GENERAL INTEREST PAPER

https://doi.org/10.4315/FPT-25-006

Visual Educational Resources to Improve Produce Safety Knowledge for Non-English Speaking Farm Workers in the U.S.: A Review

Sagar Pokhrel,[1] Angelina N. A. Adjetey,[2] Londa Nwadike,[3] Tricia Jenkins,[4] Shannon Coleman,[5] and Manreet Bhullar[1]*

[1]Department of Horticulture and Natural Resources, Kansas State University, Olathe, KS 66061, USA
[2]Department of Food Science and Human Nutrition, Iowa State University, Ames, IA 50011, USA
[3]Department of Dairy and Food Science, South Dakota State University, Brookings, SD 57007, USA
[4]School of Applied and Interdisciplinary Studies, Kansas State University, Olathe, KS 66061, USA
[5]School of Nutrition and Food Sciences, Louisiana State University, Baton Rouge, LA 70808, USA

ABSTRACT

The United States (U.S.) produces 50% of its total fresh fruits and vegetables for human consumption. Labor, one of the key inputs to fresh produce production, is required to conduct field activities such as planting and harvesting. To meet this demand of the U.S., the produce industry depends significantly on immigrant workers, who make up almost 70% of the workforce of the world's third-largest fresh produce sector. Nevertheless, fresh produce is also implicated in foodborne outbreaks. One of the factors limiting effective food safety implementation on farms is the lack of education and training. Specific to non-English-speaking immigrant workers, this challenge presents a significant obstacle in training the farm workforce and maintaining safety standards in this industry. This article discusses key issues of food safety practices within the fresh produce industry that require improved training of farm workers, particularly focusing on the development of needs-based visual educational resources, such as videos and posters, for non-English-speaking immigrant growers. It also discusses addressing those gaps by delivering tailored educational resources and the potential impact on improved transfer of knowledge.

INTRODUCTION

Despite the United States (U.S.) being the third-largest producer of fresh fruits and vegetables in the world *(55)*, this industry faces a persistent challenge: foodborne illnesses linked to contaminated fresh produce. With nearly 70% of fresh vegetables and about 45% of fresh fruits consumed in the U.S. being domestically grown, the stakes are high for public health and the economy *(53)*. The U.S. Centers for Disease Control and Prevention (CDC) estimated that around 46 percent of foodborne illness outbreaks result from fresh produce and nuts, and safety measures remain a critical issue in the supply chain.

The U.S. fresh produce industry heavily depends on immigrant and refugee labor, with most of them from non-English-speaking backgrounds *(28)*. The Food Safety Modernization Act (FSMA) Produce Safety Rule (PSR) was released in November 2015, and it defines the minimum standards for various farm activities like growing, harvesting, packing, and holding of fresh produce used in direct human consumption (without processing) *(61)*. The Produce Safety Alliance (PSA) is an educational partnership between the Food and Drug Administration (FDA), the United States Department of Agriculture (USDA), and Cornell University to train fresh produce growers about the minimum requirements included in the FSMA Produce Safety Rule. The training aims to mitigate microbial contamination risks in the fresh produce supply chain and assist growers to comply with the regulation. However, these efforts are lacking among non-English-speaking farmworkers and growers, where training curricula are mostly in English. Since immigrant workers are a major source of the workforce in the agriculture industry of the U.S., it is crucial to fill this educational gap to sustain the credibility of the fresh produce chain. This gap can be bridged by developing training materials such as visual education aids, videos, and posters to ensure that those educational resources are clear, culturally appropriate, and easily understood *(4)*.

This literature review looks at the challenges faced by immigrant fresh produce growers and farm workers in the U.S. who don't speak English. It focuses on factors that cause fresh produce outbreaks, the current food safety regulations, and the obstacles to food safety education. The review also discusses the educational resources that could help the non-English-speaking workforce on fresh produce farms while intending to offer ideas for improving food safety education.

Fresh produce outbreaks and foodborne illness in the U.S.

Globally, approximately 600 million people become sick due to foodborne illness, and 420,000 die each year *(63)*. The CDC defines an outbreak as a situation where two or more individuals get sick with the same illness after eating the same type of food *(10)*. In the U.S., the CDC and the FDA play crucial roles in investigating and responding to foodborne outbreaks *(13)*. The FDA and the USDA Food Safety and Inspection Service (USDA - FSIS) mandate food recalls

*Author for correspondence: Manreet Bhullar, PhD.; Email: msbhullar@ksu.edu

(48). Foodborne illness estimations from the CDC reveal that around 48 million people become sick due to foodborne pathogens every year in the U.S.–out of these, 128,000 individuals get hospitalized, and nearly 3,000 individuals lose their lives *(9)*.

With high per capita consumption of fresh produce like vegetables and fruits in the U.S. *(58)*, foodborne illnesses from contaminated produce are very likely, especially when consumed raw *(35)*. The key pathogens causing foodborne illnesses through contaminated fresh produce include *Salmonella* (43.1%), *Escherichia coli* (68.8%), and *Listeria monocytogenes* (51.1%) *(11)*. Fresh produce, such as tomatoes, sprouts, leafy greens, and cantaloupes have a high risk of causing foodborne outbreaks. Foodborne outbreaks from fresh produce are recurrent despite efforts to prevent them *(34)*. Leafy greens are one of the most common food vehicles for contamination through *E. coli* and *L. monocytogenes*. In 2021, the CDC investigated 74 possible multistate outbreaks, out of which 47 (64%) had their sources identified. Among these solved outbreaks, 28 (60%) were due to contaminated food *(12)*. Among all the cases examined, just 25 outbreaks had a confirmed source, with five outbreaks linked to leafy greens and one associated with underground or root vegetables. Notably, the latter was responsible for the highest number of illnesses reported in solved foodborne outbreaks, totaling 1,040 cases.

Common causes of fresh produce outbreaks

Fresh produce can be contaminated with different foodborne pathogens, which pose a risk to public health, and this contamination can occur throughout different stages, including production, harvesting, processing, packaging, and distribution. Biological contamination of fresh produce on farms is a particular concern, where pathogens like *E. coli*, *Salmonella*, *Campylobacter*, *L. monocytogenes*, and *Arcobacter* are commonly found in manure, agricultural water, and compost *(20)*. Some of the common causes of contamination on farms are biological soil amendments of animal origin (BSAAOs), improper hygiene from workers and visitors, and sick workers working on the farms. These will be discussed in more detail below.

1. Biological Soil Amendments of Animal Origin (BSAAOs)

BSAAOs, including manure, compost, poultry litter, and biosolids, enhance soil quality but may introduce microorganisms such as *E. coli*, *Salmonella*, and *L. monocytogenes* as well as parasites like *Cryptosporidium* and *Toxoplasma* to soil and produce crops *(16, 27)*. *Salmonella*, *E. coli*, and *L. monocytogenes* are related to different types of BSAAOs in that fresh manure poses a more significant threat than composted ones *(1, 8, 32)*. Manure from animals including cattle, swine, and poultry may contain pathogens such as *E. coli*, *Salmonella*, and *L. monocytogenes*, and raw untreated and improperly stored or applied manure is more likely to transfer pathogenic to produce crops than composted materials *(8, 26, 33)*.

The foodborne pathogens present in both soil and fresh produce growing in the soil treated with BSAAOs significantly decrease when the current National Organic Program (NOP) wait-time of 90-120 days is implemented, reiterating how safe food practices on the farm can ensure fresh produce safety *(52)*. These wait times cover the fact that different crops may become more or less susceptible to microbial contamination depending on factors such as the surface of the produce, its proximity to the ground, and the method by which it was harvested *(38, 43, 54)*. Leafy greens, berries, and root crops are prone to contamination by these pathogens because of their complex structure, highly developed canopy, as well as their contact with the ground. On the other hand, vegetables that are less likely to be affected are those with hard external cover, for instance, bell peppers and cucumbers, because they are less rough, grow above ground, and have a simpler structure *(1)*.

2. Hygiene (Workers and Visitors)

In fresh produce farms, there is the risk of contamination by various people, which may include workers and visitors. The FSMA PSR emphasizes providing information to the visitor about the food safety policies on the farm, the provision of adequate facilities like handwashing stations and restrooms for personal hygiene, and proper management of visitor access food contact zones in the farm *(61)*. Contamination can occur through infected workers handling produce on the farm and through contaminated workers' clothes if the workers do not implement hygiene measures *(24)*.

Farm workers working with dirty hands can also become a source of pathogens, which can contaminate fresh produce if the farm workers are involved in the harvesting, handling, and packaging processes. Illnesses can also be caused by pathogens like norovirus, hepatitis A, and *Shigella*, which may be contracted through direct contact if farm workers do not wash their hands *(42)*. Moreover, workers touching food contact surfaces, equipment, or harvested produce with contaminated hands can lead to the further spread of pathogens. Handwashing is the main weapon in reducing such microbes from hands so that the risk of contamination of produce or transmission to others is decreased. Hands should be washed after using the restroom, coughing, sneezing, before and after eating foods, and handling soiled or dirty tools, equipment, work surfaces, and after handling garbage *(7)*.

3. Worker Health

The health status of a farm worker is critical in preventing the microbial contamination of fresh produce. If sick or injured workers handle produce crops, they may introduce

pathogens through contact with produce, respiratory secretions, or bodily fluids *(47)*. So, it is important to identify symptoms that can result in contamination and pose a threat to public health *(41)*. To prevent this risk, workers who have any symptoms like fever, diarrhea, stomach pain, jaundice, vomiting, or other symptoms of foodborne pathogens must immediately notify the farm supervisor. Such workers are best to stay home until they are symptom-free, but they must not handle fresh produce if they must be at the farm for some reason. Moreover, if workers have open sores or boils, they should also be prohibited from handling the produce directly. In case of an injury, first aid kits should also be available in a convenient location within the working areas on the farm and they should be monitored monthly to ensure that they are properly stocked *(25)*.

Fresh produce safety regulations in the U.S.

The FSMA PSR was developed to protect fresh produce by ensuring proper identification and management of biological risks from poor agricultural practices, food safety ignorance among growers, and various hazards on farms *(6, 64)*. Specific guidelines for the application of compost and manure for organic farmers to comply with the organic certification are offered by the National Organic Program (NOP) for organic farms *(39)*. This guideline is also recommended for non-organic growers as well who use untreated animal manure on their farms.

However, within the FSMA PSR, there are exemptions: producers who operate on a small scale and supply locally in a 275-mile radius/inside the local state and consistently make under $25,000 in total produce sales annually for 3 years, adjusted for inflation, are exempt from the rule *(61)*. This results in smaller producers often having little to no knowledge of food safety standards and no governmental inspection of their fresh produce safety practices *(5)*. Small-scale growers, especially the ones who also work with domestic or wild animals close to produce growing areas, need to understand the intricate and diverse ways in which microbial contamination can occur unless they increase their awareness of safety *(36)*.

Immigrant and refugee farm workers/growers in the U.S.

Immigrants are a huge part of the U.S. population, and they contribute greatly to its economy. About 13.7 percent of the total population, or about 44.9 million immigrants were in the U.S. in 2018. Over the years, immigration trends have changed, with the immigrant population increasing from 9.6 million in 1970 to 44.9 million in 2018. Mexico is the largest country of origin, accounting for 24 percent of the total, succeeding India (6%), China (5%), the Philippines (4.5%), and El Salvador (3%); the immigration trend shows a growing number of African and Asian immigrants in recent years *(2)*.

More than three-quarters of the 2.4 million farm laborers are immigrants, and the farming industry in the U.S. is heavily dependent on immigrant workers. So, it becomes important that our immigrant farm workers are properly aware of proper food safety measures while working on the farm *(15)*. Nearly 258,000 immigrants received H-2A visas as agricultural workers just in the year 2019; however, more than double the number of these immigrant workers are in the U.S., working as unauthorized immigrants. These workers, distributed throughout various states in the U.S., are so critical that the estimation of the fall of agricultural output if foreign-born workers are to be lost is 30-60 billion in the dairy industry alone *(23)*.

In the U.S., the refugee population is also growing food, particularly in urban areas. Refugees have long been resettled in the U.S., with thousands of people arriving at the U.S. border or already in the country seeking asylum each year *(29, 62)*. The U.S. Refugee Admissions Program allows refugees to be admitted to the U.S., with allocation through the family preference system. Midwestern states have always welcomed refugees from Africa and Southeast Asia who speak various languages *(3)*. Most of these refugee populations prefer agriculture as a preferred occupation because it offers opportunities for placemaking, longer-term integration, and control of the food supply *(22)*. In the U.S., refugees often return to their primary occupation, farming, with assistance from non-governmental organizations in community gardens or training garden plots. *(21, 24, 30)*.

Fresh produce safety education: Gaps and barriers

Reducing fresh produce contamination and the resulting foodborne illnesses requires educational resources on fresh produce safety. In response to this need, the Produce Safety Alliance (PSA) has taken the initiative and introduced training programs like the FSMA-PSA Grower Training Course and Train-the-Trainer Course, both to educate produce safety educators as well as to help fresh produce growers learn about safety practices. In Pennsylvania, community-tailored efforts have produced educational materials and provided training to Latino fresh produce growers and farmworkers *(44)*. The Kansas Department of Agriculture (2021) also provides resources for food safety, from food safety information to information about farmers' markets and consumer safety. Assessments of Midwest growers' needs to comply with the PSR have led to the development of educational materials tailored to the specific challenges faced by fresh produce growers in the region *(45)*.

However, with PSA grower training courses available in just five languages, including English, and most of the other educational resources developed mainly for English-speaking audiences, communication challenges for other non-English-speaking farm workers or growers in the U.S. are a major challenge *(19)*. Language difficulties, along with cultural differences, make traditional educational resources less accessible and understandable for non-English-speaking growers. Among a few key problems in ensuring food safety

on produce farms is the lack of written food safety plans, financial resources, farm infrastructure, and language barriers *(46)*. Non-English-speaking farming communities may struggle to understand food safety programs, resources, and policies with food safety not being a critical part of their traditional farming approach in their native countries *(60)*. Additionally, cultural differences and limited schooling result in a lack of foundational knowledge of key food safety measures for underserved populations, including migrant workers and refugees *(40)*.

Languages other than English can be used to provide the program information to help remove language barriers and to communicate more effectively with such non-English speaking audiences. This was demonstrated to improve the food safety practices of food workers who used culturally appropriate training materials, and it is suggested that such training programs be evaluated through the feedback of the target population. If standardized materials contain pictures or examples of culturally different target populations, it is important to address their differences while designing interventions for culturally diverse communities. It is often necessary to modify educational material, and in doing so, it is important to consider the cultural differences of the audience, and the pictures and examples provided in standardized materials *(49, 59)*.

Preferred educational resources for non-English-speaking farm workers/growers

Customized educational materials specifically targeting the needs of immigrant farm workers and growers in the U.S. produce safety is necessary. It is possible to overcome the barriers they face and help them produce safe and healthy food with better outcomes by tailoring the resources to their requirements *(18)*. To better address the fresh produce safety needs of this audience in the U.S., educational programming should be developed based on factors such as farm size, region, market access, and farm type. With workshops and partnerships with local agriculture extension services, this approach, combined with the training provided, would ensure that the training given is relevant and specific to the circumstances of their work environment *(45, 56)*.

Over the past few years, it has been found increasingly that the use of visual educational resources has been more effective at engaging and educating individuals about promoting healthy behaviors like safe food-handling practices versus traditional text-based resources. The use of visual educational resources was found effective in improving participants' knowledge and behavior related to fresh produce safety *(31)*. Infographics and videos are especially useful in helping to convey information regarding fresh produce safety. However, these resources must be tailored to the realities of the target audience's work place so that the materials are relevant and meaningful. Also, technical terms should be avoided in favor of everyday terms readily understood by the non-English speaking audience *(37)*.

Posters have also been acknowledged as an efficacious educational tool due to their ability to convey complex information through visual imagery in a passively delivered educational intervention *(14, 17, 51)*. Posters developed for safe handling practices of leafy greens in food service operations in Iowa and Kansas have shown positive impacts not only on the food safety behaviors of the workers but also on the microbial contamination level of the leafy greens *(50)*. Hand hygiene educational posters tailored to the needs of agricultural growers who do not understand English are seen to have a positive impact on their handwashing practices and understanding *(57)*. Food safety training can be improved by incorporating such posters for communicating food safety messages across a wide range of produce growers. More research into this area needs to be conducted to explore the capacity of visual educational resources to promote fresh produce safety practices.

CONCLUSIONS

In conclusion, foodborne outbreaks are a huge concern in the U.S. because of their huge negative effect on public health and the economy. Immigrant farm workers and growers, who are a large part of the fresh produce industry, continue to lack sufficient educational resources in their language and culture to understand current fresh produce safety measures. This gap, discussed in this review, needs to be filled with additional educational resources, such as visual aids, to help with comprehension and retention. More research into visual teaching materials like videos and posters in the fresh produce industry could be a good way to increase the use of visual aids in education for a wide range of groups. To help this deficiency, non-English speaking audiences can learn more about food safety with materials that are both visually appealing and relevant to their culture. These materials should be used in agricultural Extension programs and food safety training programs. This approach can result in better communication and education across non-tradition and non-English-speaking growers to implement better food safety practices. Future work should create such visual education resources and evaluate the efficacy of videos and posters in increasing farm workers' and produce growers' knowledge.

REFERENCES

1. Alegbeleye, O. O., I. Singleton, and A. S. Sant'Ana. 2018. Sources and contamination routes of microbial pathogens to fresh produce during field cultivation: A review. *Food Microbiol.* 73:177–208.
2. American Immigration Council. 2021. Immigrants in the United States. Available at: https://www.americanimmigrationcouncil.org/research/immigrants-in-the-united-states. Accessed 21 November 2024.
3. Arena, K., and D. Wheaton. 2021. Midwest: a "success story" for refugee resettlement. Available at: https://www.iowapublicradio.org/ipr-news/2021-06-15/midwest-a-success-story-for-refugee-resettlement. Accessed 25 March 2024.
4. Balis, L. E., D. H. John, and S. M. Harden. 2019. Beyond evaluation: Using the RE-AIM framework for program planning in Extension. *J. Ext.* 57(2):2TOT1.
5. Beecher, C. 2013. Fresh produce at farmers' markets exempt from new food safety regs. Available at: https://www.foodsafetynews.com/2013/01/fresh-produce-at-farmers-markets-exempt-from-new-food-safety-regs/. Accessed 6 April 2024.
6. Bhullar, M. S., S. Coleman, K. Vorst, A. Nair, and A. R. Naig. 2019. Ensuring Food Safety Modernization Act Produce Safety Rule compliance through water testing and sanitation validation programs. Iowa State University, Ames, Iowa. Available at: https://dr.lib.iastate.edu/handle/20.500.12876/31828. Accessed 27 November 2024.
7. Bihn, E. A., and R. B. Gravani. 2005. Role of good agricultural practices in fruit and vegetable safety, p. 21–53. In K. R. Matthews and M. P. Doyle (ed.), Microbiology of fresh produce, First Edition. ASM Press, Washington, D.C.
8. Black, Z., I. Balta, L. Black, P. J. Naughton, J. S. G. Dooley, and N. Corcionivoschi. 2021. The fate of foodborne pathogens in manure treated soil. *Front Microbiol.* 12:781357.
9. Centers for Disease Control and Prevention. 2018. Estimates of foodborne illness. Available at: https://www.cdc.gov/foodborneburden/estimates-overview.html. Accessed 21 November 2024.
10. Centers for Disease Control and Prevention. 2022. Foodborne disease outbreak surveillance system. Available at: https://www.cdc.gov/nors/about/fdoss.html. Accessed 29 July 2024.
11. Centers for Disease Control and Prevention. 2023a. Foodborne illness source attribution estimates for *Salmonella*, *Escherichia coli* O157, and *Listeria monocytogenes* — United States, 2021. Available at: https://www.cdc.gov/ifsac/media/pdfs/P19-2021-report-TriAgency-508.pdf. Accessed 28 November 2024.
12. Centers for Disease Control and Prevention. 2023b. Key findings: Summary of possible multistate enteric (intestinal) disease outbreaks in 2021. Available at: https://www.cdc.gov/foodborne-outbreaks/php/data-research/annual-summaries/index.html. Accessed 24 November 2024.
13. Centers for Disease Control and Prevention. 2024. Key partners in foodborne outbreak investigations. Available at: https://www.cdc.gov/foodborne-outbreaks/keypartners/index.html. Accessed 21 November 2024.
14. Chapman, B., T. Eversley, K. Fillion, T. Maclaurin, and D. Powell. 2010. Assessment of food safety practices of food service food handlers (risk assessment data): Testing a communication intervention (evaluation of tools). *J. Food Prot.* 73(6):1101–1107.
15. Cheney, A. M., T. Barrera, K. Rodriguez, and A. M. J. López. 2022. The intersection of workplace and environmental exposure on health in Latinx farm working communities in rural inland Southern California. *Int. J. Environ. Res. Public Health* 19(19):12940.
16. Delahoy, M. J., B. Wodnik, L. McAliley, G. Penakalapati, J. Swarthout, M. C. Freeman, and K. Levy. 2018. Pathogens transmitted in animal feces in low- and middle-income countries. *Int. J. Hyg. Environ. Health* 221(4):661–676.
17. Dworkin, M. S., P. Panchal, and L. Liu. 2012. The CHEF project: Results of a randomized bilingual dual format passive restaurant food handler educational intervention in Chicago. *Food Prot. Trends* 32(10):564–573.
18. Enderton, A., A. M. Shaw, A. Krob, K. Plagakis, E. Johnsen, A. Naig, and M. Omolo. 2023. Produce safety alliance training: Long-term behavioral change study in the north central region. *Food Prot. Trends* 43(4):316–328.
19. Esmaeili, B., K. Grosskopf, and A. J. Will. 2014. The influence of national culture on effectiveness of safety trainings during postdisaster reconstruction. Available at: https://digitalcommons.unl.edu/archengfacpub/145/. Accessed 29 July 2024.
20. Ferguson, M., C. K. Hsu, C. Grim, M. Kauffman, K. Jarvis, J. B. Pettengill, U. S. Babu, L. M. Harrison, B. Li, A. Hayford, K. V. Balan, J. P. Freeman, G. Rajashekara, E. K. Lipp, R. S. Rozier, A. M. Zimeri, and L. S. Burall. 2023. A longitudinal study to examine the influence of farming practices and environmental factors on pathogen prevalence using structural equation modeling. *Front Microbiol.* 14:1141043.
21. Fetahovic, S. 2020. Refugee farmer development at Juniper Gardens training farm. Available at: https://newprairiepress.org/ufss/2020/proceedings/13/. Accessed 8 November 2024.
22. Foss, F., C. Gibbes, and E. Skop. 2024. Cultivating integration via placemaking: an ArcGIS StoryMap and inventory of refugee-centered farming organizations in the USA. *J. Int. Migr. Integr.* 25:133–154.
23. FWD.us. 2022. Immigrant farmworkers and America's food production: 5 things to know. Available at: https://www.fwd.us/news/immigrant-farmworkers-and-americas-food-production-5-things-to-know/. Accessed 14 November 2024.
24. Goralnik, L., L. Radonic, V. G. Polanco, and A. Hammon. 2023. Growing community: Factors of inclusion for refugee and immigrant urban gardeners. *Land* 12(1):68.
25. Gorgo-Simox, M., L. Stivers, T. Baugher, M. Chawner, C. Powell, D. Seifrit Jr., J. Stoltzfus, and L. LaBorde. 2019. Best practices for fresh produce food safety. Available at: https://extension.psu.edu/best-practices-for-fresh-produce-food-safety/. Accessed 24 November 2024.
26. Gurtler, J. B., M. P. Doyle, M. C. Erickson, X. Jiang, P. Millner, and M. Sharma. 2018. Composting to inactivate foodborne pathogens for crop soil application: A review. *J. Food Prot.* 81(11):1821–1837.
27. Heredia, N., and S. García. 2018. Animals as sources of food-borne pathogens: A review. *Animal Nutrition* 4(3):250–255.
28. Hernandez, T., and S. Gabbard. 2019. Findings from the National Agricultural Workers Survey (NAWS) 2015-2016: A demographic and employment profile of United States farmworkers. Available at: https://www.dol.gov/sites/dolgov/files/ETA/naws/pdfs/NAWS%20Research%20Report%2016.pdf. Accessed 8 November 2024.
29. Hinterlang, V. 2024. Asylum in the United States. Available at: https://www.americanimmigrationcouncil.org/research/asylum-united-states. Accessed 25 March 2024.
30. Jarman, A. 2021. An evaluation of refugee farmers in the Sacramento Valley to inform a USDA-funded food-safety training program. Available at: https://escholarship.org/uc/item/12s8j2tv. Accessed 26 November 2024.
31. Kang, H. J., M. W. Lee, I. K. Hwang, and J. W. Kim. 2015. Development of safe food handling guidelines for Korean consumers. *J. Food Prot.* 78(8):1541–1546.
32. Lemunier, M., C. Francou, S. Rousseaux, S. Houot, P. Dantigny, P. Piveteau, and J. Guzzo. 2005. Long-term survival of pathogenic and sanitation indicator bacteria in experimental biowaste composts. *Appl. Environ. Microbiol.* 71(10):5779–5786.

33. Love, D. C., R. U. Halden, M. F. Davis, and K. E. Nachman. 2012. Feather meal: A previously unrecognized route for reentry into the food supply of multiple pharmaceuticals and personal care products (PPCPs). *Environ. Sci. Technol.* 46(7):3795–3802.

34. Lynch, M. F., R. V. Tauxe, and C. W. Hedberg. 2009. The growing burden of foodborne outbreaks due to contaminated fresh produce: Risks and opportunities. *Epidemiol Infect.* 137:307–315.

35. Machado-Moreira, B., K. Richards, F. Brennan, F. Abram, and C. M. Burgess. 2019. Microbial contamination of fresh produce: what, where, and how? *Compr. Rev. Food Sci. Food Saf.* 18(6):1727–1750.

36. Marine, S. C., D. A. Martin, A. Adalja, S. Mathew, and K. L. Everts. 2016. Effect of market channel, farm scale, and years in production on mid-Atlantic vegetable producers' knowledge and implementation of good agricultural practices. *Food Control* 59:128–138.

37. Mathiasen, L., K. Morley, B. Chapman, and D. Powell. 2012. Using a training video to improve agricultural workers' knowledge of on-farm food safety. *J. Ext.* 50(1):1FEA6.

38. Mritunjay, S. K., and V. Kumar. 2017. A study on prevalence of microbial contamination on the surface of raw salad vegetables. 3 *Biotech.* 7(1):13.

39. National Organic Program. 2010. Processed animal manures in organic crop production. Available at: https://www.ams.usda.gov/sites/default/files/media/5006.pdf. Accessed 26 November 2024.

40. Nisbet, C., K. E. Lestrat, and H. Vatanparast. 2022. Food security interventions among refugees around the globe: A scoping review. *Nutrients* 14(3):522.

41. Nordgren, T. M., and C. Charavaryamath. 2018. Agriculture occupational exposures and factors affecting health effects. *Curr. Allergy Asthma Rep.* 18(12):65.

42. O'Shea, H., B. A. Blacklaws, P. J. Collins, J. McKillen, and R. Fitzgerald. 2019. Viruses associated with foodborne infections. In Reference module in life sciences. First Edition. Elsevier, Amsterdam.

43. Park, S., B. Szonyi, R. Gautam, K. Nightingale, J. Anciso, and R. Ivanek. 2012. Risk factors for microbial contamination in fruits and vegetables at the preharvest level: A systematic review. *J. Food Prot.* 75(11):2055–2081.

44. Penn State College of Agricultural Sciences. 2021. Agriculture resources in Spanish. Available at: https://agsci.psu.edu/access-equity/latinx-agricultural-network/agricultural-resources-in-spanish. Accessed 26 March 2024.

45. Perry, B., A. Shaw, A. Enderton, E. Johnsen, C. H. Strohbehn, and L. Naeve. 2019. Assessment of midwest growers' needs for compliance with the Food Safety Modernization Act Produce Safety Rule. *Food Prot. Trends* 39(3):212–217.

46. Perry, B., A. Shaw, A. Enderton, S. Coleman, and E. Johnsen. 2021. North central region produce grower training: Pretest and posttest knowledge change and produce safety behavior assessment. *Food Prot. Trends* 41(3):266–273.

47. Produce Safety Alliance. 2019. Produce Safety Alliance grower training course. Available at: https://cals.cornell.edu/produce-safety-alliance/psa-curriculum. Accessed 26 March 2024.

48. Qiu, Q., D. Dewey-Mattia, S. Subramhanya, Z. Cui, P. M. Griffin, S. Lance, W. Lanier, M. E. Wise, and S. J. Crowe. 2021. Food recalls associated with foodborne disease outbreaks, United States, 2006-2016. *Epidemiol Infect.* 149:e190.

49. Rajagopal, L. 2012. Use of visuals for food safety education of Spanish-speaking foodservice workers: A case study in Iowa. *J. Ext.* 50(2):2RIB6.

50. Rajagopal, L., S. W. Arendt, A. M. Shaw, C. H. Strohbehn, and K. L. Sauer. 2016. Food safety posters for safe handling of leafy greens. *J. Ext.* 54(2):2TOT5.

51. Rajagopal, L., J. Reynolds, and D. Li. 2019. Visual-based minimal-text food safety training tools for Chinese-speaking food service workers. *J. Ext.* 57(5):5TOT4.

52. Ramos, T. D. M., M. T. Jay-Russell, P. D. Millner, J. N. Baron, J. Stover, P. Pagliari, M. Hutchinson, J. Lilley, N. Rowley, V. Haghani, P. Aminabadi, A. Kenney, F. Hashem, B. Martínez-López, E. A. Bihn, D. P. Clements, J. B. Shade, A. R. Sciligo, and A. F. A. Pires. 2021. Survival and persistence of foodborne pathogens in manure-amended soils and prevalence on fresh produce in certified organic farms: A multi-regional baseline analysis. *Front. Sustain. Food Syst.* 5: 674767.

53. Ribera, L. A., and L. K. Young. 2024. Outlook of fresh fruits and vegetables in the United States. Available at: https://www.freshproduce.com/siteassets/files/advocacy/2024.01.outlook-of-fresh-fruits-and-vegetables-in-the-united-states-luis-final.pdf. Accessed 21 November 2024.

54. Runkel, S. 2022. Minimize food safety risks when using animal-based fertilizers. Available at: https://www.carolinafarmstewards.org/minimize-food-safety-risks-when-using-animal-based-fertilizers/. Accessed 15 March 2024.

55. Shahbandeh, M. 2024. Top producers of fresh vegetables worldwide in 2022. Available at: https://www.statista.com/statistics/264662/top-producers-of-fresh-vegetables-worldwide/. Accessed 29 September 2024.

56. Snellman, E. A. 2013. Guidelines and protocols for safe practice in fresh produce production: FDA legislation, p. 22–32. In J. Hoorfar (ed.), Global safety of fresh produce: A handbook of best practice, innovative commercial solutions and case studies. First Edition. Woodhead Publishing.

57. Soon, J. M., and R. N. Baines. 2012. Food safety training and evaluation of handwashing intention among fresh produce farm workers. *Food Control* 23(2):437–448.

58. Statista. 2024. Per capita consumption of food products in the United States in 2023. Available at: https://www.statista.com/statistics/1380934/united-states-per-capita-consumption-of-different-food-products/. Accessed 10 November 2024.

59. Strohbehn, C. H., A. Enderton, A. M. Shaw, B. Perry, J. Overdiep, and L. Naeve. 2018. Determining what growers need to comply with the Food Safety Modernization Act Produce Safety Rule. *J. Ext.* 56(7):7RIB1.

60. United States Department of Agriculture. 2023. Equity action plan. Available at: https://www.state.gov/equity/. Accessed 21 November 2024.

61. United States Food and Drug Administration. 2015. FSMA final rule on produce safety. Available at: https://www.fda.gov/food/food-safety-modernization-act-fsma/fsma-final-rule-produce-safety. Accessed 21 November 2024.

62. Ward, N., and J. Batalova. 2023. Refugees and asylees in the United States. Available at: https://www.migrationpolicy.org/article/refugees-and-asylees-united-states. Accessed 25 March 2024.

63. World Health Organization. 2016. WHO estimates of the global burden of foodborne diseases. Available at: https://iris.who.int/bitstream/handle/10665/199350/9789241565165_eng.pdf. Accessed 21 November 2024.

64. Yin, Z., B. Li, D. Gu, J. Huang, and L. Zhang. 2022. Modeling of farmers' vegetable safety production based on identification of key risk factors from Beijing, China. *Risk Analysis* 42(9):2089–2106.