knives/sickles. She reported never using mechanized tools. Their native farmland soils were nutrient-dense, often located in high mountains and hills near their small mountain-top villages. They never used chemical pesticides, rotating farmlands freely without concern about plowing the land as the soils were soft and fertile.

The U.S. farm environment was vastly different, requiring different farming techniques and practices.

Study participant Mai has lived and farmed in the Central Valley for 30 years. She has limited English skills with no formal U.S. education or training. Her farming knowledge and skills were those of generations of her ancestors in Laos. Mai was 28 years of age when she resettled near Fresno in 1988. In Wisconsin, a church group initially sponsored her family's resettlement in the United States. Mai relocated to California to help her older sister farm tomatoes. Working with her sister, Mai quickly learned about the differences between farming styles in her home country and the United States. The first farming adaption Mai mentioned was farming equipment. She said, "mother taught me since childhood the importance of agriculture. She took me and my older sister to the farm every day … we farmed with my dad's handmade hoes. The hoe was used to weed out grasses." Compared to the U.S., farming in her native land was more labor-intensive: "Everything is performed by hand and brute strength." In the United States, Hmong farmers "have the help of farming equipment," such as farm tractors and loaders. Therefore, they do not have to perform everything by hand. Pog, an elderly farmer in her early 70s, described her farming practices in Laos,

> How we began our farm is; first, we cut and slashed all the trees and bushes in the forest. The men would cut off the tree while the women slashed the bushes. After a few days, the trees would be dried out. We burned all the trees and bushes. This process would fertilize the land.

Thomas, a 61-year-old male, said, "When I started farming, my family would choose the land first. I cut trees to mark the border of my plot of farmland from every

corner. Sometimes, I asked if the land had any owner. If there was no ownership, I marked the land for my own."

Farmer narratives, such as those above, highlight the importance of gender roles when making agricultural decisions in Laos compared to the U.S. In Laos, the men tended to decide where to search for a plot of farmland for their families and took the first steps to initiate the farm plot. Ntxhoo described the process in more detail. In her mid-50s, Nxthoo has been farming for over 18 years. She shared,

> My husband had to go and prepare farming tools that would be used throughout the year for farming, such as hoes, axes, and sickles. We then had to create borders on the land which we would want to farm. We cut bamboo or wood around the farm to indicate the area in which we would want to farm. We would cut down the weed and bushes on the land with a sickle and use an ax to cut down all big trees. Mostly men and some strong younger women would chop down the big trees.

Hmong farmers reported similar decision-making patterns in the Central Valley. When I asked Sara who made most operational decisions on her farm, she said,

> My husband has to make the final decision, so I just follow. I do some of the work that he wants, but he makes most of the decisions on what to farm. I seek advice from my farm peers, but my husband has to make the final decision for our farm.

Sara farms full-time with her husband. Her husband initiates pesticide decisions, especially regarding pesticide needs for their crops, since he is more literate and can read

basic pesticide information and related instructions. Sara stresses that although her husband makes the final call, they share similar responsibilities when applying pesticide at the farm. She stated, "My husband will apply the pesticide. But if he has other farm chores, then I will apply the pesticide instead."

Study participant Yang is a 52-year-old female whose spouse works full-time at a local company. Her husband can only help her at the farm part-time, usually after work around 5 p.m. and on weekends. She said, "I do most of the farming since he [husband] works. He only comes after he is off of work; therefore, I made most of the decisions." My observations confirmed Yang's characterization.

Another farmer, Mike, a 50-year-old, farmed four acres with his wife. I met the couple at 3:30 p.m. at their farm when conducting my observation. Upon arrival, I learned that his wife had worked at the farm since 6 a.m. that morning. Mike was to join her after finishing work at 3 p.m. Mike served as my point of contact for the farm. In our interview, Mike stated that he handled most heavy chores, such as plowing and spraying pesticides. He was also responsible for attending pesticide education classes, making pesticide decisions, and purchasing pesticide products for their farm. On the other hand, his wife maintained the farm full-time, applied pesticides whenever there were pest concerns when Mike was unavailable. The couple sold their produce directly to local grocery stores. In practice, both shared responsibility for handling pesticide applications on their crops.

Economic Factors Influencing the Use of Pesticides on Farm

Study participants generally recalled farming freely without any financial obligations in Laos. Farmland was free to use, and farm tools were handmade from

available resources. In the United States, farmers can use farm tractors, fertilizers, and pesticides, but all require payment. Equipment, such as a tractor, can cost between $5,000 and $50,000 or more, depending on its condition. Tractors are valuable for plowing farmland during planting season, and they can be used to apply fertilizers and herbicides onto the soil before seeding their crops. Tractors lessen farmers' timing challenges, permitting shorter timeframes. Participants generally agreed that the farmland in Laos did not require intense plowing prior to planting. The soil in the Central Valley is mainly silica-sesquioxide cementation with hard-formed cemented textures on the surface. Such soil requires more strenuous effort if farmers only rely on hand tools such as a hoe.

Using mechanized farm equipment with advanced technology such as a tractor to plow land was new to Hmong farmers when they arrived in the United States. They almost universally had not been exposed to such resources in Laos. According to Ntxhoo, who came to the United States in 1996 when she was 32 years old and is now in her mid-50s, "We learned about new technologies like tractors and other plowing equipment. Those are all new things we only saw in the United States." She added, "when I first farmed here [Fresno] in 1997, I shared a farming plot with my aunt, who farmed 15 acres at the time. She told me that if I want to expand my farmland, I will need a farm tractor. At that time, I didn't have money to buy one…Even now, I still could not afford a new and good farm tractor because the price is too high for me to buy a new one."

In his early 70s, study participant David added, "farming in the U.S., *EVERYTHING* involves money. Everything from renting the land to the water, the bathroom, the crops, the pesticides, and building a shelter all are expensive." Ntxhoo

shared the same concern, “Here, we have to go and rent the land. You then have to hire people to come to plow the land. You use [the] money first, not your strength.” Niam Thaiv, in her early 50s, concluded,

> Living here in America, it is very different from when we lived in Laos. Here, you are only renting the land to farm on, and it depends on how big or small you want to farm. You can also hire people to work for you. They can help plow the land and help plant seeds.

In my field notes regarding harvesting lemongrass, I documented two farmworkers hired for the day to help in the harvest. I noted that both workers were already at the farm when I arrived and had been helping the farmer harvest her crops for a few weeks. This dependence on manual labor is because mechanized equipment is expensive, and farmers often lack access to such machinery. When I asked how farmers were able to plow their rented land if they did not have a tractor, Angel, in his late 50s, stated: “I hired them [a farmer who owned a tractor] to plow the land so they would do it plot by plot.” Jake, in his mid-40s, who had farmed with his parents for over 22 years, added that “We have to hire them to plow the land because that will cause the crops to grow better. We do not have a lot of equipment. We mostly do everything by hand.” I saw firsthand how difficult it is to be a small-scale family-operated farmer with no machinery. The farmers relied heavily on hand tools to plant and cultivate their crops on every farm I observed. In all of my farm observation memos, I noted how exhausting it was for me to work all day at the farm. In one of my memos, I described how I came to understand why the younger Hmong generation refrains from farming. My experience alongside farmers, particularly the older study participants, demonstrated how cultivating

the farm was HARD WORK. They relied on their hands to cultivate nearly everything they grew, from planting to harvesting crops.

The most reported reason for not owning farm equipment, such as a tractor, was summarized by Angel, "it is because they are too expensive." Most of the farmers I interviewed only farm a few acres; therefore, they do not earn enough money to purchase tractors. Jake noted that "it [machinery] is an investment that requires a lot of money." Unfortunately, not having access to equipment is one of the most challenging aspects of farming for these small-scale farmers.

According to Sara,

> For me, [it] is not having good farm tractors. I have to do everything using my hands. This is hard. But for crops like mine, it also requires hand picking. I think having a machine to pick beans and chili without damaging the crops would be great.

Another farming practice Hmong farmers have adopted in the United States is the use of pesticides. Mike stated, "farming here [United States], we have to apply pesticides and fertilizer." Tou, a 66-year-old, said, "maintaining crops in this country is hard because you must have pesticide and fertilizer and other chemicals." Ntxhoo raised another concern, "if these [pesticides] did not exist, then crops could not be produced here." Most participants reported incorporating pesticides into their farming practices when they arrived in the Central Valley. As Yia shared, "We never used chemical products back in Laos." Pog said,

> In Laos, we did not use pesticides on our land. We relied on this [natural] method to nourish the land. And we relied on our hands to maintain the farm. Unlike here

> [Central Valley], we cannot farm without using pesticide chemicals. I tried with my first farm; all my crops went bad. So now, I use pesticides to maintain my small farm. These pesticide products are expensive too. Everything is expensive.

Other farmers shared similar sentiments. Angel said, "Another difference is that we have to use chemicals and fertilizers for our crops. We did not have to use any chemicals or fertilizers back in Laos." During my farm observations, I recorded where farmers stored their pesticides. For example, in one observation, I noticed a 50-pound bag of fertilizer and one unopened bag (YaraVera Urea: i.e., granular) stored in the farm's locked cabin, which was open during my visit. In another farm observation, I noticed four used bottles of herbicide, Remuda (2.5 gallons – liquid), on the property. These bottles sat on the counter of an unlocked cabin under the open farm shed. The farmer told me that her husband applied pesticide during the early morning, at 5 a.m., and she would dispose of the bottles later in the evening.

Understanding of Health Implications and Pesticide Use

"If I were able to choose, then I would not use them (referring to pesticides), but if you do not use them [pesticides], then the crops will not grow well." – Ntxhoo

Participants often expressed concern about the use of pesticides to manage their crops. When asked whether they thought these chemicals could cause health issues, many farmers expressed concern that pesticides could harm them. For example, 59-year-old Molly answered:

> Yes, I think these chemicals can make you sick. Because these are chemicals, whenever it touches your skin, it can cause irritation, and sometimes, it would make your skin no longer healthy. You must be very careful not to get the

> chemicals on you. When you are mixing the chemicals, you must wear protective gloves so that the chemicals do not get onto your hands and cause irritation.

During the interview, Molly explained that she learned of the need to wear protective gloves from her farm neighbor, who is also one of her relatives. Molly further added that although she had not attended any pesticide training classes because she only farms a few acres, her farm neighbor attended the training, and she often watched and learned from her. She said, "I watched my farm neighbor put on protective clothes and masks while applying these chemicals."

Yang explained, "I think that if these chemicals are capable of destroying pests, they can harm people too." Mai added, "We know that chemicals are dangerous." However, pesticide use seems unavoidable. Ntxhoo explained to me:

> When you use chemicals like pesticides, you affect the crops as well. Then you have to use fertilizers to help the plant grow. Then you keep repeating the cycle, and the crops do not grow well. Insects never eat the root of the plants in Laos. Here in the United States, insects eat the root as well. You need to maintain and worry about all of this. You have to buy different pesticides for different types of insects too.

When applying any pesticide, following the requirements for personal protective equipment is intended to protect the applicator farmer. According to O'Connor-Marer (2000), wearing PPE reduces an applicator's chances of exposure to harmful chemicals and unforeseen accidents. The pesticide labels contain information on what type of PPE

to wear during pesticide applications. PPE includes coveralls, eye protection, gloves, and boots (O'Connor-Marer, 2000). I asked if there were protective measures to reduce exposure while applying pesticides. Ntxhoo nodded and said, "There has to be. You need to take protective gear when you deal with any chemicals. You have to wear gloves and masks. The chemicals stick to everything you use them on." Ntxhoo acknowledges that she acquired her PPE knowledge and practices by attending pesticide education classes and talking with her farming peers.

Despite understanding the risks, all the farmers who participated in this study must decide to apply pesticides. As Jake explained, "even if it is dangerous, you need to apply them. You have to make money in some way. It might not be healthy for us, but as long as the crops are good." Participants described understanding the importance of using PPE. Farmer Yia, who is widowed and in her early 60s, shared her thoughts, "In this country, if you do not protect yourself well while using chemical products, then you will definitely become sick from exposure. There are some people who were heavily exposed to chemical products who died from excessive exposures."

Pog told me, "For me, I always try to wear protective gear when I apply any chemicals. I mostly wear gloves and masks." When asked what Pog considered to be personal protective equipment, her response was "…boots, long sleeves, masks, and gloves." Hmong farmers most commonly mentioned these items. Eye protection, however, in the form of face shields and goggles were less frequently mentioned.

I observed pesticide application on two farms in the course of this study. Neither farmer used eye protection during their applications. During the interview with one of these farmers, I asked her which types of PPE she has used in the past, and she

responded, “we need to cover our nose and mouth by wearing a face mask, boot, glove, and wearing coverall clothing.” Since she failed to mention eye protection, I asked her about using face goggles. She said, “I think using goggles is important, but I do not use them.” In another interview, I asked whether farmers could still get sick from using pesticides despite using PPE. Sara replied, “Yes, I think you can still get sick even if you use them. The wind can still blow it, and you are still exposed to it since it is released into the environment. If I apply pesticides, I have to apply them early in the morning so that there is no wind.”

One of the characteristics that make small-scale Hmong farmers more vulnerable to pesticide exposure is the nature of how they spray pesticides. All study participants reported they relied on a backpack pesticide sprayer as their primary tool. Backpack sprayers have a hand-operated hydraulic pump that forces liquid pesticides through the nozzle. The tank is made of plastic and can hold between three to five gallons of spray mixture. The hand-operated backpack sprayer requires a continuous pumping action to maintain pressure while spraying (O’Connor-Marer, 2000, p. 264). This method introduces closer contact when applying pesticides, especially to the hands and back. Hand exposure can occur when the farmer adjusts the spray nozzle and by splashing liquids while mixing the spray tank. Back exposure is most likely due to potential leakage from the sprayer during application. During my observational visits, I witnessed two farmers using a backpack sprayer to apply pesticide to their crops. According to Angel, “those who have machines to spray the chemicals for them” have less direct contact and less exposure.

Some participants had known or heard of Hmong farmers affected by using pesticide products over the years. When I asked Yang if she had heard of any cases, she replied, “Yes, I have heard of some. I know of some people that have farmed for a long time and have an illness in their lungs. Some of them have heart diseases also. So, people do get sick from pesticide use and farming.”

Farmer Yia added:

> Yes, we did know and heard that many people have died in the past because when they handled these chemicals, they were not protecting themselves well enough. That is why we must wear gear that covers the entire body from head to toe. To protect the face, you must wear goggles and a face mask and put on rubber boots to protect the feet. If you do not wear all of this gear, then you can be exposed to the chemicals when you spray them. Some can get onto your skin, or you may inhale them if you are not wearing a mask. Everyone is afraid of the risks. That is why every time that you are at the farm spraying pesticides, you must wear the complete set of protective gear.

While my research revealed that most farmers feared not using sufficient PPE, I documented PPE underuse and overuse instances in my farm observations. I encountered two incidents where the farmers used limited PPEs while applying pesticides. One example involved a farmer using two plastic garbage bags (3 ft. 2 in. X 4 ft. 3.5 in.) as her coverall PPE while applying pesticides on her crops. Another included a farmer reusing gloves, counter to safety guidelines (O’Connor-Marer, 2000). In addition, used gloves can sometimes trap pesticide residues; therefore, reusing gloves may put farmers at increased risk of pesticide exposure. Alternately, I observed a farmer wearing multiple

layers of PPE – double layers of overall clothing – while carrying a pesticide backpack to the field to limit exposure to toxic chemicals. These observations suggest a range of understanding regarding the proper use of PPE.

Discussion and Conclusions

This chapter chronicled Hmong farming narratives comparing their home country of Laos and the transition to farming practices in the United States. I presented findings highlighting the valuable traditional farming skills the farmers built upon and how they accommodated new farming practices in the United States, including advanced farming equipment and pesticides. In addition, this chapter highlighted the importance of Hmong farmers' understanding of pesticide exposure and health risks; specifically, this chapter addressed the determining factor as to why they adopted the use of pesticides.

I was privileged to work with this small group of local Hmong farmers in Fresno, California, where I learned firsthand how difficult it is to be a small-scale family farmer. Here, Hmong farmers grow everything from Asian specialty crops of okra, bitter melon, and Chinese eggplant to U.S. staples of produce, such as broccoli, potatoes, and lettuce. The CDFA (2016) notes that California is the leading agricultural producer in the United States, with total revenue of 53.49 billion dollars reported in 2015. Agriculture is one of the largest sectors in Central Valley's local economy and helps stabilize the cost of local produce.

Small family-operated farms, in particular, are the unsung heroes of California's thriving agricultural economy. The USDA estimates that 86% of the 54,342 farms in California are classified as small. Most of these farms are in the Central Valley. Hispanic and Asian farmers own small-scale family-operated Central Valley farms. These small

farms serve only the domestic market compared to more extensive farm operations whose cash crops are meant for the international market and export most of their produce. The lemongrass grown along the outskirts of town is the same lemongrass bundle you can purchase at your local Vons. Moreover, unlike larger farm operations, the small family farms grow specialty products for local consumers that may not be sufficiently profitable for large farm operations to grow on a larger scale.

Nonetheless, small-scale farmers face many challenges (Sowerwine et al., 2015). The majority of Hmong farmers who participated in this study were not fluent in English, with 75% having no education and only 7% reported speaking English at home. This finding aligns with previous findings (Méndez-Barrientos et al., 2020; Thao et al., 2019). Hmong farms are dynamic, unique, and are often shared among multiple farmers, usually relatives or friends. Such collective farming serves them well, especially in sharing farm resources and information, despite language barriers and a lack of pesticide education.

Additionally, most study participants were much older, with 75% over 50 years of age. As reported in the literature, they generally lack education (Neitzel et al., 2014; Thao et al., 2019). In describing how farming in the U.S. is different from their home country, they generally noted the use of machine tools and pesticide chemicals. Both presented different rewards and challenges to the farmers adopting U.S. farming methods.

One characteristic among study participants that survived from their native farming practices is the shared responsibility of farm chores. Both farm partners, the husband and the wife, take collective responsibility to nurture their farms. In Laos, the husband first initiated where and when to farm, and both partners worked to maintain the family farm. Similarly, in the U.S., the husband [man] often makes farm and pesticides

decisions. However, both partners have an equal share of farming responsibilities, including applying pesticides.

Discussions with Hmong farmers revealed concerns over pesticide use and the economic challenges of lacking well-equipped farm equipment, including tractors to plow their land or apply pesticides on their crops. In addition, many Hmong farmers cannot afford mechanized equipment, resulting in less expensive means of applying pesticides (such as a backpack sprayer) that potentially places them at higher risk of pesticide exposure.

Narratives from farmers illustrate the difficult choices they face regarding whether and how to use pesticides to maintain their crops. Despite knowing the health risk of using harmful chemicals, many farmers make an economic calculation to apply pesticides. The farmers have already invested their savings into their farms; therefore, using pesticide products such as herbicides and insecticides to manage pest outbreaks and fertilizer to improve crop yields is often considered necessary. Understanding small-scale Hmong farming experiences and documenting their pesticide use are crucial to addressing appropriate pesticide safety procedures and preventative measures.

Another Hmong farming challenge is space. I found that 80% of study participants did not own the land on which they worked; they leased land through short-term contracts. Not owning farmland is a barrier to broader eligibility for government resources and assistance. For instance, most government loans require land ownership or long-term contract land rental to qualify. This requirement alone is a challenge to many Hmong farmers, who generally hold short-term contracts (Méndez-Barrientos et al., 2020; Thao et al., 2019). Méndez-Barrientos et al. (2020) corroborated that Hmong

farmers' short lease status puts them at a disadvantage and limits their access to financial resources to, for example, drill new water wells on the lands they farm.

The study's narratives clearly illustrate Hmong farmers' experiences in the Central Valley and offer insights into their opportunities and challenges as small-scale family-run farmers. Future studies should work with Hmong farmers to better understand the disadvantages of short-term lease contracts in obtaining financial resources.

Chapter 3

Dissemination of Pesticide Information among Hmong Farmers in Central Valley, California

Globally, over 5 billion pounds of pesticides are used in the agricultural sector each year. The United States alone used more than 1 billion pounds of conventional pesticides in 2017 (Atwood & Paisley-Jones, 2017). The U.S. EPA estimated that 80% of all pesticide use was in support of agriculture (Atwood & Paisley-Jones, 2017). According to Atwood and Paisley-Jones (2017), the most commonly used pesticide applications in the United States included herbicides (targeting weeds), followed by fumigants (targeting pests), insecticides (targeting insects), and fungicides (targeting fungal disease).

Scientists have linked pesticides to both short-term acute health problems and long-term chronic adverse effects (Blair & Zahm, 1995; Coronado et al., 2004; Damalas & Koutroubas, 2016; Kim et al., 2017; Sabarwal et al., 2018; Salvatore et al., 2008; Settimi et al., 2003). Pesticide chemicals are identified in the pathogenesis of various chronic diseases and disorders, including cancer of the respiratory, nervous, integumentary, and reproductive systems. For instance, Sabarwal et al. (2018) found that the oxidative stress caused by pesticides is a mechanism through which many pesticides present harmful effects on DNA, which may cause malignancies and disorders. Amweg et al. (2005) indicated that the insecticide pyrethroid, one of the most common pesticide applications in the United States, is a well-known neurotoxin and a significant public health concern. In addition, pesticide chemicals have been shown to modulate gene expression at the level of non-coding RNAs, histone deacetylases, and DNA methylation,

which means these pesticide chemicals play a role in epigenetics and could potentially kill healthy cells (Carbonell et al., 1993; Gómez-Arroyo et al., 2000; Grover et al., 2003; Mostafalou & Abdollahi, 2013).

Given the health risks associated with pesticide use, the USDA requires all pesticide handlers to pass one or more state certification examinations. For example, the California Department of Pesticide Regulation requires all farmers in California to "know, understand, and follow" federal, state, and local pesticide laws and regulations (CDPR, 2020). According to CDPR, pesticide handlers and farmworkers require training in pesticide safety. In addition, anyone using restricted-use pesticides must have a Qualified Applicator License. To obtain a Qualified Applicator License in California, one must submit an application to the CDPR, pass a state examination that covers the laws, regulations, and principles of pesticide application, and pass an additional specialized pest control area test with a score of at least 70%. The basic exam costs $50. Specialized application categories require additional examinations and fees, depending on the number of special categories of applications needed. This additional fee is $80. The CDPR must receive the fees in advance of taking the exam. In addition, this pesticide license must be renewed every two years by paying a renewal application fee of $120 and by completing 20 required hours of CDPR approved continuing education. A Qualified Applicator can apply or supervise farmworkers in applying restricted-use pesticides.

Everyone who applies restricted-use pesticides must receive state-mandated training and licensing. However, an exemption allows farmers to request a restricted-use pesticide permit from the local County Agricultural Commissioner’s office. If approved, the permit is valid annually or for an entire season, depending on the type of crop. For

instance, a permit for a perennial crop may be valid for more than a single year. In addition, this local permit requires farmers to file a Notice of Intent with the County Agricultural Commissioner at least 24 hours prior to applying a restricted-use pesticide. Farmers with a Qualified Applicator License need only file a monthly report of pesticide usage on agricultural commodities.

All study participants were considered "pesticide handlers" who had acquired training. The CDPR establishes minimum standards of pesticide training for anyone handling pesticides as part of their work. The training and regulations are to protect farmers and those handling pesticides. However, most of the materials and training are published only in English. Few counties, other than Fresno, even offer limited training sessions and translated materials in Hmong. As reported in my earlier study, most Hmong farmers in the Central Valley are illiterate and have difficulty reading pesticide labels (Thao et al., 2019). However, I argue that despite linguistic limitations, this community has a great capacity to use pesticides appropriately by traditional forms of communication and information sharing and by effectively navigating the regulatory environments through this network.

Narratives collected from in-depth interviews and casual conversations recorded in detailed field notes indicate that the current Qualified Applicator License examination for CDPR pesticide training for farmers (and farmworkers) does not reflect small-scale Hmong farmers' needs. Analysis of the data supports my argument that Hmong farmers rely on informal social and familial networks to learn about pesticides. This informal sharing builds upon the Hmong tradition of oral rather than written communication of information and instruction (Thao, 2006). By combining both field notes and interview

data, I identified sources of pesticide information, education, and the process of communicating and sharing resources among the Hmong farming community in Fresno County.

In this chapter, I defined pesticide literacy as "Hmong farmers' ability to understand, implement, and convey pesticide knowledge." I outlined the following findings as components of pesticide literacy in this community. These components include cultural forms of communication and information sharing through social networks. This process of information sharing is linked to their cultural background of oral sharing. The second component is linked to the regulatory environments. Obtaining a Qualified Applicator License can be challenging to many farmers due to language barriers. However, pesticide literacy in the community is interactional and navigational, which means that pesticide knowledge is not limited to the ability to read pesticide labels but rather to access information through these channels of information sharing and navigating around the pesticide licensing requirements.

A Brief Overview of Hmong Oral History

When Hmong refugees arrived in the United States in the late 1970s, they lacked training to enter the workforce; thus, many turned to agriculture since they knew farming from life in Laos (Lieb, 1997; Mote, 2004). However, due to limited English skills, Hmong farmers had difficulty using resources available to them (Dahlquist-Willard et al., 2015), such as applying for USDA grants or navigating other federal grant applications and educational training and materials.

Pesticide use was only introduced to the Hmong farmers when they arrived in the United States (see Chapter 2). Culas and Michaud (1997) described Hmong farmers as

industrious, independent, and willing to fight for their existence. Prior to the French Indo-China war, Hmong communities had little interaction with Western societies. They lived in the mountains, created villages in jungles, and adapted to changing environments (Culas & Michaud, 1997; Quincy, 1995). The Hmong practiced slash and burn agriculture and had long-established societal and cultural frameworks. Their lives revolved around farming, and their lifestyle, cultural practices, and traditions were passed down orally from one generation to the next. Many who encountered the Hmong in Laos described them as lively, hospitable, bold, clever, intelligent, and open-handed (Culas & Michaud, 1997; Quincy, 1995).

For centuries, Hmong communities lacked a writing system (Lee, 2005; Yang, 2010). According to Hmong history, after losing a war to the Chinese, their conquerors prohibited the Hmong writing system and destroyed all related documents (Craig, 2010). This loss of writing required the Hmong to turn to oral tradition to pass down memories of their history and cultural practices (Thao, 2006). This oral tradition, and its basis in cultural oppression, provide an essential backdrop to understanding how the Hmong share pesticide information today among community members in California's Central Valley. As I describe below, farmers use their community networks and relationships to navigate the complex pesticide policy environment to gain access to the tools they need for a productive and profitable farm. To set the stage for this exploration, I will first share my experience studying for a Qualified Applicator License, followed by instances of other Hmong farmers' pesticide training and experiences.

My Qualified Applicator License Journey

To understand Hmong farmers' experiences in preparing for and taking the Qualified Applicator License examination, I took the exam myself. I spent a semester (five months) studying for the exam. My preparation included reading *The Safe and Effective Use of Pesticides*, written by Patrick J. O'Connor-Marer (2000) of the University of California, Davis. The book consists of 10 chapters covering pesticide identification, pest management, different types of pesticides, pesticide laws and regulations, hazards associated with pesticide use, how to protect people and the environment, pesticide emergencies, how to use pesticide effectively, and how to use pesticide application equipment. The text also includes practice exam questions.

In addition to the book, I also reviewed the CDPR's *Pesticide Laws and Regulations* manual and attended two classes on pesticide training offered by the local University of California Cooperative Extension. After six months of preparation, I applied for the Qualified Applicator License examination and paid my application fees. On the application, I picked my examination schedule choice and location. Monthly examination dates and location options are listed on the application and posted on the CDPR website. I sat for the exam on a Saturday in Turlock, California. After presenting identification, the receptionist told me that 100 people would be taking the exam that day. The exam consisted of two parts. The first part covered pesticide law, regulations, and basic principles. The second part covered pest control categories chosen by the examinee and covered one or more sections of the following: (a) Residential, Industrial, and Institutional, (b) Landscape Maintenance, (c) Right-of-Way, (d) Plant Agriculture, (e) Forest, (f) Aquatic, (g) Regulatory, (h) Seed Treatment, (i) Animal Agriculture, (j)

Demonstration and Research, (k) Health Related, (l) Wood Preservative, (m) Antifouling Tributyltin, (n) Sewer Line Root Control, (o) Field Fumigation, and (p) Microbial Pest Control. The four-hour exam comprised two hours related to chemical pesticide law and regulations and two hours for particular application categories. The exam format consisted of multiple-choice questions, reading comprehension, and math (calibration of pesticide application). Based on my experience taking this exam, I realized that the exam required at least a high school or GED reading level. Additionally, some pesticide terminology related to the special category section in the second part of the exam required college-level comprehension.

The appropriate category for most farmers applying pesticides is Plant Agriculture, which I chose for my exam. This category allows the applicator to apply and supervise any restricted and general use of pesticides, substances, methods, or devices to control pests in agricultural areas. The examinee must achieve a score of 70% to pass both sections, law and regulations and at least one pest control category to receive the Qualified Applicator License. I passed the exam on laws and regulations with a score of 90%, yet, scored only 68% on the plant agriculture exam.

This experience taught me that the Qualified Applicator License examination required practical farming experience and a fundamental understanding of pesticide principles, laws, and regulations. However, as noted earlier, most farmers in Fresno County have no educational background on such matters. The intricate and advanced exam required to receive a Qualified Applicator License is far beyond the ability of an average Hmong farmer. Illiterate Hmong farmers rely on their children or others to

translate pesticide information. As demonstrated below, farmers employ alternative and traditional family and community relationships to obtain ad hoc pesticide information.

I now explain how the Hmong farmers in this study obtained pesticide information and knowledge from shared expertise within their social and peer community. The cases and scenarios were gleaned from in-depth qualitative interviews, farm and pesticide education sessions, and informal conversations. I explored the concept of "pesticide literacy" by identifying sources of pesticide education. The cases include pesticide permit holders, pesticide applicators (QALs), and farm leaders. I follow these stories with an exploration of the theme of "community education" in the context of disseminating pesticide information.

An Exploration of Pesticide Literacy

The safe and effective use of pesticides is essential for anyone handling pesticide products. Understanding the breadth of pesticide competency among the Hmong farmers is essential to understanding "pesticide literacy" in the community. To trace the components of pesticide literacy, I drew upon my detailed field notes and transcripts from interviews I conducted to explain the unique ways the farmers navigate complex pesticide information. The narratives presented below demonstrate how Hmong farmers fill a pesticide literacy gap.

At 7 a.m., on a triple-digit hot summer day, I drove 30 minutes south-east of Fresno to meet with Vue at her three-acre farm. When I arrived at the farm, I realized she shared this plot with approximately six other farmers, as there were multiple subdivisions. Vue's aunt greeted me. The aunt was helping Vue harvest her crops for the day. She instructed me to wait in the farm shed for Vue. While I waited, I assessed her

farm and realized she planted rice crops, long beans, Thai chilis, and Asian cucumbers. I later learned she also planted other Asian specialty crops such as mustard greens, bok choy, purple eggplant, along with green onions and cilantro. Unfortunately, all of these crops were currently out of season during the time of my visit.

Vue soon emerged from her long beans crop—about 30 feet from her shed—and welcomed me. She wore a face mask, long rubber boots, and a coverall long shirt. She apologized for the wait. Vue explained she was applying pesticide during my arrival and was still washing her feet and hands from a nearby water station shared with other farmers. I asked her about her farm property. She told me that a Mien farmer owned this 20-acre property that previously grew strawberries. She pointed out that the nice house at the entrance to the farm belonged to the owner. We did a quick 10-minute farm tour where I noted pesticide products on her property that Vue had purchased the day before. She applied pesticide early this morning to control an aphid pest outbreak on her long beans.

Like many other Hmong farmers I talked with, Vue told me she acquired her pesticide knowledge and skills from a family member, her aunt, who is also one of her next-door farm neighbors. She provided detailed information regarding the skills she acquired from her aunt, an experienced farmer who held a local pesticide permit that she renewed annually at the County Agricultural Commissioner's Office. She said, "when I first grew my long beans, I didn't know which pesticide to select for my pest concerns." Vue's aunt taught her "the correct type of pesticide products to use to destroy the insects and the proper fertilizer to use to foster the growth of [her] plant" since they both grow long beans. Furthermore, she described the pesticide application equipment (a backpack

sprayer) and how she measured and mixed the pesticide. If Vue needed to see which pesticide product to buy, she "goes to their [her aunt's] farm to take the brand of pesticide products that they used for their crop, and I take a sample of that bottle to the pesticide stores." If she needs help with the application method after purchasing, she asks her aunt to "walk [her] through the measurements." She concluded, "That is how I learned to use the equivalent amount of pesticide on my farm. Because when we use pesticides on our farm, we need the right quantity. Too little will not solve your pest concerns. Too much will harm your crops."

After five years of farming and learning from her aunt, Vue expressed confidence in her pesticide decisions and applications. She mentioned, "over the years, I became more efficient in using the pesticide, and I was able to better manage my crops." Vue learned her techniques from watching her aunt on the farm. In Vue's case, she had trusted resources and a role model. Physically learning how to select, mix, and apply pesticides was conveniently and efficiently obtained. Other study participants recounted similar learning contexts.

Sources of Pesticide Information among Hmong Farmers

"I learn from a culture of community sharing. We ask them [a licensed applicator] what to use to kill this type of weed, and they will tell us." - Hue

As a small farming community with fewer than 900 farms in Fresno County, Hmong farmers find unique ways of collaborating to disseminate pesticide knowledge and information. Several farmers successfully navigated the complexities of obtaining proper pesticide permits or licenses within the community and served as community assets, indirectly benefiting those who could not obtain such credentials.

One of the study participants shared the following,

> They [the CDPR] required that us farmer must take the license test; we are illiterate and cannot pass a test. Without the license, we cannot go buy the chemicals that we need for our farm. Everything in this country requires you to know how to read and write in English.

Illiterate farmers relied on over-the-counter products that did not require pesticide permits or licenses when such barriers existed. However, even understanding user instructions for these products proved to be difficult. As a result, they often obtained needed information and advice by seeking assistance from friends and others who constitute an informal social network.

In one interview, an elderly farmer shared that she did not know which fertilizer and insecticide to buy for her crops when she first began farming. However, she obtained the needed information through one of her more experienced farm relatives who had obtained a pesticide permit from the county. She also obtained additional advice and information from other Hmong farmers, such as friends and neighbors. In her interview, she stated:

> We [beginner farmers] do not really know much about it [pesticides], but there are more experienced people who had the license and started to farm before we did, so they know more about these kinds of stuff. We just ask them questions about what we should do if our crops are not growing well. Then they told us to buy a specific type of fertilizer and instructed us how to use the fertilizer.

Another farmer confirmed that this was a common means to obtain information due to his inability to read the pesticide label. In his case, he followed instructions from a licensed farm neighbor. He said:

> The instruction they [the licensed farm neighbor] give us on how to use this type of fertilizer is that we have to insert them through the water pipe, and then when we turn on the water, it will be released together with the water onto the crops. There will be two occasions when you have to use fertilizer on your crops. The first time you have to use fertilizer is when the crops are starting to grow but are still not mature yet. The second time is when the crops start to ripen and are flowering.

When farmers had additional questions about their pesticide choices, applications, or training opportunities, they often turned to local agricultural agencies, such as the Small Farms and Specialty Crops Farm Advisor from the University of California Cooperative Extension in Fresno or the USDA Natural Resources Conservation Service. Both agencies have a few Hmong agents whom the farmers trust.

Besides their trusted networks, farmers with literate adult children rely upon these family members to read the pesticide labels and information. As mentioned by one farmer,

> Pesticide labels are only written in English. We cannot read the English labels; however, our son or daughter translated them for us in Hmong. They tell you how much quantity is needed to mix it with water, and they also tell us how long we must wait until we can enter the farm again after we have finished spraying the pesticide on our crops.

Adult children also attend training sessions or obtain pesticide licenses to provide support and information to their parents. One farmer explained, “To get that license or permit, we have our sons and daughters learn when they teach pesticide classes. These classes are day-long. One of our children will attend the class and bring the information back to train us.” The farmer added, “my elder son had a pesticide license.” The son “farms minimally and only comes to the farm as needed,” especially to apply pesticide since he has the license. She said, “My son already has his own job to do. We only ask him to go get the license and come back to train us on the information because we do not know how to read or write, so he must help us.”

Farmers who have some pesticide credentials are significant assets to the community. In the following sections, I present a more in-depth review of the roles of two special pesticide credentials cases. The first case discusses a pesticide permit holder and the amplification of her credential among her farm colleagues. The second case features a licensed, qualified applicator and his impact on pesticide literacy among his circle of farmers.

Linda: A Pesticide Permit Holder

I will never forget the triple-digit summer day with hazardous air quality that I cut and cleaned lemongrass with farmer Linda. Linda specialized in the farming of lemongrass over the last 19 years. She was a 58-year-old, first-generation Hmong American farmer, who had limited English skills, a GED education, and was a pesticide permit holder. Linda began farming in the summer of 1999 after losing her manufacturing job. She learned to farm from her older brother, a full-time farmer. The day I spent with Linda again reminded me how difficult it was to run a small-scale family-operated farm.

Before dawn, I arrived at her crop site and quickly learned she never leaves the farm. She slept there overnight with another farmworker, an elderly female relative in her mid-60s who arrived from Laos in 2017. Before meeting Linda, I learned she needed to deliver nearly 8,000 pounds of lemongrass in 43-pound boxes—to a local vendor by the end of the day. Her lemongrass was ready to be harvested. Increased demand assured a higher price than the previous year. Her decision to harvest the lemongrass on the day I visited was due to a sudden rise in the market price. She would be able to sell her lemongrass for $28 a box, whereas it had been only $23 a box a week earlier. Despite that week's forecasted triple digits and poor air quality, she was determined to harvest her crops.

What was most noticeable the day of my visit was Linda's interactions with other farmers, her peers, colleagues, and farm neighbors. Her farm was a 20-acre lot owned by a Chinese landlord. She shared this 20-acre plot with two other farmers, who were relatives and friends. Linda leased seven acres, and the two other farmers leased the remaining available acres. Numerous colleagues and relatives called Linda, seeking her advice while with her on the farm. I noted a discussion with one caller who asked questions regarding which pesticide store sold "chiv 21" – potassium fertilizer (0-0-21) at a lower cost. She recommended one that she often uses, a small, private, family-owned shop in Sanger. Later in the day, her farm neighbor and close relative stopped by to ask her about the lemongrass price at the packaging company compared to the vendor she regularly used. She also asked which pesticide brand name was better for a pest outbreak in her bitter melon crop. They walked over to a small pesticide storage cabinet in Linda’s open shed so the neighbor could recognize the pesticide brand she uses for bitter

melon. During my interview with Linda, I asked her about her pesticide education; she replied,

> I attend some meetings [trainings] that Mr. M [Small Farms & Specialty Crops Hmong Agricultural Assistant] holds and learn a little. I also just learn the small things from the Internet with my children looking it up. We only do small farms, so we do not need to use a lot of fertilizers and things of that sort [herbicides and insecticides]. Sometimes I tell my kids to check the Internet and just use what it says.

When I asked about labeling instructions, she answered, "We just have our kids read it. They read it and just tell us the directions. Sometimes, I call Mr. M." Her children and Mr. M, who works at the University of California Cooperative Extension in Fresno County, were her main points of contact for pesticide-related information. In addition, she regularly shares what she learns from the pesticide training and the Internet searches conducted on her behalf.

Jake: A Qualified Applicator License Holder

The next example is Jake, a second-generation Hmong farmer. He accrued his pesticide knowledge from his parents. In his early 40s and fluent in Hmong, Jake graduated college with a business administration degree. Jake began helping his mother with the family farm after his father died five years earlier. At the time of the study, he was managing seven acres of cherry tomatoes. I learned from Jake that his parents had been farming for over 35 years. He told me, “My parents just learned from a cousin who farmed, and by observing what other farmers do…. [when they need advice] they only

ask in their own small community. They learned how to plant tomatoes in rows and on a post."

He stated that he was the person who attended pesticide training classes. Whenever he had questions, he either searched the Internet, called the UC Cooperative Extension for Small Farms in Fresno County, or asked other Hmong farmers in his network. He adapted what he learned from his parents and incorporated the current pesticide knowledge he had gained by attending training at the farm. For instance, he mentioned using the recommended protected equipment. "I learned to use waterproof jackets, boots, masks, and gloves while applying pesticide. Before my training, I thought all personal protected equipment had equivalent protection." He continued,

> When applying pesticide, we used to use half of the liquid solution mixed with water. Sometimes, add a few solid products to the mixture. The solid does not dissolve in the water well. After attending a class [pesticide training], I learned to utilize other adjuvants so the concentration will mix more evenly before applying.

Jake also told me that he shared his experience with his mother, who shared it with her network of Hmong farmers. Although Jake is bilingual and literate, it was unclear whether he also consulted with non-Hmong farmers.

His mother was an experienced farmer and a trusted member of the farming community. She often responded to questions regarding pesticide choices and applications. Jake concluded, "people call her all the time for farm-related questions."

The Power of Sharing among Hmong Farmers

"I ask my trusted friends [farmers] all the time. Sometimes, I was invited to their farms to take the brand of pesticide products that they used for their crops, and I take a sample of that bottle to the pesticide stores." - Mai

The practice of oral sharing of pesticide information, application, and knowledge documented in this study was trusted, practical, quick, and valuable for this community. For example, I witnessed Yer, a farmer in her early 50s, having a 30-minute conversation helping a relative identify why her rice crop was not doing well. In her interview, she said:

> When I first grew my long beans, I didn't know that the distance between each plant is crucial in yield production. So, I spaced each plant closely together. I also didn't know how to measure my pesticide usage, so I had a lot of pest and weed issues. Later on, I learned from a relative that I needed to plant the seeds deeper, like 2-3 inches deep and 8-10 inches between plants. I also learned from her the correct type of pesticide products to use to destroy the insects and the proper fertilizer to use to foster the growth of my plant. The second time we did it, we had [a] much higher yield.

She added,

> This year, I grew long beans again and am making [a] higher profit compared to last year. Now when I have questions, I asked my cousin. I also ask my farm neighbor if I have any questions about the use of pesticides on my crops. I call and ask them all.

Another farmer, Kab, a woman in her late 40s, completed her B.A. and worked for a law firm in Colorado before moving to Fresno. She moved to Fresno two years before the study to farm with her sister and brother-in-law on a 30-acre lot. Her sister purchased the property in the early 1990s. The land included two houses and a barn converted into a pesticide storage unit. In my field notes, I documented their shared resources, including a tractor. I noted that she often borrowed her sister's tractor when she needed to plow her lot. In addition, her sister leased two acres to her.

Kab grew okra and planned to expand to four acres in the next year. In our interview, she explained, "My sister has been a successful farmer in Fresno for over 30 years and is currently doing well with the local farmers market business. I learned all my farming skills and ideas from her." In addition to drawing upon her own pesticide training, she often communicated with her sister regarding which type of pesticide products to purchase for pest issues. She told me, "When it comes to pesticide decisions, I still consult with my sister first." Kab's plans included expanding her farm and business with the hopes of joining her sister as a vendor at Central Valley local farmers' markets. At the time of the study, she was studying for her Qualified Applicator License. Her brother-in-law was a Qualified Applicator License holder and had shared all of his study materials with Kab.

I visited the farm of Kab's sister the following weekend and spent an afternoon with her brother-in-law, David. David inherited the farm from his elderly parents when he was 51 years old. Managing the farm was his primary job. David and his wife were vendors at multiple farmers' markets throughout the Central Valley and sometimes sold at farmers' markets on the coast. Their 30-acre farm grows various crops, some native U.S.

crops, and some Asian specialty crops. When I asked about his crop choices, David told me, "After so many years of being a vendor at the farmers' markets, I learned to grow my crops based on the customers' demands." He continued, "many Hmong farmers look to me for guidance on growing Asian specialty crops," implying that he was doing his best to help the Hmong farmers' community. I also asked a question regarding the support he provided his sister-in-law Kab, and he said, "I did my best to be a good source of help, share information and provide technical assistance to her." David's family farm was among one of the original Hmong farms in Fresno in the 1980s.

Another farmer I visited was Destiny, in her late 50s. She told me how she and her husband learned to farm in the Central Valley, stating,

> Here in the U.S., I learned it from my relatives and friends. In this country, we farm by using a plowing tractor. And with the help of tractors, farming is actually quite easy. We learned to use pesticide chemicals on our crops. Pesticide helps our crops to be healthy. Back in Laos, we did not have any of that.

She added,

> To maintain our crops and make sure that they are healthy, we use pesticides to get rid of any insects, bugs, and weeds. Afterward, we use fertilizer to help the plants grow. We also use our garden hoes to weed and remove uncontrolled grass. We do this every day until each crop is ready to be harvested.

She continued, sharing that,

> We got our information from other experienced farmers, such as our farm neighbors, relatives, and friends. We asked them about what type of pesticides and fertilizers they bought and how they used them, so they shared with us their

tips and practices about what usually works. Because they have more experience, so their words were helpful to us.

Phauj, a farmer in her early 70s, first settled in Minnesota and later relocated to Fresno in 1982 to farm with her husband. She explained, "We learn from our peers. They must have learned somewhere, and we just learn from them." She first piloted one acre of cherry tomatoes on a shared lot with another relative. She expanded the number of acres she farmed the following year. She grew a variety of Asian specialty crops, which she sold directly to Fresno's local Hmong grocery market and different packaging companies throughout the Central Valley. She concluded, “I’ve farmed for so long. I'm familiar with my crops and which type of chemical is best for each crop. I based this knowledge on trial and error. I occasionally attend class or call the local Hmong agricultural advisor for guidance.” She noted, "I share [my knowledge] with my farm peers when they ask for assistance."

While I shadowed her at the farm, she also showed her neighbor's farm to me, providing me with details about how she assisted them. She mentioned, "Look at my neighbor farmer's sugar cane. I showed them how to space their sugar cane, how to water them, what fertilizer is compatible with sugar cane crops." My field notes indicated that we spent 40 minutes walking around her farm as Phauj shared stories about her farming experiences. She talked about her strategies over the years to maintain each crop grown on her farm and how she had shared the knowledge with others [farmers]. She was one of the most experienced farmers in this study.

Discussion and Conclusions

Limited pesticide educational materials and intervention programs target Hmong farmers in Fresno County. Nearly all existing pesticide training was in English. In addition, pesticide labels use advanced English scientific terminology further constraining non-English speaking farming communities. These limitations affect the reading and comprehension of technical pesticide information, making it difficult to absorb such complex information. The standard approach to delivering pesticide information to farmers is via an established institutional setting, where an institution offers a pesticide training class, interested participants sign up for the class, and then physically or virtually attend the training, which an expert in the field often teaches. Information presented on the pesticide label requires reading, writing, and understanding basic English. However, although a few Hmong farmers have educational backgrounds and can follow pesticide instructions, the vast majority of Hmong farmers in the Central Valley have a low literacy level, with 71% of the participants having no formal education (Thao et al., 2019). In the face of such obstacles, Hmong farmers found ways to obtain pesticide education by forming trusted social networks to communicate and share pesticide knowledge. For this community, pesticide education extends beyond formal institutional training. Education can occur outside of the classroom, in a farm setting, or through a simple phone call. My study documented Linda, who openly shared her knowledge with her farm neighbors and provided pesticide information to her relatives over the phone. I observed Destiny, who consulted with her farm relatives, neighbors, and friends regarding pesticide products. Others, such as Jake, learned farming practices from his parents and formal training venues. Other examples included Kab, who acquired

pesticide information and made pesticide decisions based on advice from her experienced sister and brother-in-law, David, who served as role models and resources for many Hmong farmers in the Central Valley.

There is limited research on Hmong farmers. Studies on the dissemination of information regarding pesticides among Hmong farmers are nonexistent. This study contributes to understanding Hmong farmers' means of communicating pesticide information and pesticide literacy. In a close-knit farming community, the study shows that Hmong farmers utilized their familial and cultural sharing practices to consult with experienced farm peers, colleagues, relatives, and friends to attain the required pesticide knowledge to become sufficient growers. It is to society's advantage to identify the strengths of this community and build upon that model. Many communities, such as Hmong farmers, have already established a trusted way of transmitting essential information. Tapping into their system and acknowledging the strength of their oral sharing of information is valuable for researchers. Moreover, this approach recognizes that building an educational model in a trusted, close-knit community like the Hmong farmers can work efficiently. For instance, pesticide information can be quickly disseminated, learned, and practiced if the opportunity exists for Hmong farmers. Identifying community leaders, such as respected farmers like David, experienced farmers like Linda, Phauj, or Jake and his mother and engaging them in conversation might lead to opportunities to tap into their networks to build relevant, culturally sensitive, and language-specific curricula.

My experience studying and taking the Qualified Applicator License underscored the challenges many illiterate Hmong farmers experience. On the contrary, my farm

observations illustrate that the bureaucracy imposed on the farmers to obtain a license to administer pesticides is a great barrier for many Hmong farmers. Most low literacy farmers, such as the Hmong, are experienced farmers with deep knowledge of farming skills orally passed down from their ancestors for generations, can learn about the safe and effective use of pesticides through their collective networks. I suggest that this component of the pesticide regulations adversely impacts the adequacy of Hmong farming practices. I call for a careful evaluation of this requirement and suggest working directly with the Hmong farmers to find best practices that can foster the development of their farming in the United States.

Officials should develop pesticide education in consultation with Hmong farmers. Institutional curricula must reflect the complexity of the communities they serve and need to support the needs of these communities. Currently, there is a significant lack of culturally sensitive pesticide classes and limited training in the Hmong language that includes a culturally specific understanding of the Hmong farming community. To achieve proficient pesticide knowledge in this community, address community information gaps, and invest in the community's strengths and assets are essential. Studies that focus on “pesticide literacy” are necessary to understand Hmong farmers’ ways of contextualizing complex pesticide labeling information and following manual instruction and its implications for their daily pesticide practices. A small proportion of Hmong farmers attend pesticide training, and these attendees disseminate the information to their networks. This action creates a multiplier effect in the Hmong farming community, such that the training can affect 10 individuals even if only one person attended the training. Future research studies should investigate the impact of these

pesticide courses and trace the impact attendees have in the larger Hmong farming community. For instance, a study could undertake a social network analysis to determine the main point of contact in the community, their credentials, and how these individuals connect.

Chapter 4

Pesticide Take-Home Pathways, Storage, and Application Methods

The U.S. agricultural industry has consistently increased its efficiency by adopting a wide array of pesticides to combat pest issues and increase crop production. While pesticide use has contributed to greater crop yield, there are increasing concerns about pesticide usage, particularly its impact on the environment and the health of farmers who work directly with these chemicals, as well as those living in the same households (Raanan et al., 2016). In addition, studies have found that continuous exposure to numerous pesticide chemicals is associated with adverse health outcomes. For instance, studies have shown correlations of pesticide exposure with cancer development and other chronic adverse health effects (Kim et al., 2017; Lee et al., 2007; Ntow et al., 2006; Ntzani et al., 2013; Sabarwal et al., 2018; Vergucht et al., 2006; Yassin et al., 2002).

Pesticide exposure not only occurs at the farm but also through other means, such as the "take-home" exposure pathway. The pesticide take-home pathway refers to exposure that may occur when farmers or farmworkers carry pesticide residue into their homes via contaminated work clothing, shoes, skin, and vehicles (Fenske et al., 2013),

which may indirectly expose their families or housemates to the chemicals (Raanan et al., 2016). Farmworkers' homes are more likely to have higher pesticide residues concentrations than non-farmworkers' homes (Fenske et al., 2013). For instance, my recent research demonstrated that small-scale Hmong farmers in the Central Valley of California frequently use pesticides on the farm and 60% reported wearing their field clothes into their homes (Thao et al., 2019). Numerous studies confirm the practice of farmworkers wearing contaminated clothes at home (Fenske et al., 2013; Hyland & Laribi, 2017; Salameh et al., 2004). Butler-Dawson et al. (2016) compared homes of farmworkers and non-farmworkers and found that farmworkers' homes have one or more types of pesticide residue than non-farmworkers' homes.

The existing literature has long noted farmers' indirect pesticide exposure to their families via take-home pathways. However, researchers understand less about the sources of pesticide take-home pathways among Hmong farmers as they were not a part of these studies. In this ethnographic study, I focused on the pesticide take-home pathway among Hmong farmers by documenting potential sources of pesticide residue that farmers transfer from their farms to their homes, areas in the house with the most pesticide hazards, and various pesticide storage methods that might lead to higher exposures. The analysis below focuses on data recorded in ethnographic field notes and qualitative interview transcriptions.

Ethnographic Setting: Farm Observation Days

To understand the pesticide take-home pathway of small-scale Hmong farmers, I spent time on their farms, where I participated as a farmworker for a day and followed them into their homes at the end of the day. Overall, I spent between 8 to 12 hours

working alongside Hmong farmers. Since Hmong farmers can be challenging to reach, before I could schedule an appointment with a farmer, I spent five days to two weeks calling each farmer, usually in the evening between 7 p.m. or 8 p.m., when the farmer was likely returning home from the farm. On the phone, I introduced myself. Sometimes, I had already met the farmer in person; sometimes, another farmer had referred me to the farmer on the telephone. I then proceeded to inform them about my study. Once they agreed to the farm observation, we scheduled a time and date convenient for the farmer. The night before the farm observation day, I usually called to follow-up, asking about what time to arrive at the farm, what crop we would be harvesting, and what tools I needed to bring with me, and any essentials I needed for the day.

The morning of my farm observation, I made sure to pack myself lunch, wear proper farming clothing, usually a long-sleeved shirt, long pants, farm boots, a coverall hat, gloves, and apply sunscreen. I met each farmer at their farm, usually early in the morning, between 6 a.m. – 7 a.m., farmed with them all day, except for a lunch break around noon or 1 p.m. We occasionally took quick water breaks and bathroom breaks and usually ended our work in the evening between 7 p.m. and 8 p.m. Next, we loaded all the farm tools, harvested crops, and other unused essentials (usually unused pesticide products) into their vehicles. Then, I followed the farmer in my car to their homes. Once we arrived at the house, I helped the farmer unload his vehicle, usually into their small farm storage, either a designated space inside their garage or occasionally a small shed in their back yard.

Sometimes, the farmer invited into their homes for a cup of water or to be introduced to other family members. Other times I was invited to enjoy their family meal.

Occasionally, I helped prepare the harvested crops we brought from the farm for the farmers' markets, local grocery markets, or other business vendors. My time at farmers' houses varied from a 30-minute quick introduction to two or three hours helping them prepare their crops to be sold the next day. I usually conduct a qualitative interview during this time.

A typical farm observation day included working directly as a farmworker, harvesting, weeding, or planting crops. As an inexperienced farmworker, each farmer usually spent the first 30 minutes teaching and coaching me to perform my assigned farm tasks. Sometimes I worked with other farmworkers, colleagues, or the farmer's family members. I conversed with the farmer throughout the day as we worked and walked around the farm. I conducted interviews whenever I could, such as between breaks, after lunch, or between tasks. Sometimes, the interview took place at the farmer's home later that evening.

At the end of the observation day, I added as much detail in my field notes as possible about the day, my experiences, including everything I observed at the farm. My field notes included detailed information on harvesting each crop properly, as the farmers instructed me while we were working. In addition, I recorded information on the size of the farm, the rest shelter, pesticide storage space, bathroom, handwashing station, water well, and the type of crops each farmer cultivated. On a separate document, I wrote memos about each interview. In the interview memo, I described my conversation with each farmer in detail. I wrote all field notes and memos in English in a notebook that I carried with me. I later typed the notes into a protected desktop after returning from the farm.

Typically, following a farm observation, I spent a day or two reflecting on my experiences, finalizing my memos, and recovering from a well-spent day of hard work. My field notes are replete with comments about how difficult it was to work at the farm, my exhaustion from the physical labor, and my admiration for the farmers, noting that they all worked hard for long hours every day.

Findings

I completed farm observations with 11 small-scale Hmong farmers. As noted above, I recorded these observations in detailed field notes. In the following paragraphs, I report findings based on an analysis of these field notes, including identification of cases and information related to pesticide take-home pathways, including pesticide storage area at home, crop variation, and pesticide application methods. I also asked study participants to identify frequently transported tools from farm to home and vice versa; their responses became a part of the ethnographic data.

Farming with Yer

Yer, a mother of five children, had been farming for the past eight years. Her children ranged in age from 4 to 21 years old. Her husband worked full-time and helped her part-time. Yer farmed full-time. She relied on her older children to take care of their younger siblings while she was at the farm and her husband was at work. While conducting my second-year research study, I met Yer, an exploratory survey of Hmong farmers' attitudes, knowledge, and farming practices in Fresno County, California [Thao et al., 2019]. I conducted two farm observations with her three months apart.

On my first visit, I met Yer at her farm, southeast of Fresno, at 7 a.m. in September 2019, and my second visit was in November 2019. She leased her land with

four other small-scale Hmong farmers, who were relatives or friends. This farm was on a three-year lease contract. At the time of the study, she was on the second year of the lease. She leased three acres but needed more land to farm her crops. As a result, she also leased an additional two acres at a different location with a relative.

Yer planted one acre of rice, one acre of long beans, and one acre of Asian specialty vegetables, which included Chinese broccoli, mustard greens, bok choy, eggplant, Thai peppers, and singua. She grew the crops for both packing companies and Fresno's local Asian grocery markets. I spent the first 30 minutes exploring her farm and noted that she drove the family minivan to the farm. She parked her car next to her 4 x 8-foot handmade open shed. She did not house pesticides on-site. I later learned that she stored her pesticides at home, in her garage. She told me that "if it's pesticide products, we store it high on our garage so kids cannot reach it. Farm tools can be stored inside on the garage floor."

At the farm, I noted two large blue buckets next to her shed. One bucket was for handwashing. I also noted a nearby portable bathroom, which all farmers working on the plot shared. They each paid a yearly fee for the bathroom. They also paid fees for their water usage. The farm relied on groundwater, and each farmer was responsible for their own water usage fee. At the time of this study, they paid a flat rate for their well water. However, the property owner informed them that the city might install a meter in the future, at which point each farmer would be responsible for a water usage fee. In 2015, a severe drought year, their well ran dry and broke.

The farmers of the property combined resources to fix the well. I asked if there was any program to help fix the well. Yer explained that some government programs

were available, but they did not qualify as they only leased the land. Moreover, the landowner was not interested in applying for the grants. Upon further research, I learned that Yer was referring to a program called, State Water Efficiency and Enhancement Program (SWEEP). SWEEP provided financial assistance to farmers to improve wells or irrigation systems. One of the SWEEP goals was to reduce greenhouse gases and save water for California's agricultural operations (CDFA, 2021).

On the day I observed at Yer's farm, I learned that she had been at the farm since 6 a.m. to spray pesticides on her long beans. Long beans are susceptible to various pests, particularly aphids and sometimes nematodes. Several used pesticide bottles were alongside the field. When talking about her long beans crop, she said:

> Long beans require a lot of pesticides. After I planted this crop, I sprayed weed control pesticide within a few days to control the weed issues. I continue to manage any unwanted plants and weeds by hand until my crop grows. A few weeks later, I use fertilizer to help the crops grow. Then another week later, I use pesticides to control the weeds again. Once my crop grows vines, I use insecticides to control any plant diseases or pest issues until it's ready to be picked. It's a lot of weekly management and requires pesticide maintenance to keep my crop healthy.

Yer also told me that after eight years of specializing in long beans, she became better at managing this crop and decreased her use of pesticides. I also asked her why she sprayed pesticides so early in the morning. She told me that it was due to the weather. The morning was less "windy" and, therefore, the best time for pesticide application. She and

her husband used this technique to avoid pesticide drift whenever their crops needed applications.

She used a white, 5-gallon backpack sprayer to apply the pesticide to her long bean crop. When I was on her farm, she did not wear all the required PPE while applying the pesticides. For instance, she wore a face mask, gloves, and boots but no goggles. In addition, she did not wear a coverall suit; however, she did wear a pesticide-resistant woven jacket. She also wore a black plastic garbage bag to cover her jacket for extra protection. When I asked about the importance of using personal protective equipment during a pesticide application, she said, "I think using protective gear is important to my wellbeing. So, this is very important to avoid harm from using pesticide."

During my farm observation with Yer, I assisted in harvesting her rice field. Since this was my first-time harvesting rice, she spent the first hour teaching me how to harvest the crop, including modeling her techniques for me. She demonstrated how to pick the rice grain and the proper approach to use the "vuam" to cut off each grain. The "vuam" is a handmade Hmong knife specifically to harvest rice crops.

Our interview took place at the farm after lunch, from 1:30 to 2:30 p.m. After the interview, although exhausted, I continued to help her in the rice field. We spent the next few hours harvesting this crop. We ended the day with 11 boxes of rice grains (each box weighed approximately 60 pounds). We started to pack all the boxes into her car at 7 p.m. We carried the boxes by hand to her car, where she also placed the tools she had brought to the farm in the morning. She hid the tools she would be using the next day under a cover or in one of the bushes behind her farm. For instance, she did not want to bring the pesticide sprayer back home because a few sections of her farm remained unsprayed. I

learned that it was safer to store farm tools at home as thieves often trespassed onto the farm and rummaged through farm sheds at night, looking for anything of value. Because of this, Yer purchased pesticide products "as needed" to avoid storing them at the farm.

After we packed everything in the back of her minivan with some items loaded onto the passenger side, she washed her hands, face, and feet before changing clothes and heading home. She took the clothes she wore during the day and her boots home to wash. I also changed to clean clothes before leaving the farm. We left the farm around 7:45 p.m. and arrived at her home at 8:15 p.m.

Yer parked outside the garage at her house. One side of the garage was for storing farm equipment and harvested crops. The other side was for her son's car. Her husband had built a wall of three layers of wooden shelves to store all her farm equipment and pesticide products in the garage. She told me that the top two shelves stored pesticide products. I saw a bottle of "Miracle Grower" and two bottles of weed control on the top shelf. On the middle shelf, I saw one half-used 50-pound bag of Yara Vera Urea (46-0-0). The bottom layers contained all the farm gloves, masks, hats, and other accessories. Multiple farm boots and tools were beneath the bottom shelf. Hoes and shovels were stored next to the garage door.

I noted two baskets of the family's unwashed clothes. Long-sleeve shirts and farm pants were drying on a hanger. When asked where she washed personal protective clothes and equipment, she said, "we wash most of our farm equipment at the farm. Most of these equipment types are dirty, so we don't want to dirty our car or home." However, the clothes she regularly wore at the farm were washed with the rest of the family's clothes. Upon our arrival, one of Yer's daughters came out to help. After unloading everything

into the garage, she invited me to drink water inside her home. I thanked her and went inside her house. Her husband greeted me and invited me to sit on the sofa. Her husband and children, including a 4-year-old son, were home. I spent 20 minutes with the family.

Moua's Family Farm

I met Moua during an event focused on the new California law, the Sustainable Groundwater Management Act, hosted by the local UC Cooperative Extension. Moua expressed concern about the new law's impact and how related regulations would affect small-scale farmers during this event. One of her concerns regarded the language barrier to understanding SGMA's policy. Moua and I sat at the same table. I translated her question from Hmong to English for the hosts. After the event, I approached Moua about my research, and she tentatively agreed to an interview but was unsure if she would have time to host me for a whole day at her farm. I called Moua the day after the SGMA meeting and scheduled an interview date one month later, in January 2020, to interview her at her farm. After the interview, Moua invited me for a farm observation, which we scheduled three weeks after the interview. Moua was a widow in her late 60s who had lost her husband a few months before our interview. She lives on a 40-acre property with her daughter and son-in-law, who had a 5-year-old son present on the day of my farm observation. Moua also served as the caretaker of her grandchildren. She and her deceased husband purchased the property in 2000. Because they could not get a loan to build a house on the farm, they purchased a three-bedroom mobile home.

Moua received USDA's Seasonal High Tunnels grants as well as the SWEEP. While at the farm, I saw four greenhouse high tunnels and some advanced farm

technology equipment from the SWEEP program. Her late husband's new tractor, funded by another USDA small-farm program, was parked next to their home. She said,

> When we barely started farming, we had to buy everything ourselves as we were not familiar with available resources. Now some organizations help you buy the tractor. I just barely bought this tractor through one of their programs that cost $60,000, and I only had to pay $30,000. The organization helped with the rest. Now, the USDA offers a lot of help, so it is a lot easier. If we need help with our greenhouse or fertilizers, they help with that too.

When asked where she heard about these programs, she responded that her husband learned about them from attending workshops and classes offered by Mr. S (USDA-Natural Resources Conservation Service) and Mr. M (Fresno County UC Cooperative Extension). She also noted that Mr. S and Mr. M were her contacts for pesticide information and resources.

Moua's farm is in a rural area southeast of Fresno. Her husband was a licensed pesticide applicator (QAL) and attended required continuing education classes hosted by Mr. S and Mr. M. After her spouse passed, she could no longer keep his license; therefore, her daughter-in-law would need to apply for the yearly pesticide permit for her. Moua told me she could not take the Qualified Applicator License test due to literacy barriers. Her late husband was the decision-maker on pesticide products since he had his Qualified Applicator License and attended the continuing education class. Moua began to farm in the 1980s when she was in her early 20s. At the time of the study, she was in her late 60s. She married her husband at a young age, so she never had the opportunity to attend primary school. Her husband learned basic English in Thailand and Laos and

completed his GED in the United States. Moua's husband was literate in English and, after multiple attempts, passed the Qualified Applicator License.

In addition to handling the pesticide work, Moua's husband was responsible for doing all the mechanical work around the farm, such as plowing the lot. Relatives and other Hmong farmers often called on him to assist in plowing their farmlands. The year of the study, Moua reduced her farming operation to 10 acres and rented the balance of the land to other Hmong farmers, many of whom were relatives. Additional renters heard of Moua's available property through friends. Moua specializes in growing various Asian vegetable crops, including bok choy, Chinese broccoli, daikon, sweet peas, Thai peppers, water spinach, and zucchini. She also plants four acres of grapefruit and four acres of strawberries. Moua worked as a vendor at several farmers' markets in the San Francisco Bay Area, which she operated weekly, especially on the weekends. Due to the sensitivity of her crops, Moua spent over $40,000 to build three refrigerators for storage. According to her, "Since I'm a regular farmer's market vendor and also sell my produce to other vendors, these refrigerators allow my produce to be harvested early in the week and last until it sells at the farmer's market."

Moua continued to tell me that Asian specialty crops were "harder than crops like grapes or pistachios. Our crops are seasonal and not long-lasting. This means that we have to maintain them more often [using pesticide], but we also harvest more often [more labor intensive]." She stressed the importance of having resources required by the uniqueness of Asian specialty crops,

> I have to grow over 10 types of crops over that short period of time. Right after one crop is harvested, I plant another crop. I have to plant crops at different times

so I can harvest all of them before they get too ripe. To do this, you need a tractor to plow the land right after you harvest so that you can grow new crops very quickly.

Moua told me that she makes good money from the farmers' market and hoped that her son and daughter-in-law or daughter and son-in-law could take on this business. At the time of the study, her son-in-law was training to take over the farm. I noted that her son-in-law helped a hired farmworker with some of the farming operations. She also told me she would like to pass down her farming legacy and hoped to inspire her children to keep her farm. She explained,

> I started farming when I was very young. I was only 28 years old in 1988. I started with just farming one acre and slowly started from there. I farmed for two years before my husband quit his company job to join me. We sold our crops to the company until 1996, and then we started to sell at the farmer's market, where we made more money. When we first started to sell our crops at the farmer's market, we only had a small old Toyota truck and we made only $600 a weekend. We then purchased a bigger used truck [with the money saved from the farmer's market]. This bigger truck [could carry more produce to the farmer's market], which meant we made more money, but it was not enough to be profitable right away. We encountered many issues with the truck until we were able to save enough to buy a brand-new truck. After that truck, our farming business became a lot more profitable. Now, I can buy my own land and house just from the profit from the farmer's market. If you work hard, you can make money by just doing the farmer's market.

Unlike the other Hmong farms I had visited to conduct farm observations, Moua had pesticide storage located on her farm property. Her late husband built a secure 8 x 10 ft. storage unit next to their mobile home for all their pesticide products and farm tools.

At Moua's farm, my role was to assist her in the garlic and strawberry units. We first prepared the roots to plant garlic, which she soaked overnight. Next, Moua instructed me to dice each garlic root into individual pieces in an 8 x 12-inch bucket with a handle. Rotten pieces were discarded. After this sorting, we each took a row and began hand planting the garlic. Each garlic seed was planted four inches apart. We took a lunch break from 11:30 a.m. to 12:15 p.m., after which we began weeding the strawberry field. She designated four acres of her farm to plant strawberries as this crop was popular at the farmers' market.

From 12:30 p.m. until 3 p.m., we hand weeded her strawberry crops. I left at 3 p.m. as Moua attended one of her grandchildren's birthdays. On the day of my visit, she did not have to babysit her grandchildren due to the school closure for a holiday. Typically, Moua picked up her grandson at school on regular school days, and he stayed with her while she farmed. Her son picked him up in the afternoon. She said that the open field of her farm is the playground for the grandson. While she farmed, he would play under the bush or on the field.

Before I left the farm, she walked inside her house to change her field clothes and wash before going to the family event. I had earlier interviewed Moua where she mentioned that she did not need a water station or a portable bathroom due to the convenience of her house. She just walked in and out of the house to wash her hands, drink water, or change her farm clothes. Moua stated:

> My house is my shelter. When I need a water break, I can just walk into my house and rest on the sofa and drink my water. And if I need a bathroom break, I just walk into my house…I usually don't eat breakfast since I begin my farming early in the morning before the sun rises to avoid the heat. Maybe at 5 a.m. I take my breastfast break around 11 am. That is also my lunch…..I cook freshly picked vegetables from my farm and cook simple Hmong dishes for lunch in my kitchen. I only take short lunches because I have lots of work to do on my farm, so I need to get back to the field.

Moua's house and farm are conveniently located on the same property. This introduces the potential for more pesticide exposure. Prior pesticide take-home pathway research identified that living near farmland is hazardous because of the residential exposure of pesticides from the farm via pesticide drift and transportation of pesticide residues from the field into the house (López-Gálvez et al., 2019).

A Common Pattern of the Pesticide Take-Home Pathways for Hmong Farmers

All 11 participants in the farm observations showed me where they stored pesticides on their residential property, namely the garage or a built-in unit in the back yard. One farmer said, "we do not keep it at the farm because people steal them [farm tools and pesticide products]. They steal your equipment and even steal your crops. They steal almost anything." Another farmer added that one reason Hmong farmers did not have pesticide storage at the farm was that "There are many thieves that come and steal it. If it is too heavy, then we will hide it in the field. If it is at our house, then people will come and steal it but, if we leave our goods in the farm shed, no, that is not safe." Another farmer added, "My husband and I decided not to take our fertilizer since we will

be using it the following day and did not take it home. The next day when we returned, my husband discovered someone had broken our lock and taken all the fertilizer."

Fertilizer products are usually sold in 50 to 100-pound quantities. Therefore, leaving it at the farm is convenient, especially if it will be used within days. However, "thieves" seem to be a common problem. Thefts caused farmers to design alternative storage methods, including bringing them to their residential properties, as the farmers believed their homes were safer than the farm. To prevent thefts, one farmer concluded, "we just take it [pesticide products or farm tools] home and put it in the backyard. We will take it back the next day." Another farmer supported this statement as she said,

> For the fertilizers, we have to take them with us all the time and same thing for the tools. We must take them with us to and from the farm every time. We just stored them in the garage when we get home. Before you go to the farm, you can load the tools, fertilizers, and pesticides in the car before you go.

Such rotational practices can be risky because most farmers' homes have young children present. In homes where the garage is the designated pesticide storage unit, several family members will likely come in contact with the contents of the garage, and pesticide residue from any of the farm tools or clothes can be carried into the house. Additionally, although many farmers were careful to place pesticide products in a high, unreachable area away from the children, there is a potential risk of exposure should a spill occur.

Participating farmers widely believed that a common exposure pathway was through crop variations. All Hmong farmers in my study grew seasonal Asian specialty crops that could be planted several times throughout the year. This required the use of

fertilizer year-round, switching between different specialty crops, thus introducing greater pesticide contact and exposure. Reusing the same land to grow multiple seasonal products requires more pesticide management. As one farmer indicated, "I think that because the land has been reused over and over to grow different crops, the soil is not good anymore. There are also a lot more pest issues."

Another factor in increased risk related to the crop cultivated was that most Asian specialty crops require more close, delicate handwork in cultivation. One farmer compared growing Asian specialty crops to traditional long-term crops, explaining,

> Those bigger farmers who grow long-term crops to sell, the majority of them are American farmers. These farmers only use tractors and machines and not their hands. Because we [Hmong farmers] do not have the same machines that specialize in harvesting our crops and expensive tractors as they [large longer-term crop farmers] do, we only use our hands, so this means we work much harder than they do. When we are harvesting, we have to handpick them [each crop], and then we can pick the ones that are good and box them to be sent to the companies.

Due to the nature of their seasonal crop variabilities and the vulnerabilities to pest outbreaks, the farmers stated that "our crops will not grow if we farm without the use of pesticide products such as fertilizers and pest chemicals." In addition, the farming seasons for the Hmong farmers never stop as they can grow seasonal crops year-round. As mentioned by another farmer,

> We do different things depending on the time of the year and each crop season. We grow each crop based on the season. And when it is the harvesting season,

> you harvest from morning until night. Then you box all the crops and take [them] to the packaging company where they have coolers, and they sell your crops for you. Then we focus on growing the next crop and do the same again.

Other challenges in growing Asian specialty crops include limited specialized farm equipment to assist farmers during the harvest. As this farmer explained, "I am a small farm, so I just use my strength. I use the hoes to plow out all the weeds that grow. Everything from weeding, pesticide application, and fertilizer application is done by hand. You grow and sell your crops using your own strength." When asked if any farm machines could help make farming easier for them, one farmer answered, "No, I do not think so. The current machines cannot harvest as well as by hand because our crops are fragile and require handpicking only."

Lastly, farmers noted another reason they were more likely to bring pesticide contamination home after each application. As mentioned by one female farmer, "my husband is responsible for doing all the mechanical work [tractor operator] and pesticide applications on our crops." A male farmer shared, "I am responsible for taking care of the crops and making sure that there are no weeds or pest outbreaks on my farm. If any of these issues arise, I must apply the proper chemical." For many small-scale Hmong farmers, the most affordable way to apply a pesticide is a hand-operated backpack sprayer, using a 5-gallon backpack sprayer that costs between $200 to $500. Another male farmer said,

> I am not using a machine to spray pesticides because my farm is not big enough to require such a machine. And these machines are costly. I just use my hands. I

apply the herbicide by hand to kill the weeds too. I have to apply them before the crops grow in order for the crops to grow well.

Discussion and Conclusions

This study is one of the first to explore pesticide take-home pathways using narrative descriptions and detailed field notes documentation among Hmong farmers in Fresno County, California. Field notes recording my observations documented the daily transportation of pesticides and tools from farms and into homes. Among other take-home items, this study highlighted one unique characteristic of this pathway: the pesticide storage area located at farmers' homes. Farmers regularly brought contaminated farm equipment and pesticide products. Notably, the study illustrated the challenges each farmer faced and the difficult decisions each farmer made to store pesticides at home instead of on the farm. Concerns about theft informed decisions to store pesticides at home. Farmers risked exposing themselves by daily transporting farm equipment and pesticide products between their farms and homes.

Another factor that informs pesticide use and exposure is the type of crops that Hmong farmers grow. For instance, many Asian specialty crops, such as long beans, require frequent pesticide applications due to their vulnerability to pests (UC Small Farm Center, 1998). Hmong farmers grow delicate Asian specialty crops that require greater and closer maintenance and can be rotated quarterly. This introduces greater pesticide contact and exposure. As evidenced in this study, most participants cannot justify purchasing a pesticide sprayer tractor. Therefore, they use hand-operated backpack pesticide sprayers. Using a hand-operated backpack sprayer increases the risk of pesticide

exposure and the likelihood of bringing contaminated clothes and farm boots into the home after each pesticide application.

Providing education on the pesticide take-home pathways to Hmong farmers and educating them regarding how pesticides can be brought home via contaminated sources are key to minimizing pesticide transmission. This study also provides insights into the current concerns regarding theft at the farms. In addition to providing training, offering safe and secure pesticide storage options for the farmers is crucial to breaking this cycle of pesticide take-home pathway chain.

Finally, the limitations that Hmong farmers face due to widespread leased farmlands on short-term contracts are evident in their inability to apply for various financial support programs to improve their farms and incomes. Lastly, the farmers' fear of equipment and pesticide theft must be recognized as contributing to broader pesticide exposure to the farmer's entire family, including the numerous young children present in many homes. Future studies should delve deeper into capturing the experiences of Hmong children and grandchildren living in a Hmong farmer's household.

Chapter 5

Conclusion

Agricultural studies have not explored the use of pesticides among Hmong farmers living in the United States. This study explored how the Hmong farmers have adapted to the use of pesticides by tracing (a) factors that influence pesticide practices and perception of adverse health impacts, (b) pesticide literacy and ways of information dissemination, and (c) exploring pesticide take-home pathways through Hmong farmers' narratives and ethnographic descriptions. Prior to settling in the United States after the Vietnam War, Hmong communities had little exposure to Western societies as they primarily lived in the rural mountains of Laos (Culas & Michaud, 1997; Quincy, 1995). As an agrarian people with no written language, oral sharing of information via folklore stories and embroideries kept their culture and tradition thriving for generations (Lee, 2005; Thao, 2006; Yang, 2010).

As shown in the narratives, Hmong farmers showed remarkable resilience despite being in a new and challenging environment. Hmong farmers faced substantial language and cultural barriers to farming in the U.S., especially given that U.S. farming required the use of fertilizer and pesticides, which was entirely new to them. Despite such hardships, this study illustrates unique ways Hmong farmers learned to adapt in the U.S. to small-scale family-operated farms, similar to when they migrated from China to Laos many centuries ago (Culas & Michaud, 1997).

As discussed in Chapter 2, farming in the Central Valley is drastically different compared to their home country of Laos. In Laos, the Hmong farmed on the mountain hills using the "slash and burn" method and relied on natural resources such as fertile

land and rain to nurture their crops (Lee, 2005). However, in the United States, they could not rely on the same farming methods. To foster their crop's yields, they must use pesticide products such as fertilizer, insecticide, and herbicides to maintain their crops. In Laos, the Hmong only used handmade tools such as hoes and axes to cultivate their crops. In the United States, they encountered highly mechanized farming methods that included tractors and different types of pesticide handling equipment. The Hmong farmers adapted to these practices as described in their farming experiences. Secondly, farming in Laos does not require economic expenses, such as renting the farmland, purchasing farm equipment, or buying pesticide products to maintain their crops. When they farmed in Laos, the land was free to use. Farm equipment consisted of handmade tools. As described in this chapter, farming in the United States required them to purchase or rent their farmlands and have the financial stability to buy farm resources such as tractors and pesticide products.

The farmers understood the risks required to become a farmer in the U.S. However, they faced the difficult decision to risk exposing themselves to using pesticides due to market economics, which they found outweighed the risk of pesticide exposure and poor health outcomes. The narratives captured in this chapter provide insights into how Hmong farmers adapted to this new farming environment and the methods they developed to overcome the challenges they faced navigating their way through farming resources in the Central Valley.

In Chapter 3, I explored the oral dissemination of pesticide education. This chapter traced the flow of pesticide information and presented various cases of how pesticide training attained by one Hmong farmer could, directly and indirectly, impact

another Hmong farmer. The chapter highlighted that Hmong farmers in the Central Valley shared closely knit and kinship networks to obtain necessary information through efficient, effective, quick, and information community networks. For instance, despite limited in-language pesticide resources, they relied on obtaining vital farming information through community resources comprised of trusted relationships and experts within their networks. Understanding this dynamic is fundamental to understanding pesticide literacy in the community and how to reduce the dangers of pesticide take-home pathways.

Chapter 4 presented the prevalence of pesticide take-home pathways. The findings confirmed earlier work that pesticide exposure occurs both at the farm and inside the farmer's house. The chapter provided new insights into the various reasons why many Hmong farmers transported their farm equipment, tools, and pesticide products daily despite knowledge of the dangers of pesticides.

The findings of this study validate that Hmong farmers face great adversity accessing governmental resources, mainly due to their farm lease status and language barriers. In addition, they are at risk of pesticide exposure due to their unique farming practices. Currently, there are limited usable resources available to the Hmong farmers in the Central Valley. Future work should address the impact of such inequality. Given the limitation of in-language educational resources regarding pesticide education, future work should include developing more in-language resources for this community. Hmong farmers' narratives are instructive in the robustness of informal communication networks. Learning from their narratives can lead to a better understanding of how different communities pass down knowledge and suggest new perspectives and solutions.

Limitations

Limited to 25 small-scale Hmong farmers in Fresno County, California, this study provided a preliminary look into various issues affecting the Hmong farming community. The narratives captured likely represent only be a portion of the collective needs of all Hmong farmers. Future studies should strive to include larger sample sizes. Moreover, this study represents a convenient sample of one specific region; consequently, the findings reflect only the farming experiences of the participants in this limited region. While I made an effort to recruit men as study participants, only 38% of the population were male. Future work should strive to achieve a more balanced gender representation to obtain a greater possible range of perspectives. Lastly, 75% of all participants were over age 50 and offered limited insights into a younger generation of Hmong farmers.

Research and Policy Implications

Through in-depth interviews and ethnographic observations, this study attempted to contribute to the understanding of pesticide knowledge and adverse health outcomes by examining small-scale Hmong farming in the Central Valley. Prior to this study, there was limited research on Hmong farmers and a paucity of literature providing insights about the community. Specifically, this study fills a gap in the literature on practices related to farm pesticides' potential take-home pathways and identified factors that present challenges to reducing pesticide exposure. Understanding these factors is key to addressing policy change and developing culturally appropriate training for the Hmong farmers and other groups with language barriers and difficulties in the Central Valley of California and perhaps elsewhere.

Institutions working with small-scale farmers play critical roles in providing pesticide take-home pathways training information. Many farmers shared that they utilized the limited resources available to them, such as the Fresno County University Cooperative Extension and the USDA-Natural Resources Conservation Service. More funding is needed to support local agency efforts to provide services in the Hmong language to educate community farmers about the importance of pesticide exposure risks, take-home contamination, and related concerns.

These research findings highlight the agricultural needs of the Hmong farmers by recognizing the need for more culturally appropriate pesticide safety training and educational programs in the Central Valley, promoting additional resources, and supporting services such as oral pesticide information and labels available in Hmong so farmers can make informed pesticide decisions. This study found that despite being illiterate, this community appropriately utilizes pesticide information by using trusted social networks because pesticide literacy in the community is both interactional and navigational. Additionally, the qualitative approach of this study presented readers with an understanding of the extraordinary everyday lives of the Hmong farmers and their current challenges in general, but with a special focus related to pesticide laws and regulations. Policymakers need to address pesticide laws and regulations from a community perspective through direct engagement. Small-scale Hmong farmers play a significant role in producing and distributing local foods in the Central Valley. We must consider the impact these laws and regulations have on the daily lives of the Hmong farmers to mitigate their fear of pesticide laws and regulatory enforcement.

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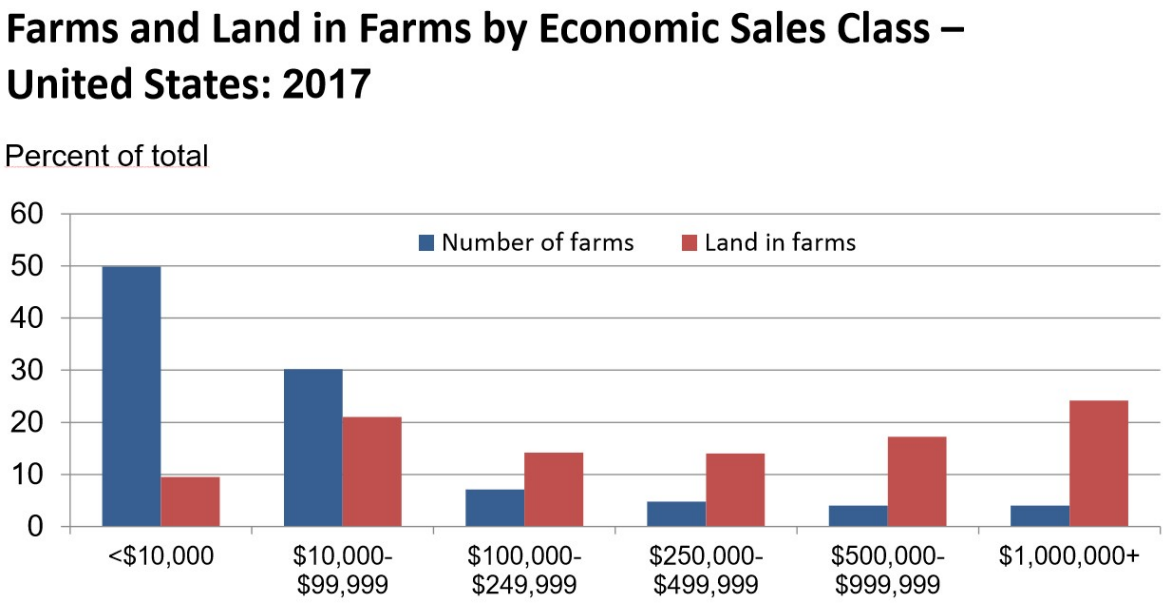
Appendix A: Figure

Figure 1

Percentage of Farms and Land in Farm Sales by NASS (2018)



Appendix B: Table

Table 2

Food Sales to Consumers in the U.S. (Adapted from USDA NASS, 2015)

Direct Sales to Consumers, by Marketing Practice and Number of Farms, 2015, USA

	Sale		No. of Farms
	$ million	%	
On-farm store	1,322	44	51,422
Farmer's market	711	23	41,156
Roadside stand away from the farm	236	8	14,959
Community-supported agriculture (CSA)	226	7	7,398
Online	172	6	9,460
Other (pick-your-own, mobile market, etc.)	360	12	39,765
Total	3,027	100	114,801*

**Is less than the sum of individual practices because a farm may use multiple practices.*

Source: USDA NASS, 2015 Local Food Marketing Practices Survey.

Appendix C:

Recruitment Script (English & Hmong)

Hello,
My name is Chia Thao. I'm a graduate student at UC Merced. I'm currently working on a project exploring how pesticide exposures can impact poor health outcomes among small-scale Hmong farmers residing in Fresno, Ca. The interview will take approximately 40-60 minutes to complete; would you be available to participate in this study? Your participation in this study will help us understand factors that are essential indicators for addressing policy change and developing culturally appropriate training for Hmong farmers and other cultural groups. However, this study is only for research purposes, and if you don't feel comfortable partaking in the study, I will completely understand their decision. If you can participate in my study, my research has two approaches. The first is an interview and the second is the ethnographic observations. You can choose which approach they are most comfortable with. Should there is any question, please feel free to contact me at (559)260-7421 or via email: cthao45@ucmerced.edu

Thank you,
Chia Thao (Ntxhiav Thoj)
Graduate Student
University of California Merced
cthao45@ucmerced.edu

Nyob zoo,

Kuv lub npe hu li (Ntxhiav Thoj), kuv yog ib tug ntxhais (xib fwb) kawm ntawv qeb siab nyob rau lub University of California. Kuv xav tshawb fawb txog txoj kev pau, kev coj cwj pum, thiab kev siv tshuaj rau qoobloo ntawm kev ua teb nyob rau ntawm haiv neeg tsawg. Kuv txog kev tshawb fawm nrog cov tub qoobloo yuav nyob rau hauv Fresno. Kuv yuav xa nrog koj tham li 40-60 feeb, koj puas khoom nrog wb tham? Koj txoj kev koom tes nrog kuv txoj kev tshawb fawm no yog los ntawm koj txoj kev txaus siab pab xwb thiab yog nyob rau tham lub sij hawm koj khoom xwb. Yog tías koj tsis khoom los tsis ua li cas. Kuv yuav tsi tu siab dab tsi li. Yog tías koj khoom, kuv txoj kev txhawb fawm no muaj ob nqi. Nqi ib, youg nrog nej sib tham xwb, ho nqi ob yog nrog nej ua teb ib hnub tas ces mam li nrog nej tham. Yog tias koj muaj lus nug, thov hu kuv ntawm (559)260-7421 or yog sau ntawv rau kuv ntawm: cthao45@ucmerced.edu

Ua Tsuag,
Ntxhiab Thoj (Chia Thao)
Graduate Student

University of California Merced
cthao45@ucmerced.edu

Hmong Farmers Interview Guide (English & Hmong)

Study 1: *Study 1: Hmong farmers' use of traditional farming practices, pesticide application, and understanding of the association between pesticide exposure and poor health outcomes.*

1. Txoj kev ua teb nyob lub tebchaws koj tuaj, yog ua li cas xwb? (What are the farming practices of the country where you are from?)
2. Txoj kev ua teb nyob lub tebchaws Meskas no yog ua li cas xwb? (What are the farming practices in the US?)
    a. Koj sim piam cov kev ua teb nyob rau lub ntuj qub qab ua koj tseem siv nyob rua teb chaws no? Rau li qoob loo? Kev siv tshuaj tua kam? Los yog kev tu nroj? (Can you describe any farming practices from your home country that you still maintain? Including crop selection? Pesticide use? Or weed control?)
    b. Thov qhia koj siv tshuaj li cas rau koj diam teb? Hom qoob loo twg sij tshuaj ntau dua? Can you describe how you use pesticide on your farm? Which type of crop(s) required the most pesticide, please explain?
    c. Koj ho sij tshua li cas? How do you apply pesticide on these crop(s)?Leej tug yog tus si co tshuaj no? (Who apply pesticide on your farm)?
    d. Ib lub lim tiam los yog ib hli twg koj siv tshuaj ntau npaum li cas? (How many times per week or month do you apply them?)

Cov tswv yim ua teb tshiab ua koj kawm tau coj los siv thiab tu koj daim teb yog dab tsi? (What new ideas of farming practices that you had adopted to maintain your farm and crops are?4. Koj xav hais tias dab tsi yog qhov nyuaj tshaj txog ntawm koj txoj kev ua teb? What do you think is the hardest thing for you about your farming?
6. Thov qhia kuv tias cov tshuaj koj siv tua kab thiab tua nroj ua tau koj muaj mob li castau? Qhia kuv hais tias ua tau li cas? (Can you tell me the possible effects of applying pesticide?
7. Koj xav hais tias koj txoj kev ua teb puas hloov koj txoj kev siv cov tshuaj tua nroj thiab tua kab? Piv txwv hais tias, koj yeem ua teb ntev ces koj yeem paub siv tshuaj ntau dua qub los yog tsawm dua qub? Yog vim li cas thiab li hloov? (Tell me if your farming practices changed over the years? The longer you farm, do you think your farming practices, such as using pesticide/chemical increased or decreased? Please explain why it changed?
8. Have you heard of anyone getting sick from using pesticide?

Study 2: *health literacy on pesticide among Hmong farmers*.

1. Koj nrhiav thiab yuav koj cov tshuaj tua kab qhov twg? Nws nyob deb npaum cas ntawm koj thaj teb? Where do you find and buy your pesticides? How far is it from your farm?
2. Kev kawm siv tshuaj tua nroj thiab tua kab, puas muaj rau koj mus kaum? Koj puas mus cov kev qhia no? Vim lis cas koj thiaj mus los sis tsis mus? Are there pesticide trainings available for you to go attend? Do you attend these trainings? Why or why not?

i. Koj mus nriag kev qhia txog cov tshuaj tua nroj thiab tua kab no qhov twg? Where do you go to find information about pesticides?

ii. Qhia txog hais tias koj siv dab tsi pab cov tshuaj tua nroj thiab tua kab qhov twg (siv hnab looj teb, looj qhov ntswg thiab qhov ncauj ua peej yig; kev qhia txog txoj kev siv/khaub ncaws PPE)? (Describe your pesticide resources (such as access to pesticide education, low-cost/free Personal Procted Equipment (PPE)?)

Ib hnub twg, thaum koj tuaj txog ntawm teb no los txog thaum koj mus tsev? What is a typical day like for you at the farm? Please walk me through your daily routine from when you arrive at the farm until when you go home. 4. Koj xav hais tias koj puas tau taub cov tshuaj tua nroj thiab tua kab no zoo? (Ua cas koj thiab tau taub zoo los sis tsis zoo?) (Do you feel that you understand the pesticide products well? If yes, how so? If not, how so?
5. Twb muaj dabtsi zoo rau koj lawm, los ntawm kev siv tshuaj tua kab/nroj? What are positive experiences from using pesticides?
6. Twb muaj dabtsi tsis zoo rau koj lawm, los ntawm kev siv tshuaj tua kab/nroj? What are negative experiences from using pesticides?
7. Koj kev chwv tshuaj tua kab/nroj no yog li cas xwb? (Koj siv puas tsawg zaus, lub sij hawm twg thiab li cas xwb?) What are your physical interactions with pesticides? (How often do you use it, when and how?)
8. Koj puas nrog cov neeg ua tes nyob ze ntawm koj thaj teb tham? Nej tham txog dabtsi xwb? Do you speak with your farm neighbors? What are the conversations about?
9. Koj cia cov tshuaj tua kab thiab tua nroj hauv koj daim teb qhov twg? Where do you store pesticides in your farm?
10. Koj sim paiv sib koj txoj kev siv cov tshuaj tua kab thiab tua nroj tam si no li cas? Hom tshuaj twg koj siv tua kab/nroj thiab vim li cas ho zoo siv? (Can you explain how you decide which pesticide to use? What brand(s)/type(s) of pesticide do you use on your farm and what benefits do these pesticide have on your farm?

11. Koj puas txhawj txog koj txoj kev siv cov tshuaj tua nroj thiab tua kab? Yog li cas koj txoj kev siv tshuaj tua kab/nroj thiab ua rau koj txawj? Can you tell me what worries you about your current framing practice? What about your pesticide use? Do you have any concern?
12. Koj xav li cas txog cov ntawv lo cov tshuaj tua nroj thiab tua kab? (What are your thoughts about the pesticide information on the bottle (label)?)
a. Koj xav hais tias hloov dabtsi thiaj li pab tau cov ntawv lo no? What changes do you recommend to improve the pesticide labels?

13. Qhia kuv seb koj paub txog txoj kev cai tswj txog ntawm txoj kev siv tshuaj tua kab thiab tua nrog? (Can you tell me about anything you know regarding the laws regulating pesticide practice?)
14. Yuav hloov cov kev cai siv tshuaj tua kab thiab nroj li cas thiaj li pab tau nej thiab nej txoj kev ua teb? (What changes to the pesticide laws will help you and your pesticide farming practice?)
a. Yuav hloov siv cov kev cai no li cas thiaj li pab tau nej txoj kev nyab xeeb? (What changes to the pesticide laws will help with your well-being?)

Study 3: *Hmong farmers' indirect pesticide exposure to their families via the take-home pathway.*
(make into check-list)
**observed a day in their life*
**transportation*
1. Nyob rua ib hnub twg, Hmong txoj kev mus ua teb nyob rua hau Central Valley nws zoo li cas xwb? (In a regular day, how is farming in the Central Valley like?)
2. Tsev neeg muaj feem xyuam rau ntawm Hmong txoj kev ua teb nyob rua hau Central Valley zoo li cas? (What is the family dynamic and role of Hmong farmers in the Central Valley like?)
    a. Leej twg yog tus txiav txim siab txog ntawm cov tshuaj tua nroj thiab tua kab? (Who makes pesticide/chemical decisions at the farm?)
    b. Leej twg yog tus mus kawm kev cob qhia txog kev siv tshuaj thiab kev cai? (Who is likely to attend the pesticide training?)
    c. Leej twg yog tus tawm tswv yim los cog qoob loo thiab coj mus muag?? (Who decides which type of crops to grow and sell at the farm?)
3. Yab cuaj yeej dab tsi ua siv tas pem teb es qa los tsev? (What type of materials are being brought back home from the farm?)

List Check:
1. Do the farmer use any pesticide products while I was present?
2. Do the farmer have any pesticide bottle (used or unused) at the farm?
3. Were there storage space for their pesticide products?
4. Do they have access to a hand washing station? Shower?
5. Do they wash their hand or farm equipments after they apply pesticide?
6. What tools do they use to maintain their crop or weed control ? _____
7. What PPE do they have at the farm?
8. What tools/equipments do they take back home?
9. Do they take off their clothes (PPE) after an application? Do they shower immediately after they apply pesticide?
10. Do they wear/take their PPE (clothes, including boots) back home?

11. At home, where are these contaminated PPE/tools/equipment being stored at? _____
12. Who is at home?
    a. Are there small children around the house?
    b. Where do the children play inside the house?

Quick Demographic Questions:

1. How long have you been farming?
2. Where do you farm? (zip code or area)
3. Years of education in the US?
4. Gender?
5. Age?
6. Language spoken at home?
7. Marital status?
8. Rental status?
9. Size of farm?