

Chapter 2

Food Safety Hazards Identified on Small Farms

Judy A. Harrison

Abstract Farmers markets have increased in number in the U.S. by almost 400% since the early 1990s. Customers shop at these markets to get to know the farmers who are producing their food, and to purchase products they view as more nutritious, better tasting, higher quality, better for the environment and safer than foods from larger, commercial farms being sold in supermarkets. Yet studies in the U.S. and in other countries have identified food safety hazards on farms and in farmers markets that may increase the risk of foodborne illnesses. Risky practices on farms include the use of raw manure without appropriate waiting periods observed between application and harvest, use of untested well or surface water for irrigation and/or washing of produce, lack of sanitary facilities and handwashing facilities for workers, lack of training for workers, food contact surfaces not properly cleaned and sanitized and lack of temperature control both on the farm and during transport to market. Hazards have also been identified with livestock and poultry products such as lack of sanitation and temperature control. A lack of sanitation practices and microbial problems associated with the use of raw milk have been identified as hazards on farms making and selling artisanal cheeses.

Keywords Farm food safety • Farmers market food safety • Food safety risks • Food safety hazards

The numbers of farmers markets have increased in the U.S. by almost 400% since the early 1990s signifying the increasing popularity of the local food movement (Fig. 2.1). This increase in visibility and popularity has been fueled by campaigns such as *Know Your Farmer*, *Know Your Food* and *The People's Garden* [1].

Several studies have examined the reasons why consumers shop at farmers markets. Reasons include beliefs that purchasing from the farmers market supports

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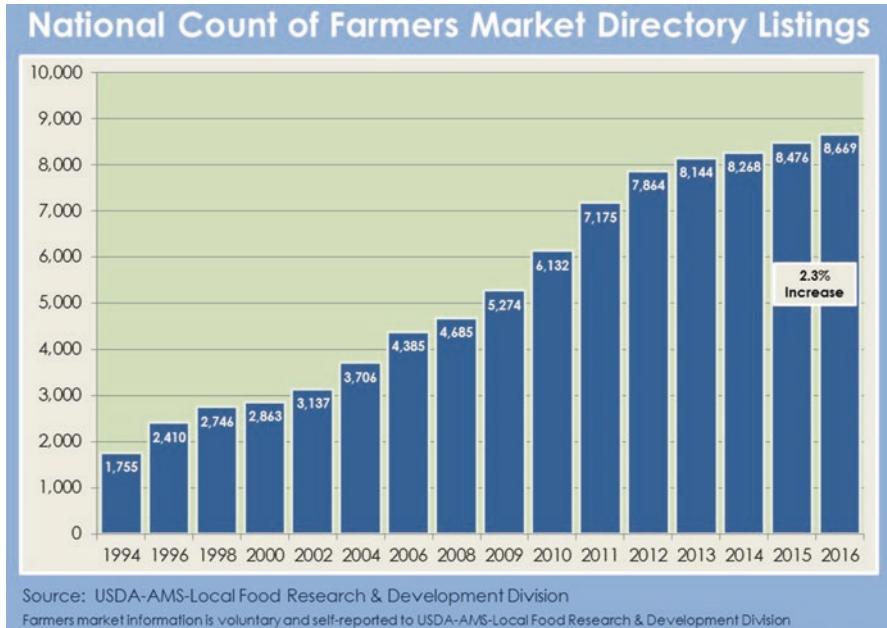


Fig. 2.1 National count of farmers market directory listings. Reprinted from <http://www.ams.usda.gov>, by AMS-USDA, Transportation and Marketing Program, Local Food Research and Development Division. Available from: <https://www.ams.usda.gov/sites/default/files/media/National%20Count%20of%20Operating%20Farmers%20Markets%201994-2016.jpg>

local farmers and is better for the environment, the food is fresher with better quality and flavor, the food is a better value for the money, the food is more likely to be grown locally and is more traceable than products from the grocery store, and the food is safer when produced locally [2–4].

In 2008, 81% of farms selling locally were small farms with less than \$50,000 in gross sales, and 14% were medium sized farms selling between \$50,000 and \$250,000 in gross sales [5]. Studies have shown that often farmers selling at farmers markets are relatively new to farming and have less experience than those on larger, more established farms [6, 7]. According to Martinez et al. [8], the 2007 U.S. Census of Agriculture indicated that farmers selling directly to consumers had four years less experience than those not marketing directly to consumers, and 40% were beginning farmers with less than 10 years of experience. The 2012 U.S. Census of Agriculture identified little change in most categories compared to the 2007 census [9]. Harrison et al found that out of 328 participants in small farm produce safety trainings in Georgia, South Carolina and Virginia during the period from 2011 to 2013, 43% indicated farming for less than 3 years, 20% from 4 to 9 years and 36% for 10 or more years. Of those participants, 34% used organic methods, 29% used conventional methods and 37% used both organic and conventional farming methods [10]. Laury-Shaw et al.

noted that prior to an initial food safety training, less than 10% of participants had food safety plans that included written policies regarding worker attire; worker behaviors involving eating, drinking or smoking while working with products and handling during transportation [7]. Parker et al. [11] stated that there is little knowledge of how food safety is handled on small and medium farms, even though a study 6 years earlier in 2006 by Simonne et al. found that out of 47 farmers market vendors, 50% thought food safety was very important and were very confident of their food safety practices, but only 32% had completed any type of food safety training [12]. The study by Parker et al. about food safety concerns among growers found that regardless of the size of farm, growers were most concerned about consumer behavior and health and hygiene of workers [11]. Other lesser concerns for large growers included sanitation of facilities and equipment, wildlife fecal contamination and quality of water for irrigating and washing produce. Lesser concerns for medium growers were similar with these growers including pesticide application and soil amendments as well. Small growers in the study included the presence of wildlife feces and pesticide drift as concerns, but only a few small growers (≤ 18) included concern over sanitation of facilities and equipment, manure use and water quality even though these issues are of concern to food safety experts and are addressed as part of good agricultural practices.

Although these studies indicate some level of awareness among local food producers of potential issues and conditions that could affect the safety of produce grown on small to medium farms and sold in farmers markets, a multi-state survey identified growing and handling practices on small to medium sized farms that could put consumers at risk for foodborne illnesses [6]. Out of 226 farmers responding to a survey, 128 (57%) used manure with 18% of those using a mixture of raw and composted manure (including one report of using humanure, human manure from a composting toilet). Almost 15% of manure users applied manure to fields more than twice a year, raising concerns that the recommended 90 day and 120 day waiting periods between application of raw manure and harvest for crops that do not touch the soil and crops that touch the soil, respectively, that are recommended in the National Organic Program are not being met [13]. Although most growers used tested water sources for irrigation, 30.5 % of respondents used untested well water or rainwater and surface water from streams or ponds, for irrigation which has the potential for microbial contamination. In terms of worker hygiene, approximately 66% of respondents reported having sanitary facilities and handwashing facilities available near fields and packing sheds. Yet the lack of facilities at many farms makes hand hygiene questionable and raises concern about potential contamination. Fifty percent of the operations indicated that crops are harvested with bare hands. Only 41% of the farmers indicated they had offered sanitation training to their workers [6].

Harrison et al. also identified post-harvest handling practices that could increase a consumer's risk for foodborne illness [6]. Approximately 16% of the farmers who responded used untested well water, surface water (such as ponds, streams or springs) and rainwater for washing produce after harvest. Only 39% of respondents sanitized surfaces that come in contact with produce at the farm, and only 33%

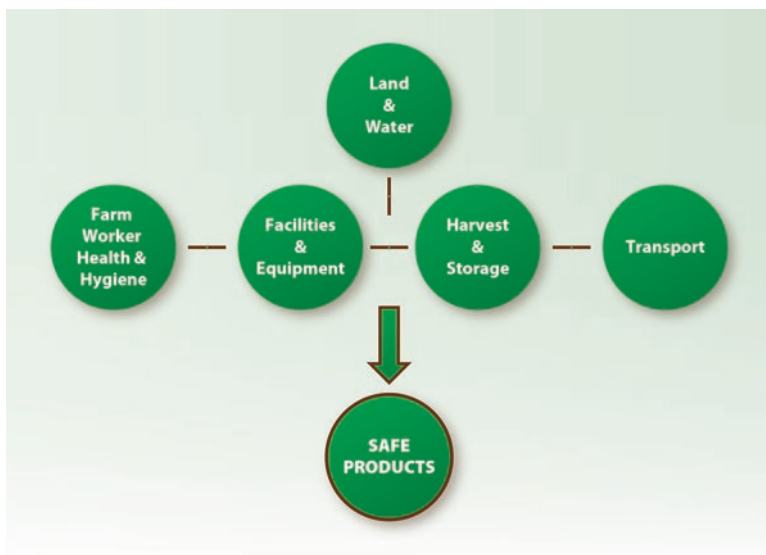


Fig. 2.2 Model of Food Safety on the farm showing areas where best practices must be implemented for production of safe produce destined for farmers markets. Reprinted from *Enhancing the Safety of Locally Grown Produce—On the Farm*. Harrison JA. 2012. University of Georgia Cooperative Extension Publication #FDNS-E-168-2

always cleaned containers used to transport produce to market between uses. Cooling of produce on the farm or during transport was also lacking with 18.1% reporting no cooling methods used on the farm and 35% rarely or never cooling produce during transport to market. These findings indicate the potential for food safety hazards associated with growing, harvesting and post-harvest handling of produce destined for the farmers market and other direct-to-consumer outlets. Based on these findings, a model illustrating areas where best practices must be used to enhance produce safety has been developed and is presented in Fig. 2.2. An assessment tool is presented in Fig. 2.3 for use on small farms selling direct market produce. A detailed description of best practices to control food safety hazards for produce grower/vendors is presented in Chap. 4.

Although produce farms accounted for more than half of direct sales to consumers in the 2007 U.S. Census of Agriculture, 7% of livestock producers also sold directly to consumers with beef, poultry, dairy and eggs accounting for the highest percentages of products sold [8]. According to Painter et al., meat and poultry (beef, game, pork and poultry), accounted for fewer illnesses than produce in the period from 1998 to 2008 but accounted for a higher percentage of deaths due to foodborne illness (29% versus 23%) [14]. While the debate continues over issues related to animal welfare, use of antimicrobials, etc. and the safety of meat products from “industrial farm animal production” systems versus small-farm production, foodborne illness can be associated with either system [15]. In 2010, the number of slaughter facilities in the U.S. had decreased



Farm Self-Help Form

<i>Practice</i>	YES	NO	DOES NOT APPLY TO ME
<i>Training & Certifications</i>			
Our farm has established food safety rules and practices.			
Our farm has completed food safety trainings and/or certification courses.			
Our farm has records of certification or evidence of training to help ensure food safety.			
<i>Land & Water Use</i>			
I know the land use history, whether the farm was previously used for livestock production or has a history of application of biosolids, septage or other by-products containing feces.			
My crop production areas are separate from or NOT located near dairy, livestock or poultry production areas or where run-off from such areas could be possible.			
If crop production areas are near or adjacent to dairy, livestock or poultry production areas, I make sure natural or physical barriers will prevent contamination of the produce growing area by wind or water.			
If I use raw animal manure, I wait at least 120 days between application and harvest for crops touching the soil and 90 days for other crops.			
I NEVER use septage or untreated human manure in crop production.			
Any composted manure I use follows the U.S. EPA or National Organic Program recommendations for temperature, turning and time to reduce disease-causing microorganisms.			
I have my well water that I use for irrigation tested for the presence of bacteria.			
I NEVER use untreated surface water (ponds, lakes, streams or springs) for overhead irrigation.			
I use municipal water or tested well water for overhead irrigation.			
I have my well water that I use for rinsing fruits and vegetables tested for the presence of bacteria.			
I NEVER use surface water (ponds, lakes, streams or springs) for rinsing fruits and vegetables.			
<i>Farm Worker Hygiene</i>			
I have policies in place to limit sick workers from coming in contact with fruits and vegetables.			
I provide sanitation training for my workers.			
I provide training for my workers on proper glove use.			
My workers have access to handwashing facilities with clean water, soap and paper towels within a short walking distance of my fields.			

Fig. 2.3 Enhancing the safety of locally grown produce—farm self-help form. Courtesy of Judy Harrison. University of Georgia Publication #FDNS-E-168-1

from over 1200 in the 1990s to around 800 with the consolidation of the meat industry [16]. This closure of many facilities has made it necessary for livestock producers wanting to sell products to seek alternative methods of slaughter and packing, either small state inspected facilities willing to serve small businesses or using the services of mobile abattoirs [17]. Regardless of the situation or

<i>Practice</i>	YES	NO	DOES NOT APPLY TO ME
My workers have access to toilet facilities within a short walking distance of my packing areas.			
I train my workers to seek immediate first aid for injuries like cuts, abrasions, etc. that could be a source of contamination for produce.			
I have trained my workers on what to do with produce that comes in contact with blood or other bodily fluids.			
Facilities & Equipment			
Toilet facilities are serviced and cleaned on a regular schedule.			
Handwashing facilities are cleaned and stocked with clean water, soap and paper towels on a regular schedule.			
Harvesting equipment (knives, pruners, machetes, etc.) is kept reasonably clean and is sanitized on a regular basis.			
Harvesting containers and hauling equipment are cleaned and/or sanitized between uses.			
Surfaces that come in contact with fruits and vegetables at my farm are cleaned and sanitized regularly.			
Damaged containers are properly repaired or discarded.			
Any cardboard boxes used are new and only used once.			
Storage & Transport			
Produce is handled carefully and packed securely to prevent bruising and injury.			
I cool fruits and vegetables after harvest.			
Produce is kept cool during transport to market.			
Containers used with fruits and vegetables are cleaned and sanitized between each use.			
The vehicle is NOT used to transport animals, raw manure, chemicals or any other potential contaminant.			
The vehicle used to transport fruits and vegetables is cleaned frequently.			

If you answered "no" to any of the questions, those questions represent areas where changes or improvements may help your farm to offer safer products, attract more customers because of your commitment to food safety and reduce potential risk of foodborne illness. Please read the *Enhancing the Safety of Locally Grown Produce* factsheets for your risk area to learn how to minimize risk.

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Fig. 2.3 (Continued)

method used, adherence to strict sanitation practices, cooling practices and time-temperature control would be essential to minimize foodborne illness risks. USDA’s Food Safety and Inspection Service provides guidance documents for mobile processing units [18].

A study of poultry products sold at farmers markets versus those conventionally processed and sold at supermarkets in Pennsylvania identified significantly higher

levels of generic *E. coli*, total coliforms, *Salmonella* spp. and *Campylobacter* spp. in whole chicken sold at farmers markets [19]. This study found increased risk of food safety hazards associated with poultry sold in farmers markets. A detailed description of food safety considerations for meat and poultry vendors at farmers markets is presented in Chap. 5.

In addition to meat and poultry, dairy products are also produced on small farms and sold at farmers markets. Although some states prohibit the sale of raw milk, other states allow the sale which can also increase food safety risks for consumers when sold through farm stands or farmers markets. Raw milk has a historic association with foodborne illness due to the presence of foodborne pathogens. Painter et al. noted a higher incidence of *Campylobacter* associated with raw milk [14]. From 2007 to 2012, 26 states reported 81 outbreaks to the Centers for Disease Control and Prevention (CDC) caused by raw milk, an increase from 30 outbreaks from 2007 to 2009 to 51 outbreaks between 2010 and 2012 [20]. The hazards associated with raw milk outbreaks in this report were *Campylobacter* (81% of outbreaks), shiga toxin-producing *E. coli* (17% of outbreaks) and *Salmonella* (3% of outbreaks). However, outbreaks have included a multistate outbreak of listeriosis linked to raw milk from an organic producer in Pennsylvania [21].

Many small dairy farms also make and sell artisan cheeses at farmers markets and other venues. In addition to risks from environmental conditions and sanitation issues on farms, some farmstead cheesemakers use raw milk as an ingredient and rely on proper aging to eliminate pathogens [22]. Outbreaks of foodborne illnesses linked to raw milk and raw milk cheeses have raised concerns about the safety of these products. Regulations for the production of raw milk cheeses require that cheeses be aged for not less than 60 days at a temperature of not less than 35 °F (2 °C) [23]. However, studies of artisan and farmstead cheesemakers historically have identified varying levels of risk associated with these products. In a study of 11 cheesemaking facilities, D'Amico et al. reported that 8 of the 11 facilities (73%) had milk samples that tested positive for *Staphylococcus aureus* (46 of 133 samples or 34.6 %), three milk samples (2.3%) tested positive for *Listeria monocytogenes* and one for *Escherichia coli* O157:H7 [24]. *Salmonella* was not found in any of the samples [24]. Another study by D'Amico et al. indicated that if contamination with *L. monocytogenes* occurs during the post-processing period of soft, mold-ripened cheeses, the 60-day aging period may not be adequate to ensure safety [25]. Machado et al. [22] reported that observations of five farmstead cheesemaking facilities in Pennsylvania and survey responses of state inspectors indicated that improvements were needed in basic sanitation, although cheesemakers had rated their knowledge of food safety, their attitudes toward food safety and their handling practices as good to very good. Outbreaks of illness have been associated with farmstead cheesemaking facilities. Evidence prompted a recall of 14 cheese varieties potentially linked to a *Salmonella* outbreak that sickened 100 people in 2016 from a farmstead creamery in North Carolina which had sold cheese through retail locations, farmers markets and restaurants throughout North Carolina, Tennessee, South Carolina, Virginia and Georgia [26].

Safety of food in farmers markets, as well as any other venues where food is sold, requires strict attention to good agricultural practices, good manufacturing practices and proper sanitation on farms where the food is produced. Improper handling on the farm can lead to increased risk of foodborne illnesses from farmers markets.

Summary

Studies have identified the potential for food safety hazards to exist on small farms selling products directly to consumers through farmers markets and other venues. Self-reported data as well as direct observations have noted problems with hand hygiene, sanitation and temperature control on farms. These conditions could lead to an increased risk of contamination of products and foodborne illnesses among consumers.

References

1. U.S. Dept. of Agriculture, Center for Nutrition Policy and Promotion. Know your farmer, know your food – growing a healthier you [cited 2017 Apr 6]. Available from: <https://www.cnpp.usda.gov/KnowYourFarmer>
2. Worsfold D, Worsfold PM, Griffith CJ (2004) An assessment of food hygiene and safety at farmers' markets. *Int J Environ Health Res* 14(2):109–119
3. Crandall PG, Friedly EC, Patton M, O'Bryan CA, Gurubaramurugesan A, Seideman S, Ricke SC, Rainey R (2011) Consumer awareness of and concerns about food safety at three Arkansas farmers' markets. *Food Prot Trends* 31(3):156–165
4. Wolf MM, Spittler A, Ahern J (2005) A profile of farmers' market consumers and the perceived advantages of produce sold at farmers' markets. *J Food Distrib Res* 36(1):192–201
5. Low SA, Vogel S (2011) Direct and intermediated marketing of local foods in the United States, ERR-128, U.S. Department of Agriculture, Economic Research Service. Nov [cited 2016 Sept 16]. Available from: https://www.ers.usda.gov/webdocs/publications/err128/8276_err128_2_.pdf
6. Harrison JA, Gaskin JW, Harrison MA, Cannon JL, Boyer RR, Zehnder GW (2013) Survey of food safety practices on small to medium-sized farms and in farmers' markets. *J Food Prot* 76(11):1989–1993
7. Laury-Shaw A, Strohheln C, Naeve L, Wilson L, Domoto P (2015) Current trends in food safety practices for small-scale growers in the midwest. *Food Prot Trends* 35(6):461–469
8. Martinez S, Hand M, DaPra M, Pollack S, Ralston K, Smith T, Vogel S, Clark S, Lohr L, Low L, Newman C (2010) Local foods systems: concepts, impacts and issues. USDA ERS Report No. 97 [cited 2016 Aug 26]. Available from: <https://ideas.repec.org/p/pra/mprapa/24313.html>
9. U.S. Department of Agriculture National Agricultural Statistics Service (2012) Census of agriculture. 2014 Aug [cited 2016 Aug 26]. Available from: https://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_1_US/usv1.pdf
10. Harrison JA, Gaskin JW, Harrison MA, Cannon JL, Boyer RR, Zehnder GW (2013) Enhancing the safety of locally grown produce through extension education for farmers and market managers [abstract]. *J Food Prot* 76(Suppl A):P1–87
11. Parker JS, Wilson RS, LeJeune JT, Doohan D (2012) Including growers in the “food safety” conversation: enhancing the design and implementation of food safety programming based

- on farm and marketing needs of fresh fruit and vegetable producers. *Agric Hum Values* 29:303–319
12. Simonne A, Swisher M, Saunders-Ferguson K (2006) Food safety practices of vendors at farmers' markets in Florida. *Food Prot Trends* 26(6):386–392
 13. Code of Federal Regulations (2017) National Organic Program, Title 7, Subtitle B, Chapter 1, Subchapter M, Part 205, Section 205.203
 14. Painter JA, Hoekstra RM, Ayers T, Tauxe RV, Braden CR, Angulo FJ, Griffin PM (2013) Attribution of foodborne illnesses, hospitalizations, and deaths to food commodities by using outbreak data, United States, 1998–2008. *Emerg Infect Dis* 19(3):407–415
 15. Rossi J, Garner SA (2014) Industrial farm animal production: a comprehensive moral critique. *J Agric Environ Ethics* 27:479–522
 16. Johnson RJ, Marti DL, Gwin L (2012) Slaughter and processing options and issues for locally sourced meat. USDA ERS Report No. LDP-M-216-01. June [cited 2016 Sept 16]. Available from: <https://www.ers.usda.gov/publications/pub-details/?pubid=37460>
 17. Thompson S (2010) Going mobile – co-ops operate traveling slaughter units to help grow local foods movement. USDA Rural Development. *Rural Cooperatives* 77(6):4–7. Available from: <http://www.rd.usda.gov/files/CoopMag-nov10.pdf>
 18. U. S. Department of Agriculture Food Safety and Inspection Service (2010). Mobile Slaughter Unit Compliance Guide [cited 2016 Sept 16]. Available from: https://www.fsis.usda.gov/shared/PDF/Compliance_Guide_Mobile_Slaughter.pdf
 19. Scheinberg J, Doores S, Cutter CN (2013) A microbiological comparison of poultry products obtained from farmers' markets and supermarkets in Pennsylvania. *J Food Saf* 33:259–264
 20. Mungai EA, Behravesh CB, Gould LH (2015) Increased outbreaks associated with nonpasteurized milk, United States, 2007–2012. *Emerg Infect Dis* 21(1):119–122
 21. Centers for Disease Control and Prevention (2016) Multistate outbreak of listeriosis linked to raw milk produced by Miller's Organic Farm in Pennsylvania (Final Update) [cited 2016 Dec 28]. Available from: <http://www.cdc.gov/listeria/outbreaks/raw-milk-03-16/index.html>
 22. Machado RAM, Radhakrishna R, Cutter CN (2017) Food safety of farmstead cheese processors in Pennsylvania: an initial needs assessment. *Food Prot Trends* 37(2):88–98
 23. Code of Federal Regulations (2017) Cheese from unpasteurized milk, Title 7, Subtitle B, Chapter 1, Subchapter C, Part 58, Subpart B, Section 58.439
 24. D'Amico D, Groves E, Donnelly CW (2008) Low incidence of foodborne pathogens of concern in raw milk utilized for farmstead cheese production. *J Food Prot* 71(8):1580–1589
 25. D'Amico D, Druart M, Donnelly CW (2008) 60-Day aging requirement does not ensure the safety of surface-mold-ripened soft cheeses manufactured from raw or pasteurized milk when *Listeria monocytogenes* is introduced as a post-processing contaminant. *J Food Prot* 71(8):1563–1571
 26. U. S. Food and Drug Administration (2016) Chapel Hill creamery recalls cheese products because of possible health risk [cited 2016 Dec 28]. Available from: <https://www.fda.gov/Safety/Recalls/ucm513946.htm>



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