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Food Safety Practices and Costs Under the California Leafy Greens Marketing Agreement

Linda Calvin, Helen Jensen, Karen Klonsky,
and Roberta Cook





United States Department of Agriculture

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Abstract

This case study investigates food safety practices and costs for seven firms participating in the California Leafy Greens Marketing Agreement (LGMA), formally known as the California Leafy Green Products Handler Marketing Agreement. All firms incorporated additional food safety practices into their food safety plans beyond LGMA requirements, for their own convenience, risk management needs, and/or to satisfy buyer requests. It was difficult to quantify food safety costs; the analysis concentrated on costs for five food safety practices. The cost-share for each practice—the cost of the individual practice divided by the total cost of the five practices—provides insight into the relative cost of food safety practices. The value of the food safety staff (including clerical staff) time in food safety tasks was relatively large—38 percent of the five costs. Another 32 percent of costs was for the food safety time of harvest foremen. Audits accounted for 17 percent, product unharvested due to animal intrusion for 11 percent, and water testing for 2 percent of costs. This analysis can increase understanding of the relative food safety costs for firms under the Food Safety Modernization Act.

Keywords: food safety practices, food safety costs, leafy greens, California Leafy Greens Marketing Agreement (LGMA), California Leafy Green Products Handler Marketing Agreement, Food Safety Modernization Act (FSMA), Produce Rule (PR)

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What Is the Issue?

Foodborne illness linked to contaminated produce is a public health concern. The Food Safety Modernization Act (FSMA), signed into law in 2011, established a risk-based approach to regulating food safety. For the first time, the U.S. Food and Drug Administration (FDA) will regulate on-farm food safety practices related to microbial contamination across the wide range of heterogeneous produce firms. While the law will establish over 50 regulations, reports, and studies, the “Standards for Growing, Harvesting, Packing, and Holding of Produce for Human Consumption,” commonly known as the Produce Rule (PR), is the most important for farm-level operations. FDA released the final PR in late 2015.

Economic information on the costs growers will incur under the PR is scarce. The experience of existing commodity-specific food safety programs may provide insight into what the PR will mean for the produce industry. This study focuses on interviews with seven California leafy greens firms, since that industry has had a food safety program since 2007, the California Leafy Greens Marketing Agreement (LGMA), formally known as the California Leafy Green Products Handler Agreement. The LGMA is a voluntary program that requires members to implement a set of food safety practices, with an independent system to verify compliance. The interviews provide a snapshot of food safety practices and costs in 2012 for a sector of the produce industry that already had a strong microbial food safety program in place. While the LGMA and the PR cover the same major categories of risk and many of the requirements are similar, LGMA is generally more demanding with respect to practices. Since the number of firms included in the study is small, this research is a case study and not a comprehensive representation of the industry.

What Did the Study Find

The case study firms all followed the LGMA food safety requirements. Firms also adopted additional practices for their own risk management, convenience, and/or to satisfy buyer demands. The interviews revealed that food safety costs are very difficult to measure; not every firm could provide complete responses. Only costs for some food safety practices could be measured: those for food safety staff, harvest foremen, third-party audits, product lost due to animal intrusion, and water testing. We present these costs as shares of the five measurable food safety costs per firm.

ERS is a primary source of economic research and analysis from the U.S. Department of Agriculture, providing timely information on economic and policy issues related to agriculture, food, the environment, and rural America.

The largest of these five cost shares was for workers implementing the food safety plan: 38 percent for the food safety staff (including the clerical staff) and 32 percent for time that harvest foremen spent on food safety tasks. The LGMA and the PR both require that an operation have at least one person in charge of food safety for the firm. The LGMA does not specify a role for harvest foremen but now they are major players in the food safety program, overseeing the plan during harvest, a critical time when produce can become contaminated. Harvest foremen spent almost one-fourth of their time on food safety tasks.

Third-party audits were a big expense for the firms in the study. LGMA requires only a LGMA audit, but all the firms interviewed also used other commercial audits. The audits accounted for 17 percent of the costs the study authors could measure, with LGMA audits making up 11 percent and other commercial audits 6 percent. The PR recommends, but does not require, a third-party audit, but major buyers are likely to demand such audits. Therefore, the cost-share of audits for firms under the PR could be similar to the commercial audits incurred by LGMA members.

Both the LGMA and the PR emphasize the importance of field inspections to look for evidence of animal intrusion. LGMA, but not the PR, specifies exactly how much area should be marked off around evidence of animal intrusion and not harvested. Total lost-product costs were 11 percent of measured costs. Under the PR, cost shares may be smaller.

Water testing made up only 2 percent of measured costs. The LGMA requires monthly water testing for all water used in the fields unless a firm qualifies for an exemption. Under the LGMA, firms test all water used in the fields for evidence of generic *Escherichia coli* (*E. coli*). In contrast, the PR requires water testing only for field water sources that are likely to touch the plant. Although the PR water requirements should cost less than those of the LGMA, buyers may require more testing than the minimum required under the rule.

How Was the Study Conducted?

This case study is based on interviews and very limited followup correspondence with seven California grower/shippers who belonged to the LGMA in 2012. The interviews complied with the Office of Management and Budget rules that require clearance only for surveys of more than nine people. The project began with informal conversations with industry representatives, extension agents, and others; this background helped us develop the written survey. Firms in the case study then filled out the detailed survey. After reviewing the survey results, we led a 2-hour conference call with each firm to talk about the data and the interpretation of the information provided. These conversations resulted in additional insight into why firms were doing certain activities and some of the challenges of measuring food safety costs.

Food Safety Practices and Costs Under the California Leafy Greens Marketing Agreement

Introduction

Foodborne illness linked to contaminated produce is a public health concern. The Centers for Disease Control and Prevention attributed 46 percent of foodborne illnesses with a known food vehicle in the period 1998-2008 to produce (Painter et al., 2013). The single category “leafy green vegetables,” accounted for the largest share of all the illnesses considered with 23 percent, half of all produce outbreaks. The Food Safety Modernization Act (FSMA), signed into law in 2011, is the most recent step in efforts to reduce the risk of microbial contamination—that is from bacteria, viruses, and parasites—that can cause human illness. FSMA establishes a national approach to regulating food safety for fresh produce, shifting the policy focus from reaction to foodborne-illness outbreaks to risk-based preventive action. For the first time, the U.S. Food and Drug Administration (FDA) is regulating on-farm food safety practices with respect to microbial contamination in the produce industry. While the law includes many provisions, the “Standards for Growing, Harvesting, Packing, and Holding of Produce for Human Consumption,” commonly known as the Produce Rule (PR), is the most important for farm-level operations. FDA released the final PR in 2015, with phased-in implementation beginning in 2018 (Federal Register, 2015b). The experience of earlier food safety programs, such as the California program for leafy greens (greens generally used in salads), may provide insight into the type of practices and costs that firms will face under the PR.

The 2006 foodborne illness outbreak linked to California spinach, which resulted in 204 illnesses and 3 deaths, forced the California leafy greens industry to reconsider its thinking about food safety (Calvin, 2007). The industry developed a new food safety program, the California Leafy Greens Marketing Agreement (LGMA), formally known as the California Leafy Green Products Handler Marketing Agreement. The LGMA program for leafy greens went into effect in 2007 as the first of a new generation of more rigorous commodity-specific food safety programs.¹ The program requires that all members follow a minimum level of food safety practices. For example, FDA, in its voluntary Good Agricultural Practices (GAPs) food safety guidelines published in 1998, specified that water should be “adequate” for the needs of the operation but left the grower to determine what that meant (U.S. FDA, 1998). In contrast, the LGMA specified exactly what type of water was acceptable. If shippers decide to participate in the voluntary LGMA, then they must follow the mandatory food safety practices. Participating shippers are required to ensure that any growers they ship for follow the LGMA rules.² Mandatory third-party audits (i.e., to verify that the firm is

¹Tomatoes and cantaloupes also have commodity-specific food safety programs (Calvin, 2013).

²LGMA is a marketing agreement of leafy greens handlers under the supervision of the California Department of Food and Agriculture (USDA, Agricultural Marketing Service). A handler, generally a shipper in California, is the entity that first ships leafy greens into commerce and in this study the term shipper is used to refer to handlers. Only shippers can vote for a marketing agreement, and only those who vote to participate are required to do so. In contrast, for a marketing order only growers vote. If the order is approved, all growers in the geographic region specified in the order must comply whether they voted for it or not. This relatively complicated structure to regulate growers through shippers was the result of a limited number of policy tools available at that time to regulate farm practices and the necessity of having a program in place before the next California leafy greens season began.

following LGMA requirements) enforce the program. The LGMA estimates that 99 percent of total State production of leafy greens is covered by the agreement (California Leafy Green Products Handler Marketing Agreement, 2013).³ Covered leafy greens are arugula, baby leaf lettuce, spring mix, butter lettuce, cabbage (red, green, and savoy), chard, kale, endive, escarole, green leaf lettuce, iceberg lettuce, red leaf lettuce, romaine lettuce, and spinach.

The objective of this research is an in-depth investigation of the food safety practices and costs for a small number of California leafy greens firms participating in the LGMA, a sector of the produce industry that has already instituted food safety standards and has had time to find the best way to comply with regulations. A written survey and follow-up phone interviews provided information about how firms implement a complicated food safety program. As the number of firms interviewed is small, this is a case study and not a representative view of the entire leafy greens industry. The case study, however, provides rich detail about what firms are doing and why, information that is only possible to obtain through interviews. Since the LGMA is a minimum standard, firms may adopt additional food safety practices for their own risk-management needs, convenience, and/or to comply with the demands of their retail, foodservice, and bagged-salad processor buyers. Buyer demands have been an important driver of food safety standards in the produce industry (Hardesty and Kusunose, 2009). Firms in the leafy greens industry sell much of their product under contract; making buyer food safety demands a contractual obligation (Calvin et al., 2001). The study results show the total food safety costs for these firms since LGMA costs are difficult to separate from other food safety costs. The PR and LGMA address the same food safety risk factors and many of the requirements are very similar, making the LGMA experience relevant to the rest of the produce industry as it comes into compliance with the PR. While not all growers will have as demanding a food safety program as California leafy greens growers, the relative importance of different costs is a useful consideration.

³The first deadline for signing up for the LGMA was March 31, 2007. On May 4, 2007, Canada, the largest U.S. export market for leafy greens, announced that it would limit imports of California leafy greens to firms belonging to LGMA and participation increased.

The Literature on Produce Food Safety Practices, Costs, and Impacts

The literature on produce food safety is relatively new and focuses on growers using practices that are part of a particular food safety standard (USDA GAPs audit, LGMA, or the PR).⁴ The current state of food safety practices determines how much more growers will have to do to comply with new PR food safety rules. The costs of adopting these new practices provide an understanding of the financial impact of the new regulations. Available national data on produce food safety practices are outdated; the only statistically representative national survey on such practices was conducted by USDA's National Agricultural Statistics Service (NASS) for 1999 and did not include any questions on costs (USDA, NASS, 2001). In the absence of more recent national data, researchers have initiated their own surveys, which are not necessarily statistically representative.

Many studies focus on relatively small producers in one or a few States. Some research looks just at practices to identify where firms are with respect to food safety (Rangarajan et al., 2002; Cohen et al., 2005; Hultberg et al., 2012). Others look at both practices and costs (Adalja and Lichtenberg, 2015; Becot et al., 2012; Federal Register, 2015a; Hardesty and Kusunose, 2009; Lichtenberg and Tselepidakis, 2014; Prenguber and Gilroy, 2013; Sullins, 2014; Tootelian, 2008). The largest of this last group of studies covers 394 producers, with a national focus and a strong emphasis on growers belonging to sustainable agriculture organizations who tend to be smaller than average (Adalja and Lichtenberg, 2015).

Studies with cost information investigate the investment costs of adopting new food safety practices and/or the annual costs of these practices. In many cases, producers are far from meeting the food safety standard being investigated. As a result, it can be unclear how practices and costs line up—water-testing costs may refer to enough tests to comply with the standard of interest, fewer, or even more tests than required. Studies often target different practices or measure costs in ways that make it hard to compare results. A few studies have taken a different approach and constructed what it would cost to use certain food safety practices based on third-party information about costs (Woods and Thornsbury, 2005; Jensen et al., 2014).

Much of the focus has been on whether economies of scale exist for produce growers; that is, whether food safety costs increase less than proportionately with size (Paggi et al., 2010). Several researchers have found evidence of economies of scale (Woods and Thornsbury; Hardesty and Kusunose; Lichtenberg and Tselepidakis; and Adalja and Lichtenberg). Estimating the impacts of new food safety programs on environmental conditions is also part of this new, food-safety literature (Beretti and Stuart, 2008).

Results from Tootelian, and Hardesty and Kusunose are particularly relevant to the present case study since they focus on the LGMA. Both used independent mail surveys (49 observations each) to examine how practices and costs changed between 2006 and 2007, the first year of LGMA implementation. Tootelian found that many firms had some of the types of practices required to meet LGMA standards in place before 2006, particularly the larger firms, although they may not have been using these practices to the same degree as required by LGMA. For example, in 2006, 76 percent of the surveyed firms did monthly water testing, averaging 11 tests. In 2007, all firms

⁴The USDA Agricultural Marketing Service offers audits that verify compliance with FDA's Good Agricultural Practices.

conducted monthly water tests and the monthly average was 52. Tootelian estimated that firms increased spending on *total* food safety by 188 percent; he did not look at costs of individual practices except for water testing. Leafy greens growers reported to Hardesty and Kusunose that *total* food safety spending increased by 127 percent between 2006 and 2007. The largest food safety costs Hardesty and Kusunose measured were product unharvested due to animal intrusion or flooding and food safety specialists.

This research looks at large California leafy greens firms who are members of LGMA and have had years to develop their food safety plans and practices. By focusing on LGMA, all firms meet a minimum food safety standard, although, as noted, they may also adopt additional food safety practices. This study adds to the literature, which often focuses on small growers who are not necessarily in compliance with any particular food safety standard.

The Survey

The objective of the research was to survey and then interview California firms who belonged to the LGMA about their leafy greens food safety practices and costs in 2012. While simple conceptually, it was difficult to determine exactly who to interview and what part of the operation to focus on. The idiosyncratic nature of the leafy greens industry provided many challenges in measuring costs.

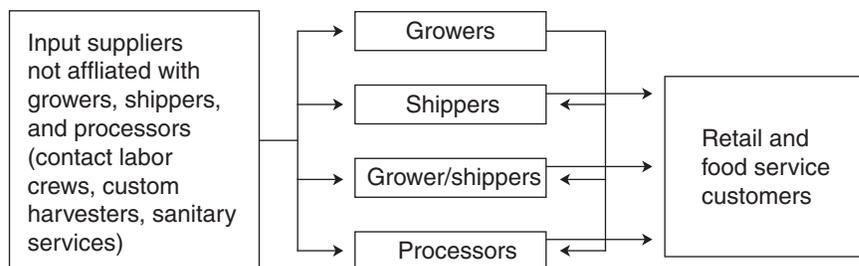
Who To Interview?

The California leafy greens industry is highly integrated, both horizontally and vertically, and this complexity made selecting the kind of operation to interview a difficult decision. The industry is not a group of individual firms that grow produce in just one area, provide all services themselves, and do their own shipping (marketing). There are many interlocking marketing exchanges in the supply chain for the leafy greens industry, and food safety costs can occur at different points in the chain (fig. 1). There are three general types of firms, depending on the production and shipping functions they perform: growers, shippers, and grower/shippers. The growers know what is happening on their operations and what they pay for. The shippers belong to the LGMA and deal with the food safety requirements of retail, foodservice, and bagged-salad processor buyers; they know the food safety costs they pay. Grower/shippers are ideal for understanding the practices and costs of food safety, since these firms control both levels of the business.

Grower/shippers can market just their own production or that of other growers as well. This research focuses on firms that sell mostly their own production. When a grower/shipper sells for other growers, the distribution of food safety services is more complicated, and this has implications for identifying and measuring costs. The shippers make decisions in terms of food safety requirements for all their growers. Shippers may provide oversight with their own food safety staff to these growers, and they may pay for some food safety practices too. In some cases, the shipper may be marketing for a grower with a very sophisticated food safety program and little oversight of the grower may be needed. In other cases, the shipper may need to exert more control over grower practices. The allocation of costs between shipper and grower varies and is determined through negotiation.

Figure 1

Representation of the California Leafy Greens Industry



Source: USDA, Economic Research Service.

Even with grower/shippers who market their own produce, costs can still be complicated to disentangle. A firm could directly provide all its own services—related to harvesting and toilet/handwashing facilities, etc.—without hiring any outside companies. The grower/shipper would control all activities and be able to provide direct estimates of food safety costs. Other firms may hire services that have some food safety component. For example, many grower/shippers hire a custom harvester that can provide harvesters, worker training, equipment cleaning/sanitizing, and other services. In such cases, a grower/shipper looking at a bill from the custom harvester might have trouble separating out food safety from other harvesting services. A firm could also hire a company to provide toilet/handwashing facilities and cleaning/disposal services, but in that case, the bill only covers food safety activities.

To get the most consistent view of food safety costs, this case study focuses on grower/shippers with their own production dominating sales and doing most of their own harvesting.⁵ While no statistics are available on the relative importance of grower/shippers, industry experts think that they are the majority of shippers at the farm-gate level in California, outweighing firms that ship with no produce of their own (Carman et al., 2004).

What Part of the Operation To Focus On?

The LGMA only covers leafy greens production, so this study focused on food safety costs for a firm's leafy greens production. Many California leafy greens firms also have Arizona leafy greens operations (see box 1, "The California Leafy Greens Industry"). We asked about operations in both States to avoid any potential difficulties in splitting up costs between the two, particularly for oversight functions such as food safety staff.⁶ Not everyone had Arizona operations or reported on them. The Arizona leafy greens industry has a counterpart to the LGMA. Although physical conditions are different, grower/shippers said the food safety costs do not vary much between California and Arizona.

The LGMA focuses only on field operations. As a result, the survey looks only at those practices and costs, although firms had food safety activities in other parts of their operation, such as coolers and warehouses. The field focus reflects the way California leafy greens are packed. Firms supply leafy greens as whole heads—what the industry calls commodity leafy greens. Most of these are packed in the field into boxes that are stacked on shipping pallets. The leafy greens leave the field in the containers that ship to buyers (Calvin and Martin, 2010). Much of the industry also sells leafy greens to bagged-salad processors; in this case, the leafy greens leave the field harvested into bins that go directly to the bagged-salad processor. The PR, in contrast to the LGMA field-level focus, covers a wide range of commodities with different types of packing and regulates field, cooler, packinghouse, and warehouse operations.

⁵In the two other studies of food safety costs for leafy greens, Hardesty and Kusunose sent their survey to growers, although some of those would have also been grower/shippers, and Tootelian looked at the shipper level, although some of those would have been grower/shippers too. There is no information on whether grower/shippers who mostly sell their own produce are significantly different from those who also sell for other growers. Similarly, there is no information on any differences between grower/shippers who do their own harvesting and those who do not. There is no obvious bias to restricting the pool of interviews to this group.

⁶For winter operations like those in Arizona, we used the 2011/12 season instead of the 2012 season that we used for the California spring-fall production.

Box 1

The California Leafy Greens Industry

California and Arizona accounted for approximately 94 percent of total U.S lettuce production in 2012 (USDA, NASS, 2013). These two States provide a seamless year-round supply: California from April to late November and Arizona during the winter season. Many of the big California firms base their operations in California, and during the winter they send their equipment and some staff to Arizona to operate there. Following adoption of the LGMA in California, Arizona developed a counterpart to the LGMA, the Arizona LGMA, so leafy greens production operates under essentially the same food safety system in both States (Arizona LGMA, 2016).

Many California leafy greens operations are very large. In 2012, the Census of Agriculture reported that harvested lettuce acres in Monterey County, California, which has the biggest share of harvested lettuce acreage in the State, averaged 983 acres per grower (USDA, 2014). (If a farm has 100 acres but double crops, the Census reports 200 acres.) In comparison, all California lettuce firms averaged 157 acres per grower. In the same year, the average harvested acreage for all U.S. vegetables, potatoes, and melons was 62 acres per grower. Marketing is concentrated. The Census showed 1,486 farms growing lettuce in California (USDA, NASS, 2014), and at the same time there were only about 100 shipper (handler) members of LGMA (California Leafy Green Products Handler Marketing Agreement). These shippers probably account for most of the leafy greens sales except for direct sales to farmers markets, community supported agriculture, roadside stands, etc. The big shippers are very big; the top four and top eight California iceberg shippers control an estimated 60 and 80 percent of the California/Arizona iceberg lettuce volume (Cook, 2011a).

Firms in the Case Study

In 2007, the number of shippers in the LGMA was more or less equally distributed across three size groups based on their carton equivalents of leafy greens (Tootelian).⁷ For this study, seven firms were interviewed; six were in the largest size group, and the seventh was nearly that large (see box 2, “Survey Design”).⁸ The case study firms are comparable with the largest farm categories in both the work of Tootelian, and Hardesty and Kusunose.⁹ Despite similarities in size, which might indicate a relatively homogenous group, the firms were very different in their structure and operations.

Table 1 shows that the number of carton equivalents of leafy greens averaged 8.6 million for the surveyed farms. Note that the number of firms in each average can vary.¹⁰ All fresh produce sales averaged \$196.6 million. These firms grew a wide range of leafy greens, as defined by the LGMA,

⁷The LGMA uses a simple calculation to aggregate various sizes of cartons of different leafy greens into one measure—carton equivalents—to determine the size of the shipper and assessments.

⁸This survey and the interviews complied with the Office of Management and Budget rules that require clearance only for surveys of more than 9 people.

⁹Tootelian’s largest size group was more than 1 million carton equivalents, and Hardesty and Kusunose’s largest size group was \$10 million or more sales of produce.

¹⁰The variation is due to the fact that grower/shippers had a hard time answering some questions, and not always the same questions. In addition, if two statistics have the same number of observations, it might not be for the same firms, except in the case of the maximum seven observations.

with an average of almost nine types per firm. Some firms grew both organic and conventional leafy greens, but none grew just organic.¹¹ In addition, the firms all produced a range of vegetables and some fruit, with leafy greens averaging 52 percent of their total produce sales. Broccoli, cauliflower, and strawberries are common crops in many areas with leafy greens. Almost all of the leafy greens the grower/shippers sold were from their own production. All firms marketed commodity leafy greens, and all but one grew some leafy greens for bagged-salad processors.

Box 2

Survey Design

The survey targeted California grower/shippers of leafy greens who belonged to the LGMA. The specific individuals we interviewed were knowledgeable about food safety practices and costs—generally the person in charge of the food safety staff. Up to nine grower/shippers could be included in the study without our needing to get the Office of Management and Budget clearance for the survey. The Institutional Review Board (California and Iowa) determined that the survey was exempt from their review.

The LGMA provides a list of members on their web page. We asked the LGMA staff to take the public list of members, divide them up into large, medium, and small shippers, and give us some names for each size group. We picked firms from that list and others we had identified ourselves. We contacted more than 10 firms to see if they met the requirements for being in a survey and were willing to participate. Of the firms that were willing, we selected nine, although larger firms had more representation than planned. In the end, we interviewed seven firms. Six of them were in the largest size group, and the seventh was nearly that large. As a result, we did not look at practices or costs across size.

After initial contact with the firms (via phone call), we sent a letter that included a short description of the survey, the survey form, and a statement with the request for obtaining informed consent. After the filled-out survey was returned, the study team conducted a 2-hour phone interview to go over the answers and discuss confusing points. The team conducted the phone interviews in May and June 2013. The survey instrument is included as Appendix A.

Table 1

Characteristics of the California firms interviewed, 2012

	Average	Number of firms with response
Leafy greens volume (million carton equivalents)	8.6	7
Fresh produce sales (million \$)	\$196.6	5
Number of types of leafy greens grown	8.5	6
Firms with organic production	43%	7
Leafy greens sales in total fresh produce sales	52%	5
Firms with sales to a bagged-salad processor	86%	7

Source: USDA, Economic Research Service.

¹¹In background conversations, people told us that there was no difference in the food safety costs for conventional and organic operations of the same size.

Interpreting Results

Practices

The LGMA and the PR are very similar in terms of risk categories addressed. Table 2 compares the field-level practice requirements for seven common risk categories: personnel qualifications and training; health and hygiene; agricultural water; biological soil amendments of animal origin and human waste; domesticated and wild animals; growing, harvesting, packing, and holding activities; and equipment, tools, buildings, and sanitation.¹² To provide additional context for considering the lessons the LGMA experience has for firms under the PR, this table also includes a section on regulatory approach that highlights several important differences between the two standards. The table identifies which LGMA practices the survey covered. It also shows some additional practices that retail, foodservice, and bagged-salad processor buyers demanded that may be a part of a grower/shipper’s food safety plan but are not required by either LGMA or the PR.

Table 2
Comparison of selected LGMA and FSMA requirements

Regulatory approach, risk categories, and practices	Practice is a required component of:		Additional practices identified as required by some buyers	Part of case study?
	FSMA	LGMA		
Regulatory approach				
Written food safety plan	No, recommended but not required	YES		YES, indirectly through food safety staff
Third-party audits of written food safety plan	NO, recommended but not required	YES, just the LGMA audit	YES, audits other than the LGMA audit	YES
Raw product testing	NO	YES, if contaminated water is used in the field	YES	YES

Table 2 continued—

¹²The elements of table 2 are presented in the order they appear in the PR. The discussion of survey results on practices and costs follows the same order. Firms subject to the PR and/or the LGMA should consult the law or LGMA website and not rely on these general descriptions of the requirements.

Table 2

Comparison of selected LGMA and FSMA requirements—continued

Regulatory approach, risk categories, and practices	Practice is a required component of:		Additional practices identified as required by some buyers	Part of case study?
	FSMA	LGMA		
Personnel qualifications and training				
Designated person in charge of food safety/food safety staff	YES	YES		YES
Recordkeeping	YES	YES		YES
External recordkeeping management service	NO	NO	YES	YES
Food safety role for harvest foremen	NO	NO		YES
Worker training	YES	YES		YES
Health and hygiene				
Hygiene training	YES	YES		YES, indirectly through worker training
Glove use	NO, but if gloves are used they must be kept intact and in sanitary condition	YES, for harvest of leafy greens going to bagged-salad processors	Yes, some buyers may require gloves for commodity leafy greens or different types of gloves	YES
Agricultural water				
Testing for water used in production	YES, but only water that is directly applied to produce	YES	YES	YES
Biological soil amendments (BSAs) of animal origin and human waste				
Restrictions on use	Allows raw manure in some cases and in others it requires BSAs that meet composting and testing standards. Human waste is not allowed.	Allows only BSAs that meet composting and testing standards. Human waste is not allowed.	Yes, may not accept use of any BSAs	NO
Interval between application and harvest	0 days	45 days		NO

Table 2 continued—

Table 2

Comparison of selected LGMA and FSMA requirements—continued

Regulatory approach, risk categories, and practices	Practice is a required component of:		Additional practices identified as required by some buyers	Part of case study?
	FSMA	LGMA		
Domesticated and wild animals				
Monitor for animal intrusion	YES	YES		NO
Follow specific rules about how much product to not harvest around evidence of animal intrusion or feces	NO	YES		YES
Growing, harvesting, packing, and holding activities				
Use practices to avoid produce become contaminated during harvest	YES	YES		NO
Food containers must be adequate for intended use	YES	YES		NO
Equipment, tools, buildings, and sanitation				
Equipment and tools are designed to be cleaned and maintained	YES	YES, except LGMA does not cover buildings		NO
Food contact surfaces cleaned/sanitized	Cleaned and sanitized, when necessary and appropriate	Cleaned and sanitized		YES
Toilets and hand-washing facilities	YES	YES		YES

FSMA = Food Safety Modernization Act.

Sources: California Leafy Green Products Handler Marketing Agreement for the LGMA rules; Standards for Growing, Harvesting, Packing, and Holding of Produce for Human Consumption for the FSMA rules; and USDA, Economic Research Service for additional practices that are not required by either LGMA or FSMA.

Costs

Measuring food safety costs is difficult. Food safety practices permeate nearly every aspect of a produce operation, but firms do not typically separate the food safety costs from other related costs. Some costs are relatively straightforward to measure, such as personnel hired specifically for the food safety staff. When field practices serve multiple purposes, costs are more challenging to measure. For example, one person may monitor a field for food quality and food safety-related animal intrusion at the same time, making it difficult to attribute time to the different roles.¹³

Although firms built their food safety plans specifically for the LGMA and leafy greens, six of seven interviewed grower/shippers reported that they used LGMA standards for all commodities; the one who did not used the LGMA plan for all but one commodity.¹⁴ As a result, it was difficult for grower/shippers to split food safety costs between leafy greens and all other produce. It was not always possible to determine exactly what costs firms reported in their interviews—costs for leafy greens, costs for all produce, or costs for a mix of both (although we assume that either leafy greens or all produce dominates these mixed costs).¹⁵ In retrospect, it would have been much better to ask about food safety costs for all produce on an operation. Because of this confusion about what food safety costs were considered, it was not possible to provide costs *per unit* (acres, production, etc.). Instead, we present cost shares for practices *per firm*, which resolves the problem of uncertain size information. This requires the strong assumption that food safety cost shares are the same across leafy greens and all other produce commodities on these operations. Cost shares, therefore, refer to either just leafy greens production or all produce production; we assume they are equivalent. Two firms, however, reported that even when they used the minimum LGMA standards on all their produce crops, they spent more money on leafy greens under their firm-specific food safety plan than on the other commodities. We do not know how widespread this view was and what the difference in costs would have been. All of the firms grew both leafy greens and other produce, with 52 percent of the value of produce sales from leafy greens with a range of 30 to 65 percent. Lacking better information, we proceeded under the assumption that the costs are equal across leafy greens and other produce, although recognizing that this may introduce some bias.

Six of the seven firms provided costs for five different practices (food safety staff, foremen food safety time, audits, lost product due to animal intrusion, and water testing), with the cost shares reported in figure 2. Even with the measurement difficulties, the results are relatively consistent. A subset of three grower/shippers provided enough data to calculate cost shares for four additional practices (harvest worker training, glove use, raw product testing, and external record-keeping management services), with shares calculated as a percent of the total costs for nine practices (fig. 3). Cost shares per firm provide insight into the relative magnitude and ranking of the costs that we could measure. Table 3 provides the range of costs per firm for different practices to provide some information on absolute costs.

¹³Quality refers to the characteristics of the product such as size, shape, or color, but not to microbial food safety.

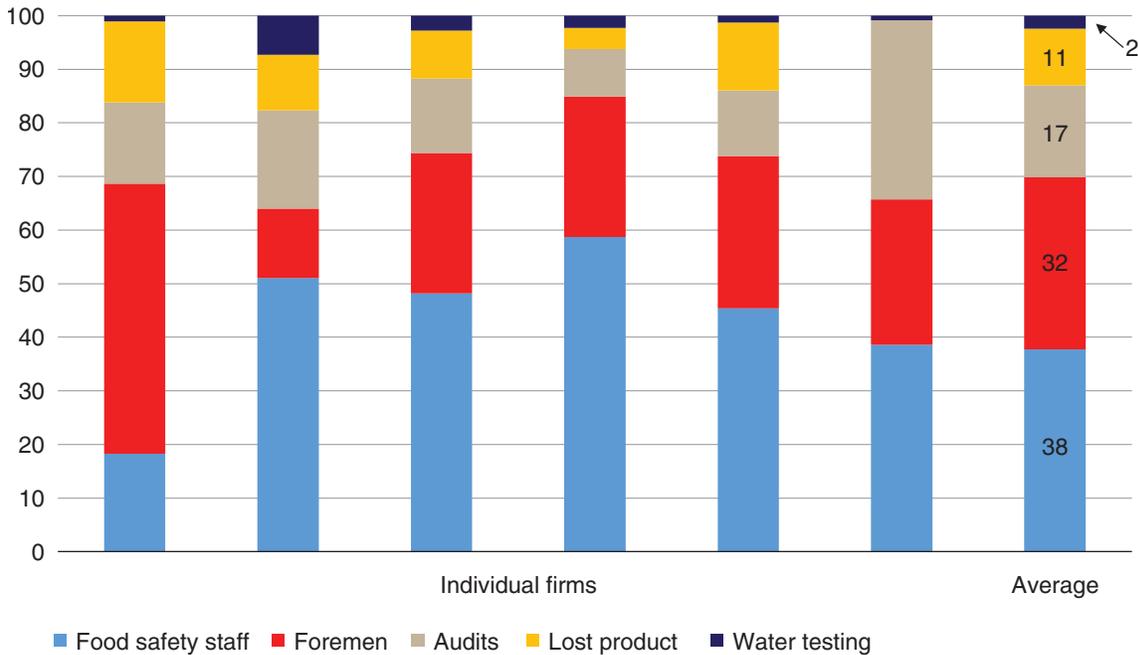
¹⁴This may have implications for the PR. Growers are required to follow the PR only on commodities covered under the rule. If growers have a mix of covered and noncovered produce commodities, they could find it easier to just apply the PR to all their produce.

¹⁵Lichtenberg and Tselepidakis reported a similar issue. They asked for food safety costs for tomatoes and lettuce, not whole farm costs, and they were concerned that some of the costs were actually for the whole farm. Hardesty and Kusunose asked for food safety costs just for leafy greens, so may also have encountered this problem. In this case study, it would have been difficult to obtain the detail required to account for just leafy greens costs or total produce costs without extensive additional questions.

The case study has no information on total production costs, so an estimate of food safety costs as a percent of total production costs is not possible. Previous research found that food safety costs are a small part of total revenue or production costs. Fresh produce is generally a low-margin commodity business, however, and even small increases in costs can have a serious impact on profitability (Cook, 2011b). Hardesty and Kusunose estimated the sum of food safety costs they measured to be about 1 percent of total crop revenue, although they included costs of implementing the food safety program as well as annual operating costs. University of California cost-of-production budgets assign per acre food safety costs of less than 1 percent of total production costs for iceberg and romaine hearts, but these budgets do not indicate what food safety costs the estimate includes (Tourte and Smith, 2010; Tourte et al., 2015).

Figure 2

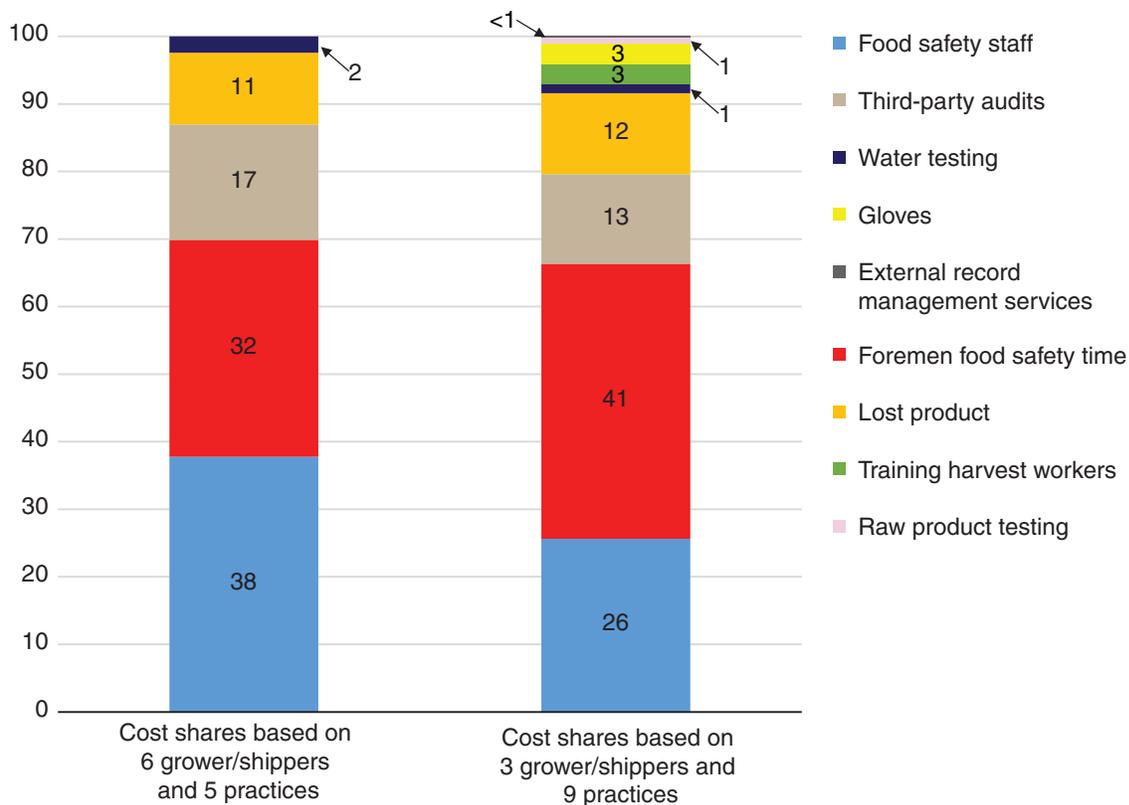
Individual costs as a share of five costs



Source: USDA, Economic Research Service.

Figure 3

Average cost shares of food safety costs for 6 firms and for 3 firms¹



¹The five cost shares do not have the same values in both cost columns. Only a subset of the firms in the left column appear in the right column, so cost shares can vary. Also, more costs are included in the second column, so shares would also change.

Source: USDA, Economic Research Service.

Table 3

Range of costs per firm for different food safety practices

	Range of costs (\$)		Number of observations
	Low	High	
Cost per firm:			
Total field-level audits	27,150	305,430	6
Raw product testing	0	90,000	6
External recordkeeping	0	8,868	7
Training	19,900	71,398	4
Protective clothing	12,000	52,000	5
Total water testing	7,000	85,000	7
Lost product	0	304,000	7
Equipment cleaning/sanitizing	21,000	250,000	4
Hired toilet/handwashing facilities and services	45,451	130,367	3

Note: In reporting individual costs per firm, there is a mix of costs for different-sized operations, and also a mix of costs for leafy greens and the whole produce operation. The combination of firms reporting data for any cost also varies. As a result, the numbers in table 3 cannot be added together to get a low and a high for all costs.

Source: USDA, Economic Research Service.

Regulatory Approach: Audits and Raw Product Testing

The LGMA requires growers to have a written food safety plan that meets the minimum requirements of the program, although the plan could include additional practices (table 2). In this report, the cost to update a food safety plan is included as part of the cost of food safety staff (the section on personnel qualifications and training covers these costs). The LGMA uses a third-party audit developed for this program to verify compliance. In addition, grower/shipper may want and/or buyers may demand additional audits. This section discusses costs for both LGMA and other audit standards.

In contrast, the PR recommends, but does not require, all producers to have a food safety plan based on their own assessment of risks in their operation. The PR provides a set of minimum practices to reduce the risk of microbial contamination. Congress specified that the PR could not require third-party audits of food safety plans (U.S. Congress, 2011). Of course, some firms that will fall under the PR already have food safety plans and third-party audits in place. Others will face buyer demands for third-party audits.

The LGMA determined that testing produce in the field for microbial contamination before harvest (i.e., raw product testing) was not merited as a general strategy to improve food safety. The LGMA requires raw product testing only if water that touches the plant exceeds the threshold of acceptable water quality. This section considers the cost of raw product testing. FDA also considered the value of raw product testing as a means to improve food safety but decided that it would not be required.

Food Safety Audits

A leafy greens grower/shipper can be involved in several different types of audits, varying by who does the audit: self-audits, LGMA audits, other third-party audits, and/or buyer audits. Third-party audits include a range of audit standards including the LGMA. Other examples of third-party audits include Primus Global Food Safety (Primus GFS) and GLOBALG.A.P.¹⁶ The structure of these two audits is different which can affect costs (discussed below). Similarly, buyers can have their own firm-specific food safety standard. Audits also vary by what part of an operation they cover—ranch, harvest crew, cooler, packinghouse, warehouse, all field operations, the whole operation, etc. (Ranch is a common California term for a farm.)

Self-Audits

The grower/shippers in this case study all performed self-audits, assessing their risks and compliance with their plan, to stay ahead of potential problems. The costs of self-audits are primarily for labor and are included in the costs of food safety staff and harvest crew foremen food safety time discussed below.

LGMA and Arizona LGMA Third-Party Audits

Due to the structure of the study, the interviewed firms all had LGMA audits; those with Arizona production had that State's audit as well. To enforce their standards, the LGMA and Arizona LGMA

¹⁶See Paggi (2008) and preliminary work by Boys et al. (2015) for more information on third-party audits. Use of the Primus GFS and GLOBALG.A.P. names does not constitute an endorsement by USDA.

both require third-party audits performed by the California Department of Food and Agriculture (CDFA) or Arizona Department of Agriculture (AZDA), respectively. USDA's Agricultural Marketing Service licenses these employees. The LGMA audit only ensures that the operation meets LGMA requirements for leafy greens and not for any other practices or other crops. LGMA and Arizona LGMA members pay assessments based on the volume of leafy greens they ship; membership rates were \$0.015 per 24-count carton equivalents in California for 2012 and \$0.0055 for Arizona in 2011/12.¹⁷ The membership assessments pay for CDFA and AZDA to conduct audits, but they also cover other services such as training seminars, crisis management, and public relations; the case study assigns all assessment costs to the audit category. LGMA audits cover field operations (see box 3, "LGMA Audit").

Box 3

LGMA Audit

The LGMA audits a shipper (handler in LGMA language) at least every 6-8 weeks during the firm's active harvest season, so the total number of audits depends in part on the length of the season. Most audits are scheduled, but all shippers are required to have at least one unannounced audit per season. For each announced visit, the auditor examines the shipper and one associated grower ranch, including any harvest crew activities on that ranch. If no one is harvesting on that day, the auditor will review harvest crew records. By the end of the year, each of these growers must be audited, but not necessarily every ranch. For an unannounced audit, the harvest crews working that day are audited and any ranch they are working on. If no one is harvesting, the auditors come back later. An LGMA audit focuses only on leafy greens production and compliance with the LGMA program. In some cases, LGMA determines the standards as for acceptable water. In other cases, LGMA only requires a grower/shipper to develop its own rules, such as Standard Operating Procedures (SOPs) for monitoring bathrooms and Sanitation Standard Operating Procedures (SSOPs) for sanitizing machines; the auditor checks that the firm's rules are being enforced.

That part of the audit focusing on the ranch would cover:

- Review of records for biological soil amendments
- Review of records of nonsynthetic crop treatments
- Review of records of water tests
- A visual check on adjacent land to look for any environmental risks
- Review of the previous risk assessments
- Review of water tests for a hydrovac if the firm uses one (a cooler is beyond the scope of LGMA but auditors will check just the water tests)
- Environmental audits (but not the day of harvest)

That part of the audit focusing on the harvest crew would cover:

- Worker practices
- Review of the SOPs and SSOPs and a check that harvesters are using them
- Review of cleaning/sanitizing of toilet/handwashing facilities
- Review of cleaning/sanitizing of tools and machinery.

¹⁷The survey did not ask for cartons separately for California and Arizona. The share of California and Arizona leafy greens production in 2012, 74 percent for California and 26 percent for Arizona, was used to separate volumes and estimate audit costs (USDA, NASS, 2013).

Other Third-Party Audit Standards

The number and types of external audit standards depend on the grower/shippers and their buyers. Some buyers may accept LGMA as a sufficient audit standard for leafy greens; other buyers may want a different third-party audit standard. The firms would probably also need a third-party audit to cover their other produce. Each of the firms in this study had an audit for at least one other third-party food safety standard, and all of them had Primus GFS audits that cover all commodities on a ranch (fig. 4).¹⁸ A firm using only the Primus GFS audit would have just one third-party audit standard but could have many third-party audits. An operation with more than one ranch would need to have separate ranch and harvest crew audits for each ranch.¹⁹ The 2012 list price for a Primus GFS ranch audit was \$810 per ranch and a harvest crew audit was \$290 per ranch (Garrison, 2014). Two firms also had GLOBALG.A.P. audits, which can be important for some export markets. The GLOBALG.A.P. audit has a flat fee for an entire operation, which can include multiple ranches. It also covers all parts of an operation together in one audit—ranches, harvest crews, coolers, packinghouses, warehouses, etc.

Generally, an audit is for one standard only. Primus GFS offers several addendums for particular buyers. In this case, there would be a substantial overlap between the Primus GFS audit and the addendum in terms of the questions asked. In one visit, the auditor records the common information and then asks the specific questions for the addendum for an additional fee. Five of the seven interviewed grower/shippers had at least one addendum to an audit.

Buyer Audits

Some retail or foodservice buyers conduct audits to their own standards. A buyer might send one of its food safety staff to assess practices; costs for these audits are often billed to the grower/shipper. Four of the seven grower/shippers had separate customer audits (fig. 4).

Audit Standards

The total number of different audit standards per grower/shipper averaged 4.6 (fig. 4). The cost of all field-level audits ranged from \$27,150 to \$305,430 per firm (table 3). After the 2006 foodborne illness outbreak linked to spinach, there were many reports of “audit fatigue” when buyers inundated grower/shippers with demands to comply with different audit standards (Paggi et al., 2008). In interviews, a few people mentioned that the number of audit standards required by buyers has since declined. This may be due to the Global Food Safety Initiative (GFSI), which published a document to serve as a benchmark for establishing the equivalency between GFSI guidance and various food safety audit standards. The expectation was that this process would reduce the demand for multiple audit standards and lower costs (box 4, “Global Food

¹⁸Hardesty and Kusunose found that 57% of their respondents in 2007 had other food safety audits beyond LGMA.

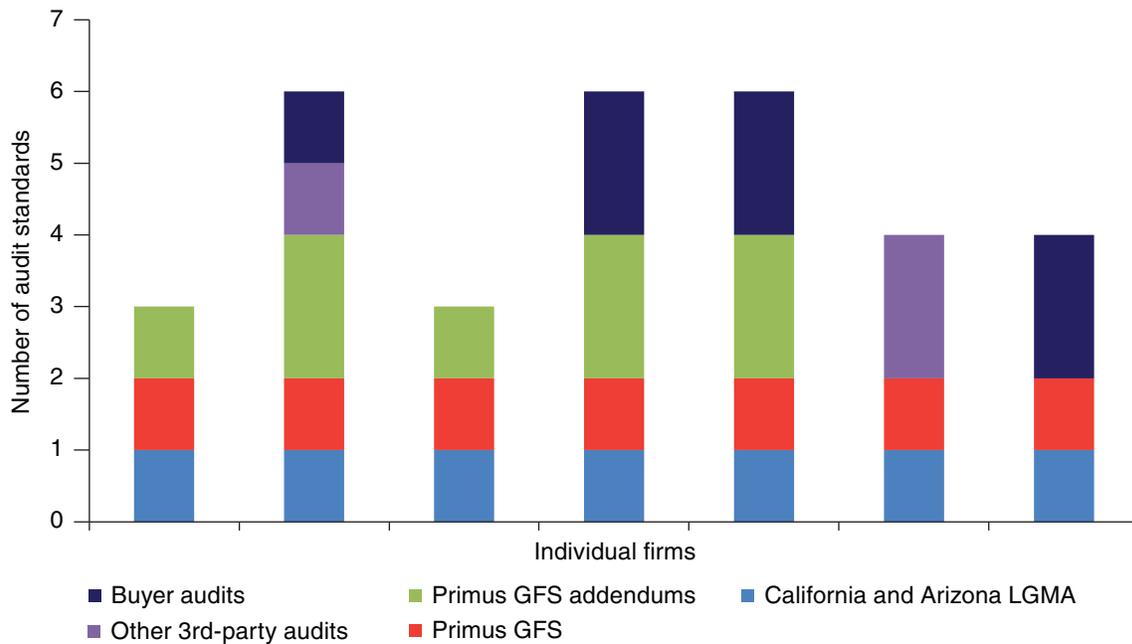
¹⁹Primus GFS ranch audits are a flat fee per ranch. Primus reports that most of the time in an audit is taken up with looking at records/documentation, and driving around a large or small ranch doesn’t make much difference to the overall length of an audit (Garrison, 2014). A firm with many smaller ranches, however, will pay more than one with fewer ranches, even if total acreage is equal. While Primus GFS is the most common audit standard for the interviewed firms, this is not universal across all areas and all commodities. For example, Safe Quality Food is a very common audit standard in the Washington apple industry. Use of the Safe Quality Food name does not constitute any type of USDA endorsement.

Safety Initiative (GFSI)”).²⁰ GFSI recognizes both Primus GFS and GLOBALG.A.P. as being consistent with their guidance.

Third-Party Audit Cost Share

Audits averaged 17 percent of the five costs we measured for six firms (fig. 2). Costs for members of LGMA are high since the grower/shippers are all paying for LGMA audits (and Arizona if included in the costs) as well as other audit standards. Audit costs reported by these six firms can be broken down with 11 percent attributed to LGMA and 6 percent to other audits. While the PR does not require third-party audits, firms will undoubtedly face pressure from buyers for third-party audits.

Figure 4
Number of food safety audit standards per firm¹



¹An audit standard is a particular set of food safety practices against which a firm is audited. Different audit standards may share many similarities.

Note: LGMA = Leafy Greens Marketing Agreement; Primus GFS = Primus Global Food Safety audit.

Source: USDA, Economic Research Service.

Box 4

Global Food Safety Initiative (GFSI)

The GFSI was launched in 2000 by the Consumer Goods Forum, a nongovernmental organization made up of consumer goods retailers and manufacturers. It started with a guidance document used to recognize or “benchmark” food safety standards that were equivalent to the GFSI guidance. GFSI does not certify or accredit food safety of any individual firm. Currently, GFSI recognizes several audit standards that are important in different parts of the U.S. produce industry: Primus Global Food Safety (Primus GFS), Safe Quality Food (SQF), British Retail Consortium (BRC), CanadaGap, and GLOBALG.A.P. In 2008, Wal-Mart was the first U.S. buyer to require audits from a GFSI-benchmarked audit standard for all produce purchases (Wal-Mart, 2008).

²⁰The use of the GFSI name does not constitute any type of USDA endorsement.

Raw Product Testing and Cost Share

Six of the seven firms reported doing some raw product testing in the field in response to customer demands, even though it is not required by LGMA except when contaminated water is used in the field. Testing typically covers several fields even if the produce from only one field will ultimately go to that buyer; the firm does not know which field will be best for the customer until the day of harvest. Four of the six firms tested only commodity leafy greens; two firms tested both commodity leafy greens and leafy greens going to bagged-salad processors. Raw product testing costs ranged from \$0 to \$90,000 per firm (table 3).

Several firms reported that they also did raw product testing for internal needs as well. A firm could use the tests as a check on their food safety program performance. A firm selling to a buyer who will do raw product testing at the destination might do a raw product test before the product is shipped to provide a comparison in case of any problems.

Raw product testing averaged 1 percent of the costs we could measure for three firms and nine practices (fig. 3).²¹ Although the PR does not require raw product testing, buyers may still demand it. While the history of foodborne illness outbreaks associated with leafy greens might make buyers particularly interested in raw product testing, researchers have reported raw product testing in other commodities as well (Adalja and Lichtenberg).

²¹Depending on the cost share in question, the discussion moves back and forth between figure 2, which shows five cost shares for six firms and figure 3, which shows nine cost shares for a subset of three firms.

Personnel Qualifications and Training

The LGMA requires at least one person in each firm to be responsible for food safety and requires training for anyone who has contact with leafy greens; the PR requirements are similar. All firms interviewed had more than one person in charge of food safety. Discussion in this section covers the main staff with food safety roles, external recordkeeping management services, and food safety training for harvest workers.

Grower/shippers say a successful food safety program requires a culture where everyone in the firm has a responsibility for food safety as part of their job description, even though a smaller group of people is responsible for most of the food safety activities. This section concentrates on two groups of workers: *the food safety and recordkeeping staff* involved in operating and documenting the food safety program and the *harvest foremen*. Sections below discuss specialized workers involved in the cleaning/sanitizing of the toilet/handwashing facilities and harvest tools/equipment. Other workers not considered here with smaller, but important, food safety roles include field and harvest workers.²² Higher level managers are not covered, although they may be critical to setting the general direction of the company food safety plans, participating in reviews of the plans, or responding to a foodborne illness outbreak traced to their firm.

The Food Safety and Recordkeeping Staff

The main task of the food safety staff in charge of field operations is to develop a food safety plan, enforce it, and provide documentation. A large number of reports come into the office: preseason and preharvest assessments, day-of-harvest assessments, self-audits, third-party audits, daily reports from the harvest crews, and water tests, among others. Staff members review and organize this information and provide it to auditors and buyers on request. Four firms had separate clerical staff to manage the voluminous recordkeeping, but for three others the food safety staff was also responsible for all documentation and recordkeeping. Merging the time and activities of food safety staff and clerical staff provided one category for analysis.

Table 4 shows the costs and allocation of food safety staff time. The number of food safety staff per firm in terms of full-time equivalents averaged 5.2.²³ None of the firms had food safety consultants for field operations. The annual costs per full-time equivalent staff (salaries and benefits) averaged \$77,666. Total food safety staff costs per firm ranged from \$179,375 to \$718,000. Several people commented that after 2006, leafy greens firms increased food safety staff but that over time the numbers declined as people became more experienced and some responsibilities were shifted to others, in particular to harvest foremen, who now play a major role in food safety.

²²Harvesters are in the field at a critical point when produce can become contaminated. Other workers in the field are crews for irrigating, planting, thinning, and weeding. These activities typically involve smaller crews of people and shorter periods in the fields, often earlier in the season, when the risk to the produce may be lower than during the harvest.

²³In some cases the food safety staff is a stand-alone department and in others it is merged with quality assurance; numbers here refer only to the food safety staff. Also, in some cases food safety people have other jobs in the firm and the number of staff just relates to their food safety time.

Table 4

**Food safety staff (including clerical staff working on food safety):
Numbers, salaries, and time allocations per task**

Item	Average	Minimum	Maximum
Total staff time in full-time equivalents (staff number)	5.2	2.5	9.5
Average staff cost per full-time equivalent (\$)	77,666	66,000	91,770
Total food safety staff salaries of full-time equivalents (\$)		179,375	718,000

Time allocation of food safety staff by task	Percent of time on each task		
Auditing (self-audits or complying with customer or third-party audits)	16	5	46
Preseason and preharvest environmental risk assessments	11	3	18
Microbial testing: water for all field and harvest uses	3	1	5
Microbial testing: raw product testing	3	0	6
Microbial testing: validating sanitation practices	2	0	10
Attending own training classes	3	0	5
Conducting training for others	7	1	13
Annual document writing, establishing operating procedures, updating the food safety plan	8	4	11
Monitoring and documentation	43	14	74
Research	2	0	7
Other	1	0	7

Note: Results are for six firms in the top and bottom sections of the table, but they are not the same six firms.
Source: USDA, Economic Research Service.

Monitoring and documenting is the most important task for the food safety staff, averaging 43 percent of their time.²⁴ Monitoring includes everyday trouble-shooting for problems in the fields. For example, if someone reports that pigs have been in the fields, a staff member investigates, documents the event, decides if there is a need for corrective action, and determines the impact on the ability to harvest the crop. The staff can investigate areas with known problems to keep on top of potential issues and spot-check documentation for water and sanitation facilities. The second largest component of time was for audits (self-audits, third-party audits, and buyer audits), which averaged 16 percent of staff time; at some parts of the year, the auditing task dominates the staff's time.

Other relatively time-consuming tasks include preseason and preharvest risk assessments, and annual document updates. The food safety plan could change from year to year, based on changes in the firm, audit standards, buyer demands, new science, or new technologies. The food safety staff writes manuals, standard operating procedures (SOPs), and sanitary standard operating procedures (SSOPs).²⁵ The staff could also design sampling plans for water tests, raw product tests, or equipment sanitation tests.

²⁴All the recordkeeping staff time was added to the monitoring and documentation time under the food safety staff. Even without the recordkeeping staff added into the food safety staff category, monitoring and documenting was still the biggest task in terms of time allocation, accounting for 31 percent of food safety staff time.

²⁵A SOP establishes practices for general operation procedures needed to produce safe food. A SSOP is specifically related to procedures for cleaning and sanitizing food contact surfaces.

Food safety staff spend an average of 3 percent of their time on their own training. Approximately 7 percent of staff time is spent training others. Some food safety staffs develop and do all their own training, while others teach harvest foremen or harvest managers to provide the training.²⁶

External Recordkeeping Management Services and Cost Share

The growth of supporting paperwork that buyers require from their shippers—not always in an easy format to transfer and read—has often been hard for the buyers to manage. This led to the development of independent external recordkeeping management services (external to the shippers and buyers) that provide a service to buyers by putting documentation from suppliers in a central, accessible, electronic location and facilitating the transfer of information. When used, both suppliers and buyers, pay for this service. Neither the LGMA nor the PR require external recordkeeping.

In 2012, there were two external recordkeeping management services operating in the produce industry; some buyers required that suppliers use a particular firm. Six of seven interviewed grower/shippers used an external recordkeeping management system because of customer demands. The annual cost per firm ranged from \$0 to \$8,868 (table 3). The cost share for external recordkeeping management was very small, less than 1 percent of the nine cost shares (fig. 3).

Harvest Foremen

Once the harvesting season starts, firms harvest leafy greens every day. In Salinas, California, the harvest lasts from April through November. A harvest foreman leads each harvest crew. Depending on size, a firm could have many harvest crews. Once, harvest foremen were mostly concerned with food quality, but now food safety is an important component of their responsibilities. The harvest foremen averaged 22 percent of their time on microbial food safety issues, and the cost of their time ranged from \$80,130 to \$1 million per firm (table 5).

Thirty-three percent of the foreman's *food safety* time is spent on monitoring and documenting the food safety plan to ensure it is carried out correctly. This includes, among other things, verification that workers are not ill and they are not wearing jewelry. Foremen are responsible for making sure toilet/handwashing facilities are available, appropriately serviced and supplied, and that the cleaning schedule is monitored. They have responsibilities with respect to the cleaning/sanitizing of tools and harvest equipment; in some cases, they do this themselves, and in other cases they only monitor and document the work that others do. Sections below discuss these two tasks (health and hygiene; and equipment, tools, buildings, and sanitation).

The foreman walks the field on the day of harvest to inspect for any problems—such as animal tracks or feces in the field—which accounts for 29 percent of the foreman's food safety time. Pre-operational equipment inspections, to ensure that equipment used in the harvest is properly maintained and not leaking any fluids that could contaminate the leafy greens, account for 10 percent of the foreman's food safety time. The foreman is also responsible for having workers'

²⁶Training time may have declined since 2007. At least one of the interviewed firms commented that training was a huge effort when LGMA first started and everyone had to develop a food safety mentality, but now food safety has become a way of doing business and workers are more familiar with their responsibilities. Even if the time spent in training has declined over time as the practices become routine, worker turnover and innovation in equipment and practices would limit the savings.

Table 5

Harvest foremen food safety time allocations

Item	Average	Minimum	Maximum
Average harvest foremen time spent on food safety (percent)	22	13	25
Total harvest foreman salary (\$)	47,150	40,000	67,500
Total cost of harvest foreman food safety time (\$)		80,130	1,012,500

Time allocation of harvest foremen by task	Percent of food safety time on each task		
Day of harvest inspection/risk assessment	29	8	59
Pre-operational equipment inspection	10	0	18
Monitoring and documentation (toilet/handwashing facilities, glove use, knife sanitation, machine cleaning/sanitizing, staff health)	33	13	80
Preparing knife sanitation operation	12	1	25
Cleaning and sanitizing harvest machinery and equipment	8	0	18
Conducting training for others	6	0	13
Attending own training classes	2	0	5

Note: Based on responses from seven firms.

Source: USDA, Economic Research Service.

tools and equipment available and sanitized and spends 12 percent of time caring for knives and 8 percent for other equipment (two firms did not have any foreman time assigned to cleaning/sanitizing equipment since other people were responsible for that work). Worker food safety training accounted for 6 percent of foremen's time. This may involve training at the beginning of the season, with periodic refresher presentations. Foremen also attend training, which averaged 2 percent of their food safety time.

Personnel Cost Share: Food Safety Staff, Recordkeeping Staff, and Harvest Foremen

All the firms interviewed had more than one person on their food safety staff (including record-keeping staff). The interviewed firms are, however, large companies, selling nationally and internationally, and operating under a very strict food safety program that requires strong oversight. Other large produce operations complying with the PR may also have more than one person in charge of food safety. The food safety staff and the foremen's time dedicated to food safety accounted for 70 percent of the reported costs in figure 2: 38 percent for the food safety staff and 32 percent for the foremen.²⁷ To our knowledge, no one else has included foreman time dedicated to food safety in food safety costs. Firms with a hand-harvested crop and complying with the PR might anticipate a similar share of costs associated with labor to manage the field-level food safety program.

²⁷These cost shares may seem large compared to other studies since this case study counted all the food safety staff time under personnel. For practices such as water testing, we asked for just lab costs since we had labor costs involved in testing already accounted for in the food safety staff costs. In some studies, water testing includes both lab costs and labor costs (for example, Adalja and Lichtenberg, U.S. FDA (2013)). It was relatively easy for firms to answer questions about total food safety staff, but this strategy limits comparability with other studies. Asking about total staff time also meant that we included time spent on all of their activities, not just the time for their activities we anticipated when developing the survey.

Hardesty and Kusunose found that the cost of food safety staff was large, second only to cartons lost due to animal activity.²⁸ In preliminary results, Sullins found that time spent on food safety practices accounted for 44 percent of average food safety costs and discussed labor (both managers and nonmanagers) as the “hidden or unanticipated” cost for food safety. The firms Sullins interviewed were relatively small, with over half having less than 10 acres.

Worker Food Safety Training Cost Share

Most California leafy greens are hand-harvested, requiring a large labor force that must receive training. Total worker training costs ranged from \$19,900 to \$71,398 per firm (table 3). Worker training accounted for 3 percent of the nine food safety costs measured for the smaller sample of three firms (fig. 3). The cost of time workers spent in training (instead of in the fields) was the largest share of total training costs. The costs of providing materials and services for the firms’ own training classes—such as notebooks, flipcharts, and translation—were relatively small. The value of the time the food safety staff and foremen spend training workers is included in the food safety staff and foreman categories and not in the training category. Hardesty and Kusunose reported that personnel training costs were also fairly small—the smallest of the six costs they measured. The relative importance of these costs for other produce firms under the PR would depend, in part, on whether the crops are hand or mechanically harvested.

²⁸Some of their food safety staff costs were included in other cost categories such as time spent monitoring fields, documenting operating procedures, and training personnel.

Health and Hygiene

The main focus of LGMA rules on health and hygiene is to keep ill workers out of the field, require workers to maintain hygiene standards, and prevent visitors from contaminating the produce. The PR requirements are similar. The LGMA requires protective clothing such as gloves for some uses, but not all; the PR does not require gloves, but if a firm uses them, they must be in an intact and sanitary condition.

Protective Clothing and Cost Share

The LGMA requires rubber gloves, aprons, and sleeves for workers harvesting leafy greens destined for a bagged-salad processor but not for workers harvesting commodity leafy greens. Aprons and sleeves for harvesting are bulky and workers do not generally use them if not required, but glove use is widespread for workers harvesting commodity leafy greens. The LGMA does not require hair-nets, but many people use them anyway since many bagged-salad processors require them.

Firms reported gloves to be the biggest cost in protective clothing because many workers use gloves and change them often. Some buyers require nitrile gloves that are more expensive. For the interviewed firms, protective clothing ranged from \$12,000 to \$52,000 per firm (table 3) and accounted for 3 percent of the nine measured cost shares (fig. 3). When gloves are used, we assume that their replacement frequency would be similar under the LGMA and the PR. The PR cost shares for protective clothing with crops that are hand harvested might be similar to the cost share under the LGMA.

Agricultural Water

The LGMA requires that firms test water used in the fields at the start of the growing season if it has not been tested in the preceding 60 days. Thereafter, growers must test water applied to fields once a month unless the firm qualifies for an exemption. If a firm is using municipal or well water and the tests are acceptable for five consecutive samples, the firm can apply for an exemption that allows testing every 6 months instead of every month.²⁹

In addition, the LGMA sets an acceptable water standard for all water used in production: a maximum *average* level of generic *Escherichia coli* (*E. coli*) in the water samples based on a rolling mean of five samples, as well as a maximum for any *single* sample (table 6).³⁰ The maximum allowed for any single sample varies depending on the risk associated with the application method; it is lower for water that touches the leafy greens than for water that does not. LGMA also sets a standard of no detectable generic *E. coli* for post-harvest water—that is, water or ice applied directly to the produce or food contact surfaces, including water used for rehydration, washing, cooling, toilet/handwashing facilities, and drinking.

The PR only requires testing for water used in the field if the water is applied directly to the produce (instead of indirectly). When testing is required for water used in the field for production, both food safety approaches apply the same standard for the average acceptable level of generic *E. coli*, but the PR allows a higher maximum level for any single sample. The PR also provides mitigation strategies for growers whose water cannot meet the standards. For example, one strategy is for a grower to wait for a specific time interval between the last irrigation and harvest to allow potentially dangerous contaminants to die off. The LGMA and the PR have the same standards for post-harvest water; but the PR generally does not require as many water tests.

LGMA firms cannot use water if test results exceed the acceptable level of generic *E. coli*, and they must take remedial actions. Two of the seven interviewed grower/shippers reported that they had water that was out of compliance in 2012. Both added chemicals to their wells and retested the water; one of these firms reported that the cost of chemicals to bring the well up to compliance was about \$100. These costs are included in the water-testing costs.

In 2012, the average number of water tests for the surveyed grower/shippers was 1,324 per firm. The number of tests depends on the number of ranches, number of water sources on each ranch, and the frequency of testing. While the LGMA only requires water testing for water used on leafy greens, firms said that it was more convenient to use the LGMA water standard on all their produce ranches than have different rules on different parts of their operations. In addition, buyers wanted the firms to use LGMA food safety practices on all their produce.

All seven grower/shippers *qualified* for the LGMA exemption. Two firms took the exemption for all their production, two took it for some fields, and three did not take it. For those who did not take the exemption, their buyers may have required monthly testing; some bagged-salad processors require monthly testing, and most grower/shippers sold some of their production to these processors. Firms

²⁹Municipal water already meets EPA standards for drinking water, which is no detectable generic *Escherichia coli* (*E. coli*). Once the water in a well is tested and found consistent, it is relatively unlikely to change over time compared to surface water, which is exposed to the elements and potential contamination (U.S. FDA, 2015).

³⁰Specifically, the maximum average of generic *E. coli* in water is 126 most probable number per 100/mL.

Table 6

Comparison of the Produce Rule (PR) and the Leafy Greens Marketing Agreement (LGMA) annual water testing requirements

Water use	PR standard			LGMA standard		
	<i>E. coli</i> in water Most probable number (MPN) per 100 mL		Annual testing frequency ¹	<i>E. coli</i> in water MPN/100 mL		Annual testing frequency ²
	Geometric mean of sample ³	Statistical threshold (STV) of sample ⁴		Geometric mean of sample	Max per single sample	
Production water directly applied to produce	≤126	≤410	A minimum of 1 sample if untreated ground water. A minimum of 5 samples if untreated surface water	≤126	≤235	Monthly
Production water not directly applied to produce	No water testing required			≤126	≤576	Monthly
Post-harvest water	No detectable <i>E. coli</i> for untreated ground water. Untreated surface water not allowed.		Once	No detectable <i>E. coli</i>		Monthly

¹For the PR, growers must develop a microbial water quality profile of each water source used on their operation. For untreated surface water a minimum of 20 samples must be taken, as close as practicable to harvest time, over a minimum time of 2 years, not to exceed 4 years. For untreated ground water, a minimum of 4 samples must be taken during the growing season or over a period of 1 year.

²Sample before the first use of the season if it has been more than 60 days since the last sample.

³A geometric mean of a sample is the nth root of the product of n individual samples. This is a measure of the average of the sample.

⁴The STV reflects the amount of variability of the samples.

Sources: California Leafy Green Products Handler Marketing Agreement; Standards for Growing, Harvesting, Packing, and Holding of Produce for Human Consumption.

with fewer sales to bagged-salad processors may do fewer water tests than the firms interviewed in this case study.³¹ Many firms think it is more efficient to test every month and avoid the possibility of missing a critical test.

Water test costs ranged from \$7,000 to \$85,000 per firm. Costs per test averaged \$29.26 and ranged from \$10.45 to \$50.72. All grower/shippers used an outside firm to analyze the water, and the variation in costs could be due to differences in how these firms conducted the tests. A member of the food safety staff can develop the water-sampling plan, go out and take a water sample, and then deliver or send the sample off to the lab for analysis. Alternatively, a firm can rely on the lab to do all these tasks. Some buyers may request that the lab take the sample rather than the grower/shipper. This broad range of costs is consistent with Tootelian's survey.³²

³¹Hardesty and Kusunose found that while firms with less than \$1 million in revenue sold 8 percent of their leafy greens to bagged-salad processors, those with more than \$1 million sold 30 percent to that market channel.

³²Tootelian found that in 2007, 19 percent of handlers paid less than \$25 per water test, 41 percent paid \$25-\$50, 21 percent paid \$51-\$100, and 19 percent paid \$101-\$500. In its "Preliminary Analysis of Impacts," FDA used certain assumptions to estimate that a water test would cost \$87.30. Our numbers for water testing are lower than the FDA estimates, but ours do not include the costs of food safety staff who might be overseeing the sampling process or taking the water samples (U.S. FDA, 2013).

Water Testing Cost Share

Water testing for field activities represents the smallest share of the costs presented in figure 2, with only 2 percent of the five costs. Similarly, Hardesty and Kusunose found water testing to be the second smallest cost they measured for California leafy greens operations. Lichtenberg and Tselepidakis, reporting on many smaller operations, found that water testing accounted for a 1-percent share of their costs (9th of 13 costs). FDA estimated that water-testing costs were about 5 percent of total costs of the PR, but this includes testing for water used in packinghouses and elsewhere beyond the fields (U.S. FDA, 2015a).³³ Since the PR does not require all water to be tested and generally requires fewer water tests than the LGMA, water cost shares for field activities under the PR could be less than under the LGMA. Firms, however, may face buyer demands for additional water testing for field activities.

³³Using FDA's five water costs for sampling/testing and treatment of \$26.7 million (Federal Register, 2015a, table 20) divided by \$530.17 million (Federal Register, 2015a, table 2) which is total annual food safety costs (minus sprout costs and learning costs) yields a cost share of 5 percent.

Biological Soil Amendments

Both the LGMA and the PR have rules for acceptable biological soil amendments (BSAs) and application methods. This case study did not include the cost of BSAs for the LGMA. See box 5, “Biological Soil Amendments (BSAs) under LGMA and the PR,” for details.

Box 5

Biological Soil Amendments (BSAs) under the LGMA and the PR

The LGMA only allows BSAs of animal origin that meet the U.S. Environmental Protection Agency (EPA) standard for compost (U.S. EPA, 1994). Raw manure is not allowed. The LGMA requires a minimum interval of 45 days between application of compost and harvest. In addition to meeting the EPA standard, the compost must be tested for fecal coliforms, *E. coli* O157:H7, and *Salmonella*.

Under the PR, BSAs that do not meet the EPA standard for compost, such as raw manure or aged manure, can be used when the BSA does not contact produce during application. If a BSA minimizes potential for contact during and after application, compost must meet the EPA compost standard and be tested for fecal coliforms and *Salmonella*. In cases where growers cannot minimize the potential for contact during application, such as for root vegetables, the PR allows only compost that meets the EPA standard with testing to show there is no evidence of *E. coli* O157:H7, *Salmonella*, or *Listeria monocytogenes*. Many root crops are typically eaten cooked and would not be covered commodities under the PR. The LGMA does not require testing for *L. monocytogenes*, a contaminant that has not been a problem for leafy greens producers in the past.

We did not measure the costs of extra regulation for compost under the LGMA. In informational discussions for developing the survey questions, it seemed that compost use was not that common in this industry. Some buyers do not allow the use of BSAs for leafy greens. The growth of organic acreage in recent years has, however, increased the demand for compost. If a firm did purchase compost, we thought the additional costs of LGMA compliance over standard compost would be small. California has the strictest regulations in the country for compost and requires testing for fecal coliforms and *Salmonella*; LGMA only required the addition of the test for *E. coli* O157:H7 to make standard California compost LGMA-compliant. One compost producer reported that the price of compost to meet the California standard and the LGMA standard were similar. The LGMA and the PR both have rules for how BSAs must be handled, whether they are purchased or produced on the farm. Industry experts reported that if a big leafy greens operation wanted to use compost, it was unlikely to make its own because of the volume required. In that case, the cost of rules regarding compost operations on farms would not be relevant to the case study firms.

Domestic and Wild Animals

The LGMA has rules about the size of required buffer zones between leafy greens and adjacent risk factors such as animal grazing and concentrated animal feeding operations. Distance from a risk factor as well as topography (whether the risk is up hill or downhill from leafy greens) are potential considerations in the size of a buffer zone. The PR does not require any buffer zones around fields if there is an adjacent risk factor; however, growers might decide to use them for their own risk management or buyers might require that growers use them. It was not possible to calculate a cost share for buffer zones.³⁴

LGMA requires monitoring fields for evidence of animal intrusion and not harvesting product from such an area—a 5-foot radius around feces and a 3-foot radius around other evidence of animal intrusion. The PR also requires monitoring for animal intrusion to make a determination about whether the affected crop can be safely harvested but does not define a specific area that can not be harvested. Produce growers under the PR might not have as high costs of lost product as do LGMA members if they view setting aside less area as acceptable. Firms we interviewed found it difficult to provide costs specifically for monitoring for animal intrusion, and we did not include this cost. Hardesty and Kusunose found monitoring costs to be the third smallest cost they measured. In this case study, it was possible to measure the cost of lost product.

Buffer Zones

During the early days of the LGMA, growers were under tremendous pressure to adopt practices, including creating buffer zones, intended to promote food safety that also had potential for unintended environmental damage. Many growers used bare-ground buffers, although the LGMA did not require that practice. Beretti and Stuart (2008) found that 32 percent of leafy greens growers in 2007 removed noncrop vegetation around fields in response to comments from auditors or others. Bare-ground buffers, however, could have an adverse impact on water quality. Forty-one percent of growers removed wildlife habitat to reduce animal intrusion risk. The size of buffer zones was also a controversial issue. After the 2006 outbreak linked to spinach, some buyers demanded much wider buffers than the LGMA required (Paggi, 2008). Although some buyers still want buffers that exceed LGMA guidelines, some firms reported that it is less common than before.

Of the surveyed firms, three of six had buffers that met but did not exceed LGMA guidelines.³⁵ The other three firms did not have buffers since they did not have adjacent risk factors. For example, some firms had roads all around their ranches and/or were far away from waterways that could attract animals. This is consistent with other research that found from 54 to 67 percent of California leafy greens firms did not lose production land to buffer zones in 2007 (Tootelian; Hardesty and Kusunose). Over time, growers have found ways to minimize taking leafy greens land out of production for buffer zones, including renting land from adjacent livestock operations to form a buffer. With experience, growers know which fields are particularly vulnerable to environmental risk factors and can sometimes plant alternative crops in those fields.

³⁴The main cost of buffer zones is probably the opportunity cost of the land taken out of production, and this was difficult to calculate since it would depend on the land values in all the ranches with buffers; we did not press firms for this information. Other costs related to buffers are probably small and incurred by different groups in the operation (someone to spray the buffer with herbicide, plow under any unwanted vegetation, put out traps for animals, etc.).

³⁵The survey did not ask whether buffers were bare ground or had some type of vegetation.

Lost Product and Cost Share

All but one of seven firms said they lost product in 2012 due to concerns over microbial contamination in the field. Lost production averaged 28 acres per firm, with an average preharvest value of \$3,186 per acre; losses ranged from \$0 to \$304,000 per firm (table 3). The preharvest value of lost product accounted for 11 percent of the five food safety costs in figure 3, the fourth largest reported cost. Hardesty and Kusunose found that the value of cartons lost due to animal activity was the highest annual cost in 2007, higher even than the costs of food safety specialists. Two factors may have influenced this result. The firms that Hardesty and Kusunose interviewed had, on average, just 1.45 full-time equivalent food safety staff, well below the average of 5.2 in this study. Those authors also used the harvested value of romaine lettuce to calculate the losses, while we used the preharvest value of the commodities reported by the grower/shippers. Lost product due to animal intrusion will depend, in part, on the animal pressure around individual operations and may vary from year to year.

Growing, Harvesting, Packing, and Holding Activities

The LGMA requires that firms protect harvested product from foreseeable hazards. This includes practices such as preventing cut produce surfaces from contacting soil and using packaging that supports sanitation standards, specifically, that is cleanable or designed for single use. The PR has similar requirements. We did not measure any of these costs—the interviewed LGMA firms all used single-use packaging for commodity leafy greens, a practice in place before the LGMA.

Equipment, Tools, Buildings, and Sanitation

The LGMA requires cleaning, and when appropriate sanitizing, of the equipment and tools used in the field. The PR is very similar but in addition covers equipment and tools used anywhere in the farm operation. Both the LGMA and the PR regulate provision of toilet/handwashing facilities in the fields. Among the surveyed firms, the costs of these two practices appear to be quite large, but we could not estimate costs consistently across firms to calculate cost shares.

Tool and Equipment Cleaning/Sanitation

Under the LGMA, the harvest knives—the main harvest tool—are sanitized several times during the day. Knives are most often dipped in buckets of chlorine solution, and the costs of supplies (chlorine, test strips, buckets, and brushes) are not large and we did not have enough consistent data to calculate a cost share. Someone must check the chlorine and pH of the solution (which affects the efficacy of the chlorine) throughout the day to ensure the sanitizing power is still adequate. Most of the labor cost of cleaning/sanitizing knives is accounted for in the foreman time, but in some cases other specialized workers may do part of this task.

The LGMA requires cleaning all harvest equipment and cleaning/sanitizing food contact surfaces. Firms generally develop the same cleaning/sanitizing SSOPs for all crops and do daily cleaning/sanitizing of the whole piece of equipment, not just food contact surfaces (Villaneva, 2014). Only one firm hired a service to clean and sanitize harvest equipment at the end of each day, while six had their own specialized food safety support staff to do these tasks. Foremen also have a role in monitoring the cleaning/sanitation tasks or even doing some of the work themselves. Foremen time allocated to this task averaged 8 percent of their total food safety time (table 4). Here we look at the specialized workers, not the foremen, involved in post-harvest equipment cleaning/sanitizing.

For the six firms that did their own equipment cleaning/sanitizing, the most important annual cost was for the specialized internal staff that carried out these tasks, which ranged from \$21,000 to \$250,000 per firm (table 3). There were not enough consistent data across the firms to calculate a cost share. Other annual recurring costs included chemicals and brushes to scrub equipment such as conveyor belts and machinery, protective clothing, test materials (such as swabs for environmental testing to ensure the cleaning/sanitizing process was adequate), and lab costs.

Tool and equipment cleaning/sanitation costs will vary by firm depending on commodity and harvest method. Typically, harvesting equipment for leafy greens destined for bagged-salad processing firms would have more food contact surfaces than equipment for commodity leafy greens (see box 6, “Harvesting Technology and Machine Cleaning/Sanitizing”). Under the PR, costs will also depend on the harvest technology for each commodity.

Providing and Cleaning/Sanitizing the Toilet/Handwashing Facilities

The Occupational Safety and Health Administration (OSHA) mandated the provision of toilet/handwashing facilities before the LGMA. OSHA rules are national and require bathrooms for firms with more than 10 employees so all the firms in the case study would have already been covered by these rules. Even so, Hardesty and Kusunose reported that 57 percent of their respondents made new investments in toilet/handwashing facilities in 2007. The investment would be consistent with firms improving food safety to meet both buyer demands and those of the LGMA (Ollinger and Moore, 2009).

Harvesting Technology and Machine Cleaning/Sanitizing

Tools and machines used for the harvest vary somewhat by commodity and commodity use, which affects the cleaning/sanitizing program. Workers hand harvest most commodity leafy greens that are going directly to consumers. For iceberg and romaine, workers involved in harvesting and packing typically use a harvest platform that moves slowly through the fields. The workers cut and trim using a knife and then place the leafy greens on a table-like structure on the back end of the harvest platform. Other workers, on the platform, wrap and pack the leafy greens in boxes that are stacked and put on pallets on another part of the platform. The table-like structure on the platform is the last food contact surface.

Leafy greens that are going to a bagged-salad processing plant are treated differently. Workers hand cut the leafy greens, use a device on the harvest machinery to core them, and then place them on the conveyor belt of the harvesting machine to be lightly rinsed with chlorinated water to minimize the risk of cross-contamination. The leafy greens are finally deposited in bulk bins to transport to the processing plant. This harvest machinery has more food contact surfaces than the machinery for packing commodity leafy greens and requires more cleaning/sanitizing.

Leafy greens field operations have two kinds of toilet/handwashing facilities, harvest toilets and ranch toilets; this case study focuses on harvest toilets.³⁶ Each harvest crew has its own toilet/handwashing facility that follows the crew as it works. Someone must clean these facilities and dispose of the waste once a day. The harvest foreman or other staff monitor the facilities to ensure they are properly stocked, clean, and sanitary.

Six firms provided information on toilet/handwashing facilities. Three firms hired facilities with cleaning/disposal services (including documentation required by LGMA); the other three firms owned these facilities and they provided some of the cleaning/disposal services and hired some. One local supply firm, that rents toilet/handwashing facilities and offers cleaning/disposal services, provided an example of costs: \$2,880 per toilet per year for rent, cleaning, and disposal of waste. Cleaning/disposal is the largest part of the cost—approximately 70 to 84 percent of the daily cost, depending on the number of toilets in each unit. Several firms mentioned additional costs when hiring toilet/handwashing facilities, such as purchasing additional toilet paper and damage repair.

For the firms that hired everything related to toilet/handwashing facilities, costs ranged from \$45,451 to \$130,367 per firm (table 3). For those who owned their facilities we did not have enough information to provide a cost range. It was not possible to calculate cost shares for either group. Under the PR, the contribution of harvest toilet/handwashing facility costs to overall costs of food safety practices may be similar to LGMA costs if a grower also has a hand-harvested crop with many workers in the field.

³⁶Ranch toilets are more or less permanent at each ranch and firms clean them less frequently than harvest toilets. Crews that come in periodically to weed, cultivate, irrigate, etc. use these facilities.

Cost Shares for Equipment, Tools, and Sanitation

It was not possible to calculate cost shares for these practices, but partial information implies these costs could be large. If we take all available costs associated with the nine practices listed in figure 3 for all seven growers and add the available costs for cleaning/sanitizing machines and operating toilet/handwashing facilities, the partial cost share for these two practices is 15 percent.³⁷ The FDA estimated the costs under the PR for cleaning machinery and providing toilets/handwashing facilities at 10 percent of the total costs of compliance with FSMA (Federal Register, 2015a).³⁸ FDA attributed another 7 percent of costs to cleaning/sanitizing tools; we counted the labor to do this in the harvest foremen costs.

³⁷Cleaning/sanitizing costs include the time of specialized staff and supplies. The costs of providing toilet/handwashing facilities includes rental, cleaning/disposal services, cleaning and paper supplies, specialized cleaning staff, and repairs.

³⁸Dividing FDA's cost of cleaning machines and providing toilet/handwashing facilities of \$51.1 million (Federal Register, 2015a, table 24) by \$530.17 million, the total annual cost (minus sprout and learning costs) (Federal Register, 2015a, table 2), yields a cost share of 10 percent.

Conclusions

This case study looks at seven grower/shippers in California who all belonged to the LGMA food safety program in 2012. The LGMA provides a minimum standard for food safety practices for leafy greens, an industry linked to foodborne illness outbreaks, to reduce risk of microbial contamination. Since the LGMA began in 2007, firms have had time to adapt and design strategies to minimize the cost of these food safety practices while still complying with required practices. For example, the industry has shifted some responsibilities from the food safety staff to foremen with lower wages. Similarly, firms have had time to decide whether they need more risk reduction than the LGMA provides and incorporate that into their food safety plans. All the grower/shippers in this case study went beyond the required LGMA practices for their own convenience, risk-management needs, and/or to meet buyer demands. For example, some firms provided more water testing than the LGMA required due to the demands of bagged-salad processors.

This project provided many challenges with respect to asking firms about food safety practices and costs, with practices much easier to understand than costs. With a case study based on seven firms, costs share results must be interpreted with some caution. The case study approach, however, provides rich insight into why leafy greens grower/shippers used certain practices. For example, even though the LGMA does not require raw product testing (unless water applied to the fields does not meet LGMA standards), most firms used it, not just because buyers required it but for their own risk management needs. The importance of keeping the food safety program as simple as possible was a theme in the interviews; firms preferred to use LGMA standards on all their production rather than have different practices for different crops.

For a group of six firms, five field-level costs per firm were available for each, and shares for the costs were fairly consistent across the firms. Labor used to operate a food safety program represented the largest share of total costs we could measure—on average, 38 percent for the food safety staff and 32 percent for the food safety time of harvest foremen. The importance of labor dedicated to food safety confirms findings from several other researchers. The PR, like the LGMA, requires only one person to be in charge of food safety for each firm, but firms under the LGMA had more; large operations under the PR may also have more. The information on the role of foremen is new to the literature.

In addition to the two labor cost shares, the other costs measured for six firms were audits (17 percent), lost product due to animal intrusion (11 percent), and water testing (2 percent). For three of the grower/shippers, we could estimate average cost shares for four other practices: harvest worker training (3 percent), glove use (3 percent), raw product testing (1 percent), and external recordkeeping management systems (less than 1 percent). In addition, two other kinds of costs are probably quite large, but we did not have enough consistent information across firms to develop cost shares for them: costs for the specialized support staff engaged in cleaning/sanitizing tools and harvest machinery and the supplies they used; and costs for providing toilet/handwashing facilities with cleaning/sanitizing and emptying services. Being able to include these would have changed the cost shares reported here, but not their relative ranking.

Field costs under the PR are likely to be lower than the same types of costs under the LGMA because the PR generally requires fewer practices. Since the LGMA does not cover practices beyond the field, we did not ask about any of those practices, although the case study firms would have had food safety costs at that level, too. The PR covers practices in the field and beyond.

The subjects in this case study are large firms selling nationally and internationally and may appear to be different from many firms who will come under the PR. The cost shares presented here for different food safety practices can provide some insight into the relative costs for other firms. There is, however, some evidence in the literature that there are economies of scale in the provision of food safety for produce firms. Therefore, the structure of costs presented here is likely more typical of larger firms.

Food safety practices and costs also depend on other characteristics of the industry. Commodities like leafy greens, which are mostly hand harvested, will have more costs related to harvest foremen, food safety training, toilets/handwashing facilities, glove use, and tool cleaning/sanitizing than operations with commodities that are mechanically harvested. Firms with packinghouse operations would have additional costs over commodity leafy greens that are field packed. Market channels also matter. LGMA members are selling to bagged-salad processors who are very demanding in terms of food safety. For commodities where fresh-cut products like bagged salads are not an important market channel, firms may face fewer demands from their buyers for food safety practices exceeding the PR requirements.

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Appendix A-Survey Instrument

Survey on Costs of Food Safety Programs in the Leafy Greens Industry

Our study concerns the practices and costs of microbial food safety for California grower/shippers participating in the LGMA who grow leafy greens for processing or for the fresh market.

Production: Most questions ask about food safety practices and costs for your *own* leafy greens (defined as the commodities covered by the LGMA) production on all your ranches in California and Arizona (CA/AZ). This excludes your production outside of CA/AZ. It also excludes production, anywhere, of other growers for whom you market. We are asking about your own production only because you have complete knowledge about those food safety practices and costs.

Type of food safety: We are interested in practices and costs related to *microbial food safety*. Please exclude practices or costs related to quality assurance/control or pesticide-related food safety except to the extent that the costs also are incurred in controlling microbial food safety in the field. In some cases it is too difficult to separate out costs for activities carried out for both food safety and food quality purposes (such as stainless steel knives). The survey focuses on the costs of practices specifically related to food safety, not food quality. Not all parts of the LGMA are covered in this survey either; specifically, we exclude costs of soil amendments and nonsynthetic crop treatments.

Food safety staff/worker expenditures: We ask about costs for people with direct roles in producing safe food or documenting the activities: this could include your own professional food safety staff, supervisory staff with some food safety responsibilities, and workers with specific food safety responsibilities. We expect that a large portion of food safety activities will be performed by your own staff/workers, what we call *internal costs*. We also ask about *external costs*, costs related to utilization of outside consultants and other services.

Type of costs: We ask primarily about annual recurring costs. At the end of the survey we ask about investments you have made in previous years to achieve your current level of food safety.

Production and harvesting activities only: We are looking only at costs of food safety from the beginning of production through harvesting when the LGMA commodities leave the field either as packed product or in bins for processing.

Time period: Please report practices and costs for calendar year 2012. However, for production in the southern desert areas please report for the November 2011 through October 2012 crop year.

Filling out the form: Please fill out all the questions to the best of your ability. Should you have questions, please feel free to call us. We plan to review the responses with you and can address any additional questions you have. Grey areas are not to be filled in.

Thank you for your help!

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Date of interview:

Name of Firm:

Person(s) Interviewed:

Background questions: Leafy greens production

1. Your own production by regions, 2012

- California
- Arizona
- Florida
- Mexico
- Other, please specify _____
- Other, please specify _____

2. Production of leafy greens volumes, 2012

	<i>Own production</i>		<i>Outside production from ranches that you market for or use in processing</i>
	<i>CA/AZ</i>	<i>Outside CA/AZ</i>	
Leafy greens: physical acres	B1		
Leafy greens: crop acres	B2		
Leafy greens: 24 count carton equivalents			
Cored Iceberg Lettuce			
Uncored Iceberg Lettuce			
Romaine			
Romaine Hearts			
Butter			
Green			
Red			
Spinach			
Spring Mix, Baby Leaf			
Cabbage (red, green, savoy)			
Arugula			
Endive			
Escarole			
Kale & Chard			
Total leafy greens production volume	B3		

Leafy greens marketing—for questions 3 and 4 consider total sales (in terms of \$) of your own leafy greens production plus any production you market for others *from any region*.

3. Distribution of your total leafy greens sales to all buyers, 2012

Distribution by type of product and buyer:	\$
Commodity (fresh market sales)	
Directly to retail	
Directly to food service	
Directly to wholesale	
Sold to other shipper	
Fresh-cut processing sales	
Your own processing : Directly to retail	
Your own processing: Directly to food service	
Your own processing: Directly to wholesale	
Grown for another processor	
Total leafy greens sales to all buyers	
Distribution by ownership (for total leafy greens sales):	
Sales of own production	
Sales for other growers you market for	
Total leafy greens sales by all types of ownership	

4. What were your firm's total fresh produce sales in 2012? (\$) _____

General leafy greens food safety questions (applies to your own production in CA/AZ)

5. Do you use LGMA standards on any other of your fresh fruit and vegetable production besides leafy greens? Yes No

6. Did you use external food safety standards other than the CA or AZ LGMA on any of your own leafy greens production in CA/AZ in 2012? Yes No

a. If no, go to question 7.

b. If yes, how many different external food safety standards other than the CA or AZ LGMA do you audit for on your own leafy greens production in CA/AZ? _____

c. If yes, which other standards to you audit for? (please list):

d. If yes, do you apply these other standards to all of your own leafy greens production?
 All Some

7. Have you changed any cultural practices (such as timing of operations or irrigation management) for food safety reasons since 2006?

Yes No

If yes, please explain:

8. Have you changed your leafy green production mix in response to food safety reasons since 2006?

Yes No

If yes, please explain:

Your staff and workers implementing the food safety plan in the field

The following five questions (Questions 9-13) ask about annual salary/wage costs and time allocations across tasks for all your employees with food safety responsibilities in the field. First we ask about all the salary/wage costs for your employees working on food safety for your entire operation (your own ranches and growers you market for) and then ask about the share of those costs related just to microbial food issues for your own LGMA production in CA/AZ.

9. Clerical staff working on food safety documentation: salaries and time allocations for microbial food safety activities, 2012. Here we assume that all staff are similar and the only task is documenting food safety activities.

	Clerical staff working on food safety documentation
Number of your full-time equivalent employees (entire operation)	
Sum of annual salaries + benefits (A)	
% of time related to microbial food safety documentation for your own leafy greens production in CA/AZ (B)	
Total staff costs devoted to documentation of microbial food safety of your own leafy greens production in CA/AZ (AxB)	G1

10. Dedicated food safety staff: salaries and time allocations for microbial food safety activities, 2012. If all staff has similar time allocations, put all information under the column for Group 1. But if time allocations vary among individual staff or groups of staff, use a column for each distinct group. If you have more than 3 groups, copy this table and use that for additional groups.

	Group 1	Group 2	Group 3
Type of food safety staff			
Number of your full-time equivalent employees of this type (entire operation)			
Sum of annual salaries + benefits (A)			
% of time related to microbial food safety for your own leafy greens production in CA/AZ (B)			
Total staff costs devoted to microbial food safety of your own leafy greens production in CA/AZ (AxB)	G2		
Activities related to microbial food safety of your own leafy greens production in CA/AZ	% of time spent on food safety activities (Each column from here to the bottom of the table should sum to 100%)		
Auditing (self-audits or complying with customer or third-party audits)	G2a		
Preseason and preharvest environmental risk assessment	G2b		
Microbial testing: water for all field and harvest uses	G2c		
Microbial testing: raw product testing	G2d		
Microbial testing: validating sanitation practices (swabs on machines, etc.)	G2e		
Attending own training classes	G2f		
Conducting training for others	G2g		
Annual document writing, establishing SOPs, updating the food safety plan	G2h		
Monitoring and documentation	G2i		
Research	G2j		
Other (please specify):			
Other (please specify):			
Total	100%	100%	100%

11. Harvest foremen: salaries and time allocations for microbial food safety, 2012. If all staff has similar time allocations, put all information under the column for Group 1. But if time allocations vary among individual staff or groups of staff, use a column for each distinct group. If you have more than 3 groups, copy this table and use that for additional groups.

	Group 1	Group 2	Group 3
Type of staff			
Number of your full-time equivalent employees of this type (entire operation)			
Sum of annual salaries + benefits (A)			
% of time related to microbial food safety for your own leafy greens production in CA/AZ (B)			
Total staff costs devoted to microbial food safety of your own leafy greens production in CA/AZ (AxB)	G3		
Activities related to microbial food safety of your own leafy greens production in CA/AZ	% of time spent on food safety activities (Each column from here to the bottom of the table should sum to 100%)		
Day of harvest inspection/risk assessment	G3a		
Preoperational equipment inspection	G3b		
Monitoring and documentation (toilet and hand washing facilities, glove use, knife sanitation, machine cleaning and sanitizing, staff health)	G3c		
Preparing knife sanitation operation	G3d		
Cleaning and sanitizing harvest machinery and equipment	G3e		
Conducting training for others	G3f		
Attending own training classes	G3g		
Other (please specify):			
Other (please specify):			
Total	100%	100%	100%

12. Workers with some specific food safety responsibilities (toilet/washroom cleaning crews, machine cleaning/sanitizing crews, etc.): salaries and time allocations for microbial food safety activities, 2012. If all workers have similar time allocations, put all information under the column for Group 1. But if time allocations vary among individual staff or groups of staff, use a column for each distinct group. If you have more than 3 groups, copy this table and use that for the additional groups.

	Group 1	Group 2	Group 3
Type of staff or workers			
Number of your full-time equivalent employees of this type (entire operation)			
Sum of annual salaries + benefits (A)			
% of time related to microbial food safety for your own leafy greens production in CA/AZ (B)			
Total staff costs devoted to microbial food safety of your own leafy greens production in CA/AZ (AxB)	G4		
Activities related to microbial food safety of your own leafy greens production in CA/AZ	% of time spent on food safety activities (Each column from here to the bottom of the table should sum to 100%)		
Cleaning toilet and hand washing facilities	G4a		
Checking sanitizers in knife buckets	G4b		
Cleaning and sanitizing machinery and equipment	G4c		
Preparing, monitoring and documenting traps and bait stations	G4d		
Attending training classes	G4e		
Other (please specify):			
Other (please specify):			
Total	100%	100%	100%

13. Other staff with some specific food safety responsibilities: salaries and time allocations for microbial food safety activities, 2012. You may not have any other staff/workers with food safety responsibilities who have not already been discussed (in Questions 9-12); if so leave this table blank. If all workers have similar time allocations, put all information under the column for Group 1. But if time allocations vary among individual staff or groups of staff, use a column for each distinct group. If you have more than 3 groups, copy this table and use that for the additional groups.

	Group 1	Group 2	Group 3
Type of other staff or workers			
Number of your full-time equivalent employees of this type (entire operation)			
Sum of annual salaries + benefits (A)			
% of time related to microbial food safety for your own leafy greens production in CA/AZ (B)			
Total staff costs devoted to microbial food safety of your own leafy greens production in CA/AZ (AxB)			
Activities related to microbial food safety of your own leafy greens production in CA/AZ:	% of time spent on food safety activities (Each column from here to the bottom of the table should sum to 100%)		
Activity 1 (please specify):			
Other activity (please specify):			
Other activity (please specify):			
Other activity (please specify):			
Total	100%	100%	100%

For Questions 14-32, we are only asking about microbial food safety activities for your own CA/AZ leafy greens production

14. Miscellaneous costs for the food safety staff on own CA/AZ production, 2012

	(\$)
Costs for hiring any external food safety consultants (include people making changes to the food safety plan)	G5
Costs of hiring any external food safety recordkeeping service	G6
Internal costs for travel and per diem with respect to CA/AZ food safety excluding training	G7

Training costs

15. Food safety training costs for all your CA/AZ staff and workers excluding salary, 2012

Internal training costs besides staff salaries such as training materials (notebooks, videos etc.) and any travel costs associated with training (\$)	Costs of hiring an external firm to conduct training for your staff and workers (\$)
G8	G9

16. Work time lost due to food safety training for your workers with no specific food safety responsibilities on your own CA/AZ production, 2012 (if easier, just give total costs)

Please provide the value of the time of your workers (not a hired crew that someone else trains on their own time) spend in training instead of working. This can be either in-house training or external training provided by an outside firm. Do not include any workers already considered in questions 9-13.

Type of Worker	Hours in training per Year (A)	Average wage/hour (B)	Total cost of time in training (AxB)
Harvest workers			
Other field workers			
Other (specify type):			
Total			G10

Audits

17. Number of audits on field operations and costs on your own CA/AZ production, 2012

	Self audits by your internal food safety staff		External third party (3PA) audits			
	Total number of self audits	Costs other than staff time (\$)	Total number of external audits			Costs for audits (\$)
			CA LGMA	AZ LGMA	Other 3PA	
Ranch audits						
Harvest crew audits						
Other (please specify):						
Other (please specify):						
Total number of audits						
Total cost of audits		G11				G12

Raw product testing on your own LGMA commodities in CA/AZ, 2012

18. Did you do any raw product testing, at the field level, for microbial food safety issues in 2012?

Yes No (If no, skip to Question 20)

If yes, was it due to the LGMA requirement to test raw product if it has been potentially contaminated from flooding?

Yes No

If yes, was any raw product testing done for another reason that was not a LGMA requirement?

Yes No

In this case, if yes what type of leafy greens did you test?

Commodity leafy greens? Yes No

Leafy greens going to processing? Yes No

If yes, do you have your own internal lab for microbial food safety testing?

Yes No

If yes, what are the total internal costs (beyond staff time included in salary) for any raw product testing? \$ _____ G13

19. Did you incur any external costs of hiring a firm to do raw product testing?

Yes No

If yes, what were the external costs of hiring a firm to do raw product testing? \$
 _____ G14

Environmental Assessments and Mitigation Activities

Please indicate the annual cost of environmental assessments and mitigation practices, by type of cost listed in the table below: we will ask about water testing separately. Here we want just annual recurring costs of environmental assessments and mitigation practices on your own CA/AZ production. At the end of the interview we will ask about investments that last more than one year such as fences or changes in wells for food safety concerns. Exclude any costs associated with day-of-harvest environmental assessments.

20. Annual costs of environmental assessments and mitigation practices, 2012 for CA/AZ

	Mitigation efforts in 2012	
	Acres	Costs (\$)
Land for creating buffer zones on your own land (acres of land out of production)		
Additional land rented for creating buffer zones		
Materials for trapping animals (traps, bait, etc.)		
Additional costs for your environmental assessments by your own food safety staff (besides salary) (please specify):		E1
Additional costs (besides the cost of the audit) for environmental assessments by external firms		E2
Others (please specify):		
Total costs		E3

21. If you have land in buffer zones, are they larger than the buffers required by LGMA?

Yes No

22. In 2012 how many planted crop acres did you leave unharvested out of concern of potential contamination (including potential water problems, feces, tracks, etc.) or after positive raw product testing? _____

Value of this lost production in 2012? E4 _____

Please indicate how you estimated the value of the lost production: _____

Water

23. Total number of water tests for your own operations in CA/AZ, 2012

Type of water test	Number of tests per year for all field and harvest uses
Generic <i>E. coli</i>	
<i>E. coli</i> O157:H7	
EHEC/STEC	
<i>Salmonella</i>	
<i>Listeria</i>	
Other (please specify):	
Total	

24. Total costs for water tests for your own operations in CA/AZ, 2012

Types of costs	Cost (\$)
Internal water testing costs such as sampling or testing materials (exclude food safety staff time)	
External costs (fees to outside labs)	
Total costs	^{W1}

25. Do you do generic *E. coli* testing more frequently than required by LGMA?

Yes No

26. If you use municipal or well water, do you qualify for the LGMA exemption to the requirement to test water (for preharvest foliar applications) for generic *E. coli* every month during production?

Yes No (If no, go to question 27)

If yes, have you taken advantage of that exemption and reduced the frequency of your generic *E. coli* water tests? Yes No

27. During 2012, was any water ever tested out of compliance with CA or AZ LGMA metrics?

Yes No (If no, go to question 28)

If yes, what were the total costs of response? This could include any disinfectants applied to a water source. Do not include costs for any un-harvested land, additional water tests, raw product testing or food safety staff costs which are already accounted for above.

\$ _____ W2

Harvest Food Safety Activities

28. How many of your own crop acres of leafy greens in CA/AZ did you harvest yourself in 2012? _____ acres

Worker practices (for your own CA/AZ production only)

29. Cost of providing toilet and hand washing facilities services, 2012.

Do you hire out the whole operation? Yes No

If yes what is the total cost of these services? \$ _____ H1a

If no, please provide more detailed information below:

	Costs (\$)
<i>Contracted services</i> for cleaning and emptying facilities	
<i>Contracted services</i> for monitoring and documenting toilet and hand washing facilities cleaning, hand washing practices etc.	
Cleaning supplies and paper supplies	
Rental costs of toilet and hand washing facilities	
Other internal costs besides food safety salaries	
Other (please specify):	
Total cost	H1b

If you own your own toilet and hand washing facilities, how many toilet/hand washing units do you provide for the field operations? _____

Harvest worker practices (for your own CA/AZ production only)

30. Costs of harvest worker food safety practices, 2012

	(\$)
Materials (gloves, hairnets, aprons, etc.)	
Sanitation of harvest equipment such as knives (chemicals for cleaning, chlorine for water, materials for testing such as ph strips)	
Contracted services to monitor and document food safety program	
Other internal costs besides food safety salaries	
Other (please specify):	
Total cost	H2

**Field sanitation for machines and other harvest activities
(for your own CA/AZ production only)**

31. Costs of food safety programs to reduce contamination of machines and other harvest materials in the field, 2012

	(\$)
Rental cost of any cleaning equipment	
<i>Contracted</i> services to clean and sanitize machines and other harvest materials, monitor and document food safety program	
Chemicals, brushes, etc.	
Other internal costs besides salaries (test materials, etc.)	
Other (please specify):	
Total costs	H3

Investments to Improve Food Safety

What kind of investments have you made over time to get your operation up to its current food safety standards? We are interested in investments of more than one year duration and their general maintenance and repair costs.

32. Investments in the past to improve food safety (for CA/AZ production only)

	Cost of Investment		Type of investment (describe)	Was the investment due to microbial food safety objectives (Yes/Partially/No)	Estimated annual maintenance and repair costs (\$)
	1998 to 9/14/2006 (\$)	9/15/2006 through 2012 (\$)			
Development of first food safety program or major revisions beyond minor annual updates					
Equipment for food safety staff—trucks, computers, etc.					
Upgrades of documentation systems—new computers					
Upgrades of documentation systems—accounting systems specifically for food safety					
Investments to improve microbial quality of water (repair wells, drill new wells, pipes)					¹¹
Investments to reduce flooding					¹²
Vegetation removal					¹³
Fences					¹⁴
Moving telephone or other poles					¹⁵
Harvest machinery					
Equipment for sanitizing and cleaning harvest machinery					¹⁶
Toilet and hand washing facilities					¹⁷
Other (please specify):					
Other (please specify):					
Other (please specify):					

Summary Cost Page (for internal use)

Microbial food safety costs for own leafy greens CA/AZ production, 2012

	Costs
General food safety staff services	$G2*(G2f+G2h+G2j)+G3*G3g+G5+G7$
Monitoring and documentation	$G1+G2*G2i+G3*G3c+G6$
Conducting food safety training	$G2*G2g+G3*G3f+G8+G9$
Worker time lost in training	$G4*G4e+ G10$
Audits	$G2*G2a+G11+G12$
Raw product testing	$G2*G2d+G13+G14$
Environmental assessments	
Assessments (not including day of harvest assessments)	$G2*G2b+ E1+E2$
Remedial actions	$E3-E1-E2+G4*G4d+I1+I2+I3+I4+I5$
Lost production due to potential contamination due to animal intrusion etc., and positive raw product testing	E4
Water	
Water testing	$G2*G2c+W1$
Remedial actions if water quality is out of compliance	W2
Harvest practices	
Day of harvest risk/environmental assessments	$G3*G3a$
Sanitation practices	$G4*G4a+H1a+H1b+I7$
Harvest worker practices	$G3*G3d+G4*G4b+H2$
Field sanitation	$G2*G2e+G3*(G3b+G3e)+G4*G4c+H3+I6$
Total costs	TC

Total CA/AZ own production food safety costs per acre: TC/B1

Total CA/AZ own production food safety costs per crop acre: TC/B2

Total CA/AZ own production food safety costs per carton: TC/B3