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Assessment of needs for produce safety educational resources for non–English-speaking growers in the Midwest

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Abstract

Refugee growers possess diverse agricultural knowledge, but they often face barriers to complying with U.S. produce safety practices due to language limitations and unfamiliarity with Food Safety Modernization Act standards. This study conducted a needs assessment using focus group interviews with advisory board members (n = 6) and refugee growers (n = 10) in Iowa and Kansas

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to evaluate produce safety knowledge and identify educational gaps. The interviews with advisory board members aimed to identify refugee populations, crop types, and training needs. The interviews with growers' focus groups explored knowledge gaps regarding worker health and hygiene, biological soil amendments, and agricultural water safety. The interview transcripts were analyzed using constant comparative analysis. The findings revealed that refugee growers spoke various languages, including Swahili, Kirundi, Nepali, Burmese, Chin, and French. While refugee growers possessed basic knowledge of hygiene and food safety, they lacked understanding in key areas such as sources of contamination, visitor protocols, biological soil amendments, and water testing. We found that language barriers, limited access to training, and cultural differences further hinder effective produce safety compliance. Based on these findings, developing culturally relevant and linguistically tailored educational materials such as short-format, multilingual videos, and posters that reflect growers' traditions and experiences was recommended. Making these resources accessible via platforms like WhatsApp and YouTube can enhance produce safety practices and support compliance with the Food Safety Modernization Act. This research highlights the importance of accessible training to promote produce safety, regulatory compliance, and sustainable agricultural practices among refugee growers.

Keywords
produce safety, refugee growers, needs assessment, educational resources

Introduction

According to World Health Organization (WHO) research, foodborne outbreaks affect approximately 600 million people annually worldwide, resulting in an estimated 420,000 deaths (WHO, 2024). Poor food safety management practices at fresh produce farms have frequently been identified as a significant source of contamination during the investigation of various foodborne outbreaks. In the U.S., one of the deadliest outbreaks was caused by cantaloupes contaminated with *Listeria monocytogenes* consumed across 28 states, leading to the disease Listeriosis, resulting in 33 deaths and a miscarriage (Centers for Disease Control and Prevention [CDC], 2012). This deadly event was traced back to a farm in Colorado, which led to the recall of 300,000 cantaloupes (McCollum et al., 2013). Furthermore, 15 outbreaks of *Escherichia coli* infection occurred between 2010 and 2017 that were associated with vegetable row crops such as romaine lettuce, spinach, and iceberg lettuce. These outbreaks resulted in 299 illnesses and two known deaths (Carstens et al., 2019). An outbreak of 69 infections and 22 hospitalizations caused by *Salmonella* was recently traced to a cucumber grown in Florida (CDC, 2025). The number of reported outbreaks related to the "fresh produce" food category has rapidly increased over the last few decades. Foodborne illness investigations from 1998 to 2008 identified six plant categories as the probable cause of 46% of reported illnesses, which included fruits, nuts, , mushrooms, leafy vegetables, root vegetables, sprout vegetables, and vine stalk vegetables (Painter et al., 2013).

Although substantial improvements have been made in produce safety education, including the establishment of the Produce Safety Alliance (PSA) through a partnership between Cornell University, the U.S. Food and Drug Administration (FDA), and the U.S. Department of Agriculture (USDA) (Produce Safety Alliance, 2019), not every grower community gets equal access to the resources. Most of the current training is tailored toward large-scale farm enterprises and for the English-speaking grower audience. However, some resources have been developed recently for immigrant farmworkers, mainly Hispanic farm workers who are usually trained to perform specific tasks under the guidance of farm managers who oversee food safety (Rajagopal, 2012, 2013). Nevertheless, many refugee and resettled immigrant growers who run small-scale urban farm plots, which are communal, have different farming operations and responsibilities compared to the other immigrant farmworkers in large-scale farms or the produce industry (Nguyen, 2020). These are not employees but independent operators who do all the farming activities themselves, including soil preparation, harvest, postharvest handling, and, in many cases, do this all without regulatory oversight. Many inde-

pendent operators and growers do not speak Spanish; instead, they use languages such as Swahili, Karen, Somali, Nepali, Chin, Burmese, Falam, and others, resulting in a shortage of accessible produce safety resources (Jarman, 2021).

Immigrants and refugees form a large part of the workforce in the agricultural industry, accounting for nearly 70% of all workers (Pokhrel, 2025). Despite the helpful development of Spanish-language resources, there is still a significant gap for non–Spanish-speaking, low-literacy refugee growers whose products are becoming part of local food systems through farmers markets and community supported agriculture. Although small-scale farms produce lower volumes than commercial operations, their produce is distributed directly to consumers, often without the involvement of intermediaries. This means that any contamination can reach vulnerable populations quickly. Moreover, some of these farms often operate with limited infrastructure, such as wash stations, cold storage, or record-keeping systems, which can increase food safety risks if best practices are not implemented (Parker, Schlegel et al., 2016). Without linguistically, culturally, and educationally relevant materials, these growers cannot adopt the best produce safety practices that ensure microbial safety of their fresh produce crops. It has been identified in the literature that the lack of food safety knowledge and educational resources are a significant barrier to compliance with produce safety practices among growers (Chen, Ellett et al., 2021). Education is crucial in mitigating these risks by equipping growers and farm workers with the knowledge and practices necessary to minimize contamination. However, barriers to effective education persist, particularly among non–English-speaking and low-literacy populations, who may struggle to access or comprehend traditional food safety training materials (Fox, 2020; Parker, Wilson, LeJeune, & Doohan, 2012). These challenges are further compounded by refugee growers, who often face unique cultural and linguistic barriers that hinder their ability to understand, trust, and adopt recommended food safety practices (Aning, 2023). Therefore, addressing these challenges through culturally and linguistically tailored training can foster greater trust and improve the adoption of the practices.

Since the resettlement of refugee groups in the U.S., particularly those from Myanmar, Nepal, and the Democratic Republic of Congo, many of these immigrants have engaged in urban small-scale agriculture at an increasing rate. These individuals often participate in production on their own or on shared plots provided by nonprofit organizations or city agencies (International Rescue Committee, 2021). Unlike hired farm workers who perform specific tasks under close supervision, refugee growers manage their plots independently, carrying out activities such as soil preparation, planting, watering, harvesting, processing, and marketing, often without formal agricultural training (Goralnik et al., 2023; International Rescue Committee, 2021). Non–English-speaking immigrants with refugee backgrounds also make up a substantial portion of the Midwest U.S. workforce and are engaged in a wide range of activities within fresh-produce systems. However, growers from diverse backgrounds face multiple barriers, including language differences, cultural variations, and limited food safety literacy. In Kansas and Missouri, refugee resettlement has been supported by social service institutions and agricultural programs such as Global Greens and New Roots for Refugees programs (Fetahovic, 2020). These initiatives are operated by Lutheran Services in Iowa (LSI) and Cultivate KC, respectively, both of which play central roles in providing refugees with access to small production plots, shared infrastructure such as greenhouses, wash stations, and coolers, as well as linguistically accessible training and business development support. Together, they help refugees reconnect with agriculture, build market-oriented production skills, and develop direct market outlets, including farmers markets, community supported agriculture (CSA) programs, and wholesale channels supporting their transition from subsistence gardening to independent, culturally relevant farm enterprises. (Fetahovic, 2020; Nguyen, 2020). These growers sell directly to consumers in local markets, where produce is often consumed raw; thus, their understanding of safe handling practices is crucial.

One of the primary barriers to food safety education is the overwhelming amount of information presented in formats that are not accessible to all

growers (Bianco et al., 2016; Neal et al., 2011). Many educational programs are designed for English-speaking audiences and heavily rely on written materials, which may not be effective for individuals with limited literacy or unfamiliarity with the concepts (Arena & Wheaton, 2021; Dunlap, 2016; Fetahovic, 2020). This is particularly problematic for non–English-speaking growers, who may lack proficiency in English and come from countries with agricultural practices and food safety regulations that differ significantly from those in the U.S. (Nabwiire et al., 2021). To address these challenges, education programs need to be tailored to the specific needs of these populations by incorporating more visually based training and materials in their native languages. Videos, images, and hands-on demonstrations can be more effective than text-heavy manuals, providing clearer, more actionable guidance that transcends language barriers (Li, 2015; Rajagopal, 2012, 2013; Rajagopal et al., 2019). By addressing these barriers and customizing education to the unique needs of diverse grower populations, food safety training can become more inclusive and effective, ultimately reducing the risk of contamination in the fresh produce supply chain.

Hence, it is essential to have needs assessments that reflect practitioners' realities, preferences, and resource availability so that curriculum organizers can adjust the educational content to fit the target population better (Archila-Godínez et al., 2022). The objective of this research was to conduct a needs assessment to identify the gaps in produce safety knowledge and practices among non–English-speaking refugee growers in Kansas and Iowa. The research identified gaps in produce safety knowledge and practices through focus groups, which helped understand these gaps in the context of the growers' operations. The results of this paper will directly guide the creation of visually appealing and multilingual education tools, including posters and video materials that will enhance the safety practices of the produce in this underserved population.

Methodology

Previous research among underrepresented refugee growers revealed different key knowledge gaps among growers from Iowa and Kansas (Fetahovic, 2020; Nguyen, 2020). Needs assessments were employed to reconfirm and identify unique produce safety knowledge gaps. The needs assessment consisted of two focus group interviews that included the participation of advisory board members and refugee growers. The study was deemed exempt by the university's institutional review board (IRB ID no. 24-381).

Selection of Advisory Board Members

Advisory board members ($n = 6$) were purposively selected to represent key stakeholders supporting refugee growers. Selection criteria included: (a) ability to speak the growers' native language; (b) expertise in agriculture, social service, and/or refugee grower support; and (c) being 18 years or older. Members were recruited from Lutheran Services of Iowa (LSI), Cultivate Kansas City (KC), and Catholic Charities of Northeast Kansas. The advisory board comprised two representatives from LSI, two from Cultivate KC, one from Catholic Charities, and a Swahili-speaking student from Iowa State University. This purposive recruitment ensured inclusion of members with diverse perspectives and direct engagement with refugee growers, strengthening the representativeness and relevance of the advisory input.

Advisory Board Members Focus Group Interview Study Design

Focus group questions ($n = 10$) were adapted from Marine et al. (2016) and designed to capture advisory board members' knowledge of the refugee populations they serve, the types of crops cultivated, marketing channels, produce safety needs, and dissemination strategies. Questions were reviewed and refined by four food safety experts and a program evaluator from Iowa State University, Kansas State University, and Louisiana State University, with attention to cultural and contextual appropriateness for the refugee grower population.

Two virtual focus group sessions were conducted using Microsoft Teams in May 2023. Each session was moderated by the program evaluator and lasted 60–90 minutes. The moderator posed questions, guided discussion, and took detailed notes, while a co-moderator ensured thorough documentation of participants' engagement and inter-

actions. The online format enabled participation across geographic locations and accommodated busy schedules.

Data Analysis of Advisory Board Interviews

The program evaluator expanded the session notes by transforming brief notes into detailed narratives while ensuring participant confidentiality. The responses were reviewed multiple times for accuracy by the program evaluator. Two trained researchers performed coding independently. Data were coded using thematic analysis in Microsoft Excel as adapted by Pichayapinyo et al. (2024). Themes were refined through discussion until consensus was reached. These steps ensured transparency, reliability, and reproducibility of the analytical process.

Refugee Growers Interview Design

The advisory board focus group data and prior LSI research (Nguyen, 2020) informed the development of a 10-question interview guide for refugee growers. The interview guide covered growers' characteristics (farm size, crops cultivated, prior produce safety training) and three modules of the Produce Safety Alliance grower training: worker health and hygiene, biological soil amendments, and agricultural water. This focus ensured alignment with high-risk contamination sectors identified in prior research (Olaimat & Holley, 2012; Soon & Baines, 2012). A four-person food safety expert panel, one program evaluator, and two community navigators reviewed the interview guide for clarity, relevance, cultural appropriateness, and ease of translation. The interview guide was revised based on their recommendations to ensure face and content validity.

Selection of Refugee Growers for Focus Group Interviews

A recruitment email was sent to the content development specialist at LSI and to the farm manager at Cultivate KC. Both organizations are nonprofit organizations that provide farm training support focused on refugees and maintain direct engagement with refugee growers, making them suitable connectors for recruitment. Growers were recruited using convenience sampling and had to be 18 years or older and designated as refugee produce growers affiliated with these programs. This approach ensured participants had sufficient experience with agricultural practices and engagement with the organization of interest.

Refugee Growers Interview Protocol

Interviews were conducted with 10 growers (five from Cultivate KC and five from LSI) in January and February 2024. This sample, representing about one-fifth of the total grower population (≈50), was sufficient for capturing diverse perspectives, and interviews reached thematic saturation with consistent and overlapping responses. A moderator, co-moderator, and translator facilitated each session. To enhance communication and comfort, growers were grouped by language (Kirundi, Swahili, Burmese, and Nepali), with translation provided throughout to ensure clarity and ease of discussion. Interviews lasted between 30 and 60 minutes and were audio-recorded with participants' permission using a portable handheld digital recorder. The moderator introduced the research, asked the interview questions, and followed up with probe questions when necessary. At the same time, the co-moderator took notes on responses, participants' ability to engage with questions, and the overall interview atmosphere. Growers were compensated for their time.

Data Analysis of Refugee Growers' Interviews

Audio recordings were transcribed verbatim by the moderator and compared to the co-moderator's field notes to ensure accuracy. Data analysis followed thematic analysis, where open coding was applied to identify key concepts and patterns, as adapted by Pichayapinyo et al. (2024). Microsoft Excel was used to organize and categorize data. Two independent researchers coded the transcripts separately, then met to merge their findings and reach consensus on themes. Trustworthiness was ensured through triangulation, peer debriefing, and detailed documentation of procedures. Credibility, transferability, dependability, and confirmability were addressed by describing research context, participant characteristics, data collection, and analysis steps, ensuring the study's rigor and reproducibility.

Results and Discussion

This section presents the findings from the focus group interviews and discusses the characteristics, farming practices, and food safety communication needs of refugee growers. The results provide insight into the cultural and agricultural diversity of refugee growers and their integration into local food systems.

Refugee Growers' Characteristics from Advisory Board Members

Six advisory board members participated in the focus group interview conducted on Zoom. The information on refugee growers is presented in Table 1. Refugee growers speak various languages, including Swahili, Kirundi, Nepali, Chin, French, and Burmese, and originate from a variety of countries, including Cameroon, Burundi, Ethiopia, Uganda, Burma, and Nepal. These growers cultivate a wide range of crops. The African growers' crops include African eggplant, African corn, roselle, watermelons, mustard greens, and long beans. The Asian growers' crops include Thai chilis, loofa gourd, amaranth greens, and kohlrabi. These findings support previous research by Pivarnik et al. (2018), who indicated that many small-scale produce growers engage in diverse crop production. Many of the crops they grow are staple crops in their home countries. Similarly, Jarman (2021) found that cultural background plays a significant role in determining the crops cultivated by refugee growers. In addition to these culturally significant crops, refugee growers cultivate crops widely consumed in America, including tomatoes, broccoli, lettuce, potatoes, onions, and garlic. This crop diversity illustrates both cultural preservation and adaptive integration into local agricultural systems.

The growers sell their produce through various market channels, as highlighted in Table 1. This diverse marketing approach enables them to reach a broader customer base. The primary marketing channels used by refugee growers align with findings from previous research, which indicate that most small-scale produce growers primarily sell through farmers markets, direct sales, and CSA programs (Chen et al., 2022; Fetahovic, 2020). These channels respond to growing consumer demand for local produce, but as reported by Harrison et al. (2013), farmers markets can present measurable food safety risks when foundational practices are not followed consistently. Observational and microbial analyses have identified gaps in sanitation, temperature control, and access to hand-washing facilities, with higher levels of pathogens such as *E. coli*, *Salmonella*, and *Campylobacter*, on produce sold at farmers markets compared with supermarkets (Harrison et al., 2013; Norwood et al., 2019; Sirsat et al., 2015). These findings indicate the need for enhanced food-safety training with refugee growers who are involved in direct-to-consumer markets.

The focus group responses further reflect key principles of community-based development,

Table 1. Language Proficiency, Country of Origin, Crops, and Market Channels of Refugee Growers in Lutheran Service of Iowa and Cultivate KC (*n* = 6)

Characteristics of growers	Responses
Language proficiency of growers	Swahili, Kirundi, Nepali, Burmese, Chin, French
Country of origin of growers	Cameroon, Burundi, Ethiopia, Nepal, Uganda, Burma
Traditional American crops grown by growers	Roselle, watermelons, mustard greens, long beans, kohlrabi, lettuce, tomatoes, broccoli, amaranth greens, squash leaves, turnips, radish, potatoes, onions, garlic, spinach, black nightshade, loofa gourd, Thai chilis
African crops grown by growers	African corn, African eggplant, okra, lenga-lenga
Asian crops grown by growers	Malabar, loofa gourd, bitter melons
Produce market channels of growers	Farmers markets, CSA programs, direct community sales, and occasional long-distance trade

which emphasize improving quality of life, strengthening livelihoods, and fostering sustainability (Samadder & Lal, 2024). Refugee growers' participation in local markets demonstrates how they contribute to culturally relevant local food systems, while also enhancing social and economic connections within their resettled communities. By cultivating culturally significant crops and engaging directly with consumers, these growers reinforce community identity, expand access to diverse foods, and promote economic self-sufficiency, while adhering to the importance of strong food safety practices to support both market access and public health.

Advisory Board Insights on Enhancing Produce Safety Training for Refugee Growers

Interviews with advisory board members revealed consistent themes regarding information accessibility, logistics, produce safety needs, and available resources (Table 2). The advisory board reported that existing produce safety training programs across various organizations generally combine basic on-farm demonstrations and classroom instruction. These sessions typically cover key topics such as hand washing, cooler cleanliness, cleaning harvesting containers, and contamination prevention, aligning with Fetahovic's (2020) findings on common training topics for refugee growers. However, our advisory board members identified a critical need for more comprehensive training in cold-chain management, standard operating procedures, and handling practices for fresh produce.

A significant barrier to effective training identified is refugee growers' limited English proficiency, a challenge also observed by Liu and Eaton (2023),

Table 2. Advisory Board Focus Group Themes and Responses (*n* = 6)

Theme	Responses
Cleaning and Sanitation	"At the farm, we provide training on washing hands, wash utensils, harvest containers, and cooler cleanliness."
	"In-field there is wash station where they actually wash produce."
Insufficient Standard Operating Procedures (SOPs) and resources	"Growers have a hard time keeping it fresh—growers are really interested in how to extend the shelf life of the vegetables."
	"Cold chain storage and understanding the proper storage temperatures for different crops."
	"Standard operating procedures—sanitizing, pests, etc., are needed."
	"Signage at the farm, need regular reminders, separating clean produce from unclean."
Proper Produce Washing Practices	"With American vegetables, food safety gets lost in translation. … There's over washing due to the fear around food safety."
	"Overdo vegetable washing because of fear they've acquired about being food safe."
Produce Safety Protocol for Growers	"For new farmers, basic training is good; they need to understand cleaning practices."
	"Need regular reminders, separating clean produce from unclean, wash hands before and after."
	"Advanced growers need FSMA-level training, especially if they're looking for land or market access."
Language Barriers and Interpretation Needs	"Using children as translators because that's all they have."
Cultural Relevance in Training Materials	"Avoid the use of snakes in videos."
	"Use cultural dresses, wear overalls, straw hat, colorful skirts and dresses, pants, colorful shirts, varied head wear.
Preferred Learning and Communication Methods	"Videos and posters are top two formats needed."
	"WhatsApp, YouTube because it can be sent through WhatsApp text."
	"Short-format videos (3–5 minutes) with multiple language options."

Jarman (2021), and Strohbehn et al. (2018) among Hmong, Nepali, Bhutanese, and Lue Mien produce growers in the U.S. The advisory board recommended short-format videos (3–5 minutes) with multiple language options, visual demonstrations, and culturally appropriate representation featuring farming scenarios that reflect the demographic and cultural backgrounds of the growers as also concluded by Doyle et al. (2023).

The advisory board also emphasized that training materials should be predominantly visual, easily accessible via platforms like YouTube and WhatsApp, and designed with cultural sensitivity in mind, particularly by avoiding imagery that could be traumatic for refugee populations. Various researchers have highlighted the importance of tailoring produce safety training to growers' linguistic, cultural, and technological realities, ensuring that educational resources are both accessible and impactful (LaBorde et al., 2024; Parker, DeNiro et al., 2016; Perez Peguero, 2024).

Refugee Growers' Characteristics

Table 3 provides an overview of refugee growers' characteristics, which includes farming areas and crops grown by growers from different refugee groups. Ten growers participated in the interview; all farm on quarter-acre plots and cultivate various fruits and vegetables (Table 3). This finding aligns with previous studies, such as those by Fetahovic (2020) and Nguyen (2020), which observed that resettled refugees are commonly allocated quarter-acre plots to farm independently as part of broader integration and self-sufficiency initiatives. The uniformity in plot size among growers in this study suggests a structured resettlement approach. Moreover, the crops grown by growers reflect strong ties to their cultural backgrounds. Nguyen (2020) emphasized that refugee growers often cultivate crops that resonate with their cultural heritage. In the current study, growers selected crops familiar to their countries of origin. Similarly, Jarman (2021) highlighted the influence of cultural background on crop selection, noting that refugee growers tend to prioritize culturally meaningful produce.

Refugee Grower Produce Safety Training

During the interviews, growers described several hygiene and produce-safety protocols they have learned and now apply on their farms (Table 4).

Table 3. Refugee Growers' Farming Characteristics (*n* = 10)

Category	Characteristics	Responses
Farming area	Plot size	One-quarter acre
Crops grown	Native American vegetables	Potatoes, pepper, cauliflower, broccoli, tomatoes, daikon radish, eggplant, mustard green, lettuce, cabbage, garlic, onion, beans, cucumber, red onion, amaranth, peas, spinach, squash, sweet potatoes, leeks, carrot, beet, Swiss chard, kale, arugula, green beans, cilantro, snap bean, pumpkin, celery, herbs
	African vegetables	African eggplant, African corn, lenga-lenga, okra, cassava leaves
	Asian vegetables	Malabar, bitter melon, loofa gourd

Table 4. Refugee Growers' Engagement in Produce Safety Training (*n* = 10)

Category	Characteristics	Responses
Prior produce safety training	Attendance	All growers attended produce safety training during winter sessions.
	Topics covered	"For farming they taught us to wear clean clothes. … Cleaning the material that I use to put the vegetables in. … Make sure nobody uses the farm as bathrooms … and when you go to the restroom you need to wash your hands with sanitizer or soap."
		"When I'm working on the farm, and I get cut on my hand, I have to wash my hand, and I have to go to first aid kit and find bandage and if I need to harvest then I have to use gloves or not to harvest on that day."

They reported wearing clean clothing and using separate outfits for different farming tasks to reduce the risk of cross-contamination. Additionally, they emphasized the importance of cleaning and sanitizing storage materials such as crates and containers used for vegetables. Growers in our study also reported using portable washrooms and practicing personal hygiene, such as regular handwashing, to prevent contamination.

These practices were often attributed to produce-safety training received during weekly winter classes, which many growers attended. The classes were delivered primarily by program and market supervisors and by farm management specialists. Interpretation services were consistently provided to ensure linguistic accessibility, and the instructional materials were adapted to support cultural relevance for participating growers. Similarly, Fetahovic (2020) noted that refugee growers commonly engage in produce safety education during the colder months.

In the current research, growers' responses suggest that some key produce safety measures are being implemented, especially those related to minimizing cross-contamination. However, the level of consistency and depth of application varied among growers.

Refugee Growers' Perspectives on Worker Health, Hygiene, and Training on the Farm

Our needs assessment revealed growers' existing knowledge and challenges regarding worker health, hygiene, and training. Recognizing the critical role these factors play on produce farms, the assessment aimed to understand how well growers perceive safe produce handling practices to prevent contamination and health problems. The importance of this understanding is revealed in research by Chen, Kinchla et al. (2021), which highlights that growers themselves can unknowingly harbor and transmit various pathogens, including *Shigella, E. coli, Salmonella*, and *Cyclospora* to produce through contact with hands, clothing, feces, saliva, and blood. Therefore, prioritizing worker health, hygiene, and proper training emerged as a vital strategy to mitigate cross-contamination risks. Our focus group interviews yielded key themes that explain growers' understanding of contamination sources, visitor guidelines, and practices concerning working while ill. These themes, which are detailed below and summarized in Table 5, highlight the growers' current knowledge and reveal areas where enhanced education and standardized protocols are essential to ensure produce safety**.**

The first theme identified was understanding the sources of contamination on the farm. Overall, there was a lack of understanding about sources of contamination. Previously, research has reported limited knowledge among small-scale growers regarding cross-contamination and pathogenic contamination of fruits and vegetables during gardening (Pivarnik et al., 2008; Sinkel et al., 2018). Conversely, in our study, some growers correctly identified animal fecal matter, pets, and manure as sources of contamination on the field. They mentioned that animal fecal matter can contaminate produce, so they collect and dispose of it when it is sighted. They also reported adhering to the 90 and 120 days waiting period after manure application before harvesting to prevent contamination. Furthermore, pets are not allowed on the farm because they were taught during produce safety training that pets can contaminate produce.

The focus group participants had basic knowledge regarding these key food safety recommendations. However, they did not mention water quality and tools as sources of contamination. That observation supports research by Lewis Ivey et al. (2012) that most Midwestern produce growers do not believe that water quality, wildlife intrusion, and failure to sanitize tools and equipment are significant sources of food safety risk. The results in Table 5 indicate a mixed understanding of the sources of contamination on the farm; hence, there is a need for enhanced education on contamination risks.

A theme regarding visitors' guidelines emerged from growers' responses (Table 5). They all expressed uncertainty about how to define a visitor. The confusion around this definition was compounded by the fact that their friends and family members, who occasionally visited the farm, were not recognized as visitors. They only categorized students and extension agents as visitors, so they did not orient their families and friends with produce safety practices, even during their first visit.

Table 5. Themes and Responses from Interviews with Refugee Growers on Worker Health, Hygiene, and Training (*n* = 10)

Themes	Responses
Understanding sources of contamination	"I don't have any idea."
	"Bird poop can carry bacteria."
	"Make sure you look around to see if any animal came to poop in your land. So, you can remove that poop."
	"For example, like these big insects or animals who kind of call it like the raccoons and deer when they invaded the farm and the poop in there."
	"Normally in our culture. We don't have pets in our homes. But they taught us that you cannot take your pet to the farm because when they are walking around, they can contaminate those vegetables.
	"The first rule is the 90 days and 120 days. If you don't follow that when you are using the compost on the manure, you are sure that your vegetables will be contaminated no matter what."
Safe farm visits: Guidelines for visitors on the farm	"Yeah, so our kids, we take them as ourselves. … We don't treat them as employees or visitors."
	"Usually in my farm I don't get many visitors, but I do get many customers at the farm, and I tell them not to step on my farm, not to come to my farm, don't have to harvest nothing just stay there."
	"So, some students who are visiting are curious, they want to see, they want to touch. So, there are gloves, extra gloves we have at the farm, we oblige them to wear those."
	"Yes, we tell them not to bring any kind of animals or pet. Since, they might destroy our plants or other things."
	"I don't allow the visitors to go in the middle of my farm. They must stay outside of the perimeters of the farm."
	"Before you harvest my veggies or produce, you must wash your hands first or I can do it for you. If they need something, I grab it for them."
Ensuring sick worker protocol on farms through best practices and proper communication	"Yes. When anyone is not feeling well or sick, we stay at home until we feel better.
	"Well. I don't really tell anyone on the farm because we don't really communicate, we don't have to tell each other or let them know. If I am sick, I just stay at home."
	"If I feel my body myself heavy, that's the strength of my body is weak, and I feel like a fever. If I have those kinds of things, then I will not go to the farm."
	"If I feel like dizziness or something when I'm working. I do have a phone always and I will call a family member to come and help me."
	"If I feel like I have a severe headache or if I'm having running nose those kinds of things, if I have a diarrhea then I don't go to the farm."
	"If I am sick and I have to go to the farm, I do not go to the wash areas or touch produce."

According to the U.S. Food and Drug Administration (2019), a visitor is anyone other than farm personnel who comes onto the farm with permission. Previous research by Shaw et al. (2015) highlighted the need for growers to clearly set expectations for proper produce safety practices for visitors. Similarly, Parker, Wilson, LeJeune, and Doohan (2012) indicated that visitors should be directed to stay out of the farms to prevent contamination. Research by Astill et al. (2018) emphasized that visitors should be informed about key protocols, including handwashing practices, accessible areas, and farm produce safety policies to ensure safe produce. Therefore, standardized visitor protocols should apply to all farm visitors.

Growers reported avoiding going to the farm when experiencing symptoms of foodborne illnesses, such as diarrhea and fever, as shown in Table 5. They typically stay home and return only after fully recovering. Similarly, Parker, Wilson,

LeJeune, Rivers, and Doohan (2012) and Pivarnik et al. (2008) found that growers prohibit working when sick to prevent produce contamination. In the current study, growers relied on self-evaluation to determine when to return to work. Five growers said they called family members to assist them on the farm when they felt weak during farming hours. Others reported that they sometimes went to the farm while sick but avoided contact with produce. Hamilton et al. (2015) emphasized that restricting ill growers from handling produce is a critical baseline for on-farm hygiene. While growers typically avoid working on produce when sick, a protocol for sick leave is necessary to minimize contamination risks.

Refugee Growers' Understanding and Use of Biological Soil Amendments

All the growers reported using biological soil amendments on their farms. These amendments included manure, compost, and feather meals (Table 6). These reported biological soil amendments are like those used by growers in research by Pires et al. (2018). Most of the growers in our study demonstrated limited awareness of the risks associated with using these amendments. Five growers mentioned the 90- and 120-day waiting periods for applying untreated biological soil amendments before harvesting crops but could not differentiate which crops required 90 days versus 120 days. In line with previous research by Pires et al. (2018), most organic produce growers surveyed in their multiregional U.S. study adhered to the waiting period before harvest. However, in our study and in previous research by Strohbehn et al. (2018), growers did not understand the rationale for the waiting period when asked. In our study, three growers attributed the waiting period to crop yield and income. Meanwhile, three others reported tracking manure application dates to comply with the 90- to 120-day rule. Most growers in our study did not maintain formal documentation of soil amendment applications. This finding is consistent with previous studies by Adalja and Lichtenberg (2018) that only a third of growers kept records of soil amendment application dates. Similarly, Laury-Shaw et al. (2015) identified proper documentation as a key challenge for small-scale growers. The need for improved manure application practices and documentation was evident among refugee growers, highlighting the importance of providing targeted educational resources and support for this group.

Refugee Growers' Perceptions and Practices on Agricultural Water Use

All the growers reported obtaining agricultural water from municipal sources (Table 7). However, none of the growers could explain the importance or reasoning behind water testing. They stated that because they use the same municipal water at home for domestic chores and drinking without experiencing health issues, they see no need for testing. This supports research by Hamilton et al. (2015) and Lewis Ivey et al. (2012) that less than half of produce growers strongly agreed that agricultural

Table 6. Theme and Responses from Interviews with Growers on Biological Soil Amendments of Animal Origin (*n* = 10)

Theme	Responses
Understanding the risks and appropriate use of biological soil amendments	"I don't really know about the risk but for me personally using compost or other don't make people sick because it is organic. We share our veggies with family and friends, and they are fine."
	"I use manure, compost, fertilizer, and feather meal. … I wait some 1 week, 2 week, or a month depending on the crop."
	"It will affect somehow the growth of the vegetables, some will grow taller without the product you expect, some will be shorter or take long time to produce fruit, those will affect the income you expect to have, so if you want to be successful, you need to wait, you need to follow those days 90 and 120."
	"The kind of compost or manure we use cannot be dangerous."
	"When we deposit the manure, they [the growers] write down the date."

Table 7. Theme and Responses from Interviews with Growers on Agricultural Water (*n* = 10)

Theme	Responses
Ensuring microbial safety of water	"Use the city water, the water that people normally drink in their homes."
	"We run the farm by rivers, but we never use the water from the rivers, so the city we are sure they test the water and also we drink from that same water, so it is really clean water."
	"It depends on the vegetable and how many times we have to change water."
	"We have three sinks, put water in the first sink, once you pull out the vegetables, put them in the second sink, you open the first sink for the water to go, then you refill the sink, so you can wash the second vegetables, and you keep doing the same until the produce are clean."
	"One vegetable wash three times then you start over with new set of vegetables."
	"It doesn't matter how many times, if you still see that they are not clean yet, you will redo and redo and redo until you see they are really clean."
	"We do not use sanitizer."
	"We dispose of the water by draining it through the pipes."

water was a potential source of contamination. In the present study, three growers noted that municipal water is tested before being distributed to the public, reinforcing their belief that additional testing is unnecessary. It aligns with the findings of Chen, Kinchla et al. (2021), who reported that produce growers often have limited knowledge of water-testing requirements, including the required test types, testing frequency, and result interpretation. However, one grower with surface water near the farm stated that he does not rely on municipal water for farming activities to prevent contamination.

In the present study, growers use water for various tasks, including irrigation and washing. At the washing station, produce is rinsed in a sink without adding antimicrobial agents, such as sanitizers. To prevent contamination, they frequently change the washing water based on the type of produce, the volume being washed, and the level of soiling. Similarly, Tong et al. (2017) reported that growers changed the wash water when it was dirty. Growers ensure that produce is washed thoroughly before disposing of the used water down the drain. These findings highlight an opportunity to educate growers on the significance of water testing and its role in produce safety.

Overall, the focus group data offers valuable insight into growers' current food safety practices and highlights key knowledge and practice gaps that could pose produce safety risks to both the industry and consumers. These findings can guide improvements to local and national produce safety education programs, particularly those serving linguistically and culturally diverse grower communities. In particular, the clear need for multilingual, highly visual, and culturally responsive educational materials indicates that existing, federally standardized training frameworks such as the Produce Safety Rule (PSR) Grower Training may require greater flexibility and adaptation to reach refugee growers more effectively.

Limitations

This study has limitations. Although the research was carefully designed and implemented, the sample size was small ($n = 10$). The study included two groups of growers, Asian ($n = 4$) and African growers ($n = 6$), which could have introduced bias, leading to the underrepresentation of other growers. Also, the findings from this study may not be generalizable to the broader refugee population, particularly those from different geographical regions or countries of origin. Future research could expand this scope by incorporating refugee growers from broader geographic areas in the Midwest and by increasing the sample size.

Conclusion

This study highlights the need for targeted produce safety education tailored to the linguistic, cultural, and experiential backgrounds of refugee growers. While growers demonstrated foundational knowledge of hygiene and sanitation practices, the

findings reveal significant gaps in understanding and applying key produce safety standards, particularly regarding sources of contamination, sick-worker guidelines, biological soil amendments, visitor protocols, and agricultural water testing. These knowledge gaps pose challenges to fully complying with FSMA PSR guidelines and may hinder safe produce-handling practices.

Advisory board members of the refugee growers expressed the growers' preference for accessible and culturally relevant educational resources, such as short, visually driven training videos delivered via platforms like WhatsApp and YouTube, indicating a strategic opportunity to design and implement produce safety messages that resonate with refugee growers.

The results of this study highlight a critical need to support the development of effective produce safety messaging strategies. Educational resources should reflect the cultural identity of the target audience, accommodate limited English proficiency, and simplify complex produce safety regulatory language. Future interventions should prioritize co-creating resources with advisory board members and using an iterative feedback loop to ensure relevance and impact.

By aligning content delivery with the growers' communication and cultural preferences, these tailored resources can help bridge knowledge gaps, improve produce safety compliance, and strengthen the overall sustainability of refugee farming operations in the Midwest.

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