THESIS

FARM FOOD SAFETY PLANS: CUSTOMIZING EDUCATIONAL MATERIALS FOR SMALL-SCALE AND CAMPUS-BASED FARMS

Submitted by

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ABSTRACT

FARM FOOD SAFETY PLANS: CUSTOMIZING EDUCATIONAL MATERIALS

FOR SMALL-SCALE AND CAMPUS-BASED FARMS

A comprehensive farm food safety plan is an integral part of all growing operations, regardless of size, output, or production practice. As small-scale and campus-based, student-run farms grow in popularity, there is an increasing need to establish the concept of comprehensive produce safety practices as a vital part of the farming process. Moreover, the passing of the Food Safety Modernization Act (FSMA) in 2011 addresses mandated accountability for large-scale agriculture within the Produce Safety Rule, but leaves many small farms exempt from regulation, including the types of farms targeted within this study.

A need for a curriculum addressing produce safety on campus farms and small-scale operations, and lack of literature surrounding food safety training curriculum development drove the research design for this project. The components of this study were three fold: 1) university and college campus farm managers (n=12) from 14 states were surveyed on current practices; 2) classroom and on-farm presentations were developed and delivered to Colorado State University horticulture students (n=54), and a pre-and post- questionnaire was delivered to assess learning objectives; and 3) three on-line modules and a 27-page farm plan template were developed for Colorado growers, detailed during a webinar for Colorado Fruit and Vegetable Growers Association (CFVGA) members (participants n=33). Results offered positive

a relationship between resource delivery and food safety knowledge for both students and growers.

The pre-and post-questionnaire responses showed change ($p \leq 0.05$), including Likert scale questions stating that farm workers ($p=0.001$) and volunteers ($p<0.0005$) should receive food safety training. Post-webinar polling questions revealed that 100% ($n=21$) of voluntary respondents learned something new during the webinar, which focused on utilization of resources to build and modify farm food safety plans for any growing operation. With the national movement toward a prevention-focused food safety strategy, the need for implementing better produce safety practices has been identified as a top priority. Review and feedback from this study will aid in the continued development of materials for both campus and small-scale growers to expand their food safety practices.

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CHAPTER I: INTRODUCTION

As interest in local food systems continues to be on the rise, communities will be supporting an ever-growing number of both existing farms and aspiring horticulture professionals. This provides an opportunity for educators to work with farmers on developing best practices, including broad spectrum food safety. There is a need to instill food safety knowledge early on in agricultural programs to establish these practices as a natural and integral part of managing a successful growing operation.

In recent years, there has been a wide-reaching impact of foodborne illness outbreaks involving produce (CDC, 2006-2016), and finally prevention-based legislation passed in order to reduce that impact. The Food Safety Modernization Act (FSMA), passed in 2011, included the Produce Safety Rule that progressed in the establishment of mandated regulations for farms to analyze hazards and reduce risk of pathogen introduction into the production cycle of fresh produce (FDA, 2017a). Although this ruling will keep large farms accountable for their practices, many smaller growing operations and most campus farms are not only exempt from the regulated standards, but also often lack the necessary staff or resource pool to be able to implement food safety as easily.

This is not the only factor these two groups have in common. Small farms and campus-based, student-run growing programs often utilize similar marketing and selling strategies, including heavy reliance on direct-to-consumer sales, such as farmers' markets and offering Community Supported Agriculture (CSA) shares. As such, both types of farms can benefit greatly from comparable produce safety resources, and are targeted for this study.

An extensive review of literature included past and current research on food systems, food safety, campus farms, and relevant curriculum development studies, and revealed limitations regarding food safety education for small growers and campus farms. There is a need for research dedicated to creating and implementing effective and efficient training programs for these populations, which steered this thesis proposal. The focus of this thesis can be divided into three distinct parts: 19 university and college campus farm managers from 14 states were recruited, and participants (n=12) were surveyed on current practices related to food safety; a classroom presentation and experiential harvest best practices demonstration were developed and delivered to Colorado State University horticulture students (n=54), with a pre-and post- questionnaire administered to assess learning objectives; and resources including a 27-page farm plan template and three narrated online modules outlining the development of a farm food safety plan were designed for Colorado growers, and detailed during a webinar for Colorado Fruit and Vegetable Growers Association (CFVGA) members (n=33). Specifically, there was a heavy focus on aiding the creation of a farm food safety plan, as they have been reported to be a beneficial practice for all scales of production (PSA, 2017a).

The overall purpose of this study was to assess food safety curriculum, training, and resource needs, analyze learning outcomes, and deliver materials to targeted audiences. Moving forward, we hope to publish this study to foster a more complete and broad literary body of work focused on farm food safety for small growers and campus farms. By growing the platform of literature, we are actively working toward bringing the importance of integrative food safety practices to the forefront of horticulture and agriculture.

CHAPTER II: REVIEW OF LITERATURE

Food and Health

Food Systems

Food systems describe an entire network of industries and processes that bring food to people, and include production, consumption, and waste. These systems establish the way people access the food they eat, and exist on a spectrum from personal (backyard gardens) to global (imports and exports) (Chase and Grubinger, 2014). One definition of a food system is "an interconnected web of activities, resources and people that extends across all domains involved in providing human nourishment and sustaining health, including production, processing, packaging, distribution, marketing, consumption and disposal of food" (Grubinger et al., 2010). As recently as the 20th century, food systems were hyper-local and seasonal, but major shifts such as the Green Revolution and consolidation of farms changed the scope of agriculture and led to the globalization of the American food system.

The Green Revolution began in the 1940's, and spiked the development of new crop varieties and agricultural practices that significantly increased yields for major commodity crops such as wheat, corn, and soybeans (Bedell, 2013). A shift toward commodity farming led to larger but fewer farms with less biodiversity across most of the acreage (MacDonald et al., 2013). In 2007, corn, hay, soybeans, and wheat accounted for 83% of harvested acres or farmland, and 2.6 percent of farms in America account for 59% of national agricultural sales, (MacDonald et al., 2013 and Grubinger et al., 2010).

The globalization of food systems facilitated access to produce from anywhere in the world, no matter what the season. The list of imported foods increasingly expanded, and in grocery stores during any month, consumers could purchase bananas, tomatoes, and coffee beans (Chase and Grubinger, 2014). Seasonality became less significant.

These changes affected our relationship with food. The 1950's brought an increase in processed and ready-to-eat foods and food additives, including the introduction of high fructose corn syrup and a wider selection of frozen foods (Kim, 2013). Households with vegetable gardens declined from 49% to 33% just between 1975 and 1987 (Caplow, 1994). In the last 10 years, the U.S. imported between 15-20 billion dollars of produce annually, equating to 50 percent of fresh fruits and 20 percent of fresh vegetables (Hamburg, 2011). Almost two-thirds of annual produce volume is imported between December and May, when U.S. production is low (ERS, 2016). These drastic changes contributed to the current situation, with many people not knowing where their food originates or understanding how it is grown. However, the United States is experiencing a resurgence in interest in local food systems, growing vegetable gardens, and understanding how food is produced. This segment of our culture, although still the minority in production outputs compared to large industrial systems, is allowing for the growth of small farms and increased access to freshly harvested produce (USDA, 2017a).

Small, local food culture is slowly growing. According to a 2013 study by the National Gardening Association, 42 million households were growing their own food or participating in community gardens – a 17% increase from 2008, just 5 years prior (Sinnes, 2014). The United States Department of Agriculture (USDA) reports that the number of farmers' markets in the

U.S. has increased 494% in the last 20 years, from 1755 markets in 1994 to 8669 markets in 2016. Of those, 155 markets exist in Colorado (USDA, 2016b).

Access to Fresh Produce

Having local growers involved in direct-to consumer and direct-to-retail sales allows the communities around them to become more connected with their food, and enables access to fresh produce. When consumers have the ability to speak directly with growers, it gives them a platform to ask about growing practices and offer feedback, and strengthens the relationship between producer and consumer. Research suggests that residents living in close proximity to farmers' markets have higher consumption rates of fresh fruits and vegetables. A recent study of North Carolina farmers' markets showed 60% of attendees self-reporting an increase in overall produce consumption and 49% reporting an expansion in the variety of fruits and vegetables consumed when they began shopping at a local market (Pitts et al., 2017).

Families participating in food assistance programs may also have greater opportunities to take advantage of locally grown produce through farmers' markets. There are currently three USDA funded food assistance programs that are accepted by farmers' markets in the U.S.: the Supplemental Nutrition Assistance Program (SNAP), the Senior Farmers' Market Nutrition Program (SFMNP), and the WIC Farmers' Market Nutrition Program (FMNP). These programs allow families to use Electronic Benefit Transfer (EBT) cards at farmers' markets to purchase fruits and vegetables (CFTM, 2017). Additionally, many markets in Colorado have enlisted in the Double Up Colorado program, which provides a voucher for up to $20 to match purchases of fresh produce for food assistance program participants (DUC, 2017).

However, an increase in the number of farmers' markets or community gardens in the U.S. does not necessarily imply equal access to healthy, fresh produce for all (USDA, 2016b). Many communities, particularly in low-income and rural areas, are still lacking consistent access to fresh fruits and vegetables from local markets or grocery stores. Researchers have shown that 8% of all residents in rural counties, 35% of whom are low income, live more than 10 miles from the closest grocery store, and that 30 million Americans do not have a grocer within a mile of their home (Bell et al., 2013). Many residents in these communities must either drive long distances to gain access to fresh produce, or they must rely on convenience stores to shop, where heavily processed food with low nutrient content tends to dominate the shelves. This disconnect has been shown to be a part of the overall lifestyle equation that may lead to obesity and diet-related diseases such as cardiovascular disease and diabetes (ERS, 2009).

The concepts of expanding equal access to fresh produce and the need for the growth of local food supplies are intertwined. As we see the continued rise in small farms selling direct to consumer and an increase in interest of home vegetable production, it is possible that a larger number of underserved communities can boost their fresh produce access and consumption. This suggests room for growth in those particular sectors of the American food system.

Produce Safety

Foodborne Illness

One critical component of a healthy food supply is safety. Food safety is an area of concern in America. According to the most recent comprehensive estimates by the Centers for Disease Control and Prevention (CDC), foodborne illness affects 1 in 6 Americans each year, resulting in 48 million cases of illness, 128,000 hospitalizations, and 3,000 deaths (Scallan et al.,

2011). Foodborne illness results from consumption of contaminated food. Contamination can be attributed to a number of different types of human pathogens including bacteria, viruses, parasites, or toxins (CDC, 2015).

Changes in American culture and demographics have put the population at an increased risk for illness. The food supply chain has become progressively centralized, globalized, and concentrated. Food products travel longer distances, are collectively transported and stored with commodities from multiple farms, and are more widely available year-round (Chan, 2014). The amount of both minimally and highly processed foods have increased. Minimally processed foods retain their natural state, but have been washed, bagged, or cut and combined with other minimally processed foods. This could include bagged spinach or baby carrots. Highly processed foods cannot be recognized as their original forms and often include added sugar, fat, or preservatives. Examples of highly processed foods include potato chips, crackers containing vegetable products, and fruit sodas (Wolfram, 2016). Additionally, the number of highly susceptible populations continue to grow, including the elderly and very young (Table 1) (Vincent, 2010). Over the next 30 years, the baby boomer generation will continue to age and the population of adults over the age of 65 will more than double, increasing the risk for widespread foodborne illness dramatically (USCB, 2008).

A foodborne illness outbreak is defined by the CDC as “the occurrence of two or more similar illnesses resulting from ingestion of a common food” (CDC, 2013). Identification of foodborne illness outbreaks are improving, partly due to more effective detection methods and increased surveillance overall.

Table 1: Projections of the population by age in the United States: 2010 to 2050 (in thousands) (Vincent, 2010).

Age	2010	2015	2020	2025	2030	2035	2040	2045	2050
Total Pop.	310,233	325,540	341,387	357,452	373,504	389,531	405,655	422,059	439,010
>5 years	21,100	22,076	22,846	23,484	24,161	25,056	26,117	27,171	28,148
<65 years	40,229	46,837	54,805	63,908	72,094	77,543	81,239	84,457	88,548
Median Age	36.9	37.1	37.7	38.2	38.7	39.0	38.9	38.9	39.0

Detection of an outbreak often begins with local and state health agencies, which receive reports of illness from primary health care providers, individual people, or laboratories. State agencies report outbreaks to the CDC, which also helps in large and multi-state outbreak investigations. The CDC collaborates with the U. S. Food and Drug Administration (FDA) and the USDA's Food Safety and Inspection Service (FSIS) to investigate contamination sources, announce recalls, and prevent future illness (FDA, 2015).

Detection, surveillance, and reporting strategies have improved, leading to increased tracking of foodborne pathogens. Established networks with online platforms allow for quick and global information sharing. These platforms include the National Outbreak Reporting System, Foodborne Disease Active Reporting Network, and the Food Disease Outbreak Surveillance System (CDC, 2016). Whole Genomic Sequencing has been utilized by the FDA since 2008 for surveillance of foodborne pathogens, and is becoming more routine as a means of identifying closely related strains (Wang et al., 2016). PulseNet, a national laboratory network, utilizes DNA fingerprinting to detect outbreaks sooner than formerly possible (CDC, 2016).

Produce Related Outbreaks

With the USDA recommending that adult men and women consume between two and three cups of fruits and vegetables every day, the importance of having fresh produce that is free of human pathogens is clear (USDA, 2016a). Yet, fresh and minimally processed fruits and vegetables are increasingly implicated in foodborne illness outbreaks. Between 1973 and 2012, leafy greens alone were linked to 606 outbreaks, resulting in 19 deaths (Herman, 2015).

Fresh produce is at a high risk for contamination, as many factors from farm to fork lead to increased susceptibility to human pathogens. Many fruits and vegetables grow close to or in direct contact with soil, which naturally harbors pathogenic bacteria (Jeffrey and van der Putten, 2011). Hand-picking is often used for harvest for produce, as few varietals of fruits and vegetables lend well to mechanization (Huffman, 2012). Hand harvesting increases the likelihood of contamination through human pathogen transfer, such as Hepatitis A virus, and improper handling leading to bruising or skin punctures on the crop. When fruit and vegetable skin is compromised, risk for contamination increases (Garcia and Barrett, 2002). Additionally, the complex and intricate surface area of some crops, such as leafy greens and cantaloupe, make thorough cleaning difficult. Finally, fresh produce is often consumed raw, eliminating heat-treating as a pathogen "kill step" (Starobin and Foong-Cunningham, 2017).

In recent years, fresh produce has been linked to 46% of all domestically acquired foodborne illnesses associated with outbreaks and 23% of deaths associated with outbreaks in the United States (Painter, 2013). Common pathogens include *Escherichia coli* O157:H7, *Salmonella* species, *Listeria monocytogenes*, Cyclospora, Hepatitis A, and norovirus (Starobin and Foong-Cunningham, 2017). These fresh produce commodities have included leafy greens

(Herman, 2015), cantaloupes, cucumbers, and sprouts. Specific examples of implicated foods and the associated pathogen for outbreaks between 2006 and 2016 are shown in Table 2 (CDC, 2006-2016). Of those commodities mentioned, tomatoes, spinach, lettuce, cucumbers and cantaloupes are grown commercially in Colorado (CDA, 2015).

Table 2: Examples of foodborne illness outbreaks, United States, 2006-2016 (CDC, 2006-2016)

Implicated Produce	**Pathogen**	**Year**	**# Cases**
Tomatoes	*Salmonella* Typhimurium	2006	183
Fresh Spinach	*Escherichia coli* O157:H7	2006	199
Cantaloupes	*Salmonella* Litchfield	2008	51
Alfalfa Sprouts	*Salmonella* Saintpaul	2009	234
Romaine Lettuce	*Escherichia coli* O145	2010	26
Cantaloupes	*Listeria monocytogenes*	2011	147
Spinach and Spring Mix	*Escherichia coli* O157:H7	2012	33
Raw Clover Sprouts	*Escherichia coli* O26	2012	29
Cucumbers	*Salmonella* Saintpaul	2013	84
Mixed Fresh Produce	*Cyclospora*	2013	631
Cilantro	*Cyclospora*	2014	304
Frozen Strawberries	Hepatitis A	2016	143
Packaged Salads	*Listeria monocytogenes*	2016	19

Public Health and Economic Impact

To reduce the prevalence of foodborne illness outbreaks and their negative economic impacts, there is an immediate need to provide guidance and transfer knowledge on food safety practices to all contributors along the supply chain (Ivey, 2012). Foodborne illness outbreaks impose a $14 billion financial burden on the United States each year (Hoffman et al., 2012). This burden is placed not only on the healthcare system, but on producers as well. A study of 511 jury trials relating to foodborne illness between 1979 and 2014 revealed that plaintiffs received an average pay-out of $276,148 (Pollard et al., 2016).

Ninety-five percent of illnesses, hospitalizations, and deaths from foodborne pathogens resulted from just 15 pathogens, and 84% of the economic burden from those pathogens are from death (Hoffman, 2015). To compute impact, the USDA's Center for Food Safety and Applied Nutrition and Food Safety and Inspection Service employs an enhanced cost-of-illness economic model which accounts for patient pain and suffering. This model, compared to basic models, more thoroughly estimates the economic burden of foodborne illness. Both models include costs associated with hospital stays, physician care, pharmaceuticals, and loss of productivity, but the enhanced model also includes a quality of life measurement (Scharff, 2012). The cost of an illness takes into account the severity, frequency, and health impact caused to a patient and population. Foodborne pathogens such as Norovirus cause more illnesses each year, but have a lower death rate than *Listeria monocytogenes* and, therefore, may carry a lower economic burden (Hoffman, 2015).

A commonly used example for the impact of a foodborne illness outbreaks is the case of a 2011 multi-state outbreak of *Listeria monocytogenes* from cantaloupes grown in Colorado.

The cantaloupes originated from Jensen Farms in Granada, southeastern Colorado. The final report by the CDC cited a total of 147 cases, 33 deaths, and 1 miscarriage in 28 states from the distribution of cantaloupes infected with *Listeria monocytogenes* (CDC, 2012). The financial impacts were far reaching. The farmers were criminally charged, and Jensen Farms was forced to file Chapter 11 bankruptcy and pay $150,000 in restitution to victims (Food Safety News, 2015). National sales for cantaloupes dropped over 33% after the outbreak gained national attention (Bottemiller, 2011). Overall, the law firm that represented the families of the outbreak victims reported the medical expenses to be in total of at least $12,000,000 (Marler Clark, 2012).

Voluntary and Mandated Food Safety Implementation

Background

The importance of regulating the safety of food is not a novel concept. The 1800's brought the importance of food safety to public and political attention, with figures such as Peter Collier and Dr. Harvey Wiley conducting multiple studies on food adulteration (FDA, 2014). The Jungle, written in 1905 by Upton Sinclair, infamously shined a light on the shockingly unsanitary practices being carried out in meat-packing plants at the time (Sinclair, 1905). Sinclair's book directly led to the passage of the Meat Inspection Act in 1906 (FDA, 2014). Although new legislation continued to be passed regarding regulation of almost every other food source, it was not until a century later that this precedent was applied to produce safety.

GAPs

Good Agricultural Practices (GAPs) is a voluntary audit and certification program developed in 2002 by the USDA. The GAPs program verifies conformance and adherence to USDA's *Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables*, published originally in 1998 (USDA, 2017b). The aim in the development of GAPs was to minimize fresh produce contamination by setting standardized, research-based recommendations for several high-risk areas of production, including, agricultural water, soil amendments, worker health and hygiene, wild and domestic animal management, post-harvest best practices, traceability, and most recently, food defense (USDA, 2014b).

Participation in the program recommends that farmers create a food safety plan, documenting worker training, test results, and best practices for all aspects of operation. Once a food safety plan is developed and implemented, the USDA suggests that a farm conduct a self-audit prior to scheduling an official audit, allowing for revision and improvement of procedures. An initial audit is scheduled with a third-party auditor. Auditors are either federal or state department of agriculture employees with no financial interest in the products or operation being auditing. If a farm fails an initial audit, an unannounced follow-up audit is performed to ensure improvement of areas that did not initially meet requirements (USDA, 2011).

Although voluntary, GAP certification can be crucial to the success of a farm's market viability in several areas. Growers have reported that buyer expectations and requirements are a primary incentive for obtaining certification (Marine, 2015). Supermarkets and other private retailers often implement their own food safety requirements, calling for suppliers (producers)

to be GAP compliant before they will contract services. This could include third party certification and/or an active farm food safety plan (Tobin et al., 2013). Compliance with GAP has worldwide implications as well. The implementation of GAP pre-harvest best practices is recommended by the Codex Alimentarius Commission, Food and Agriculture Organization, and World Organization for Animal Health (Young et al., 2011).

Food Safety Modernization Act (FSMA)

The coverage of high profile outbreaks involving fresh produce contributed to the need for a major food safety overhaul (Abbott, 2011). On January 4, 2011, President Barack Obama signed the Food Safety Modernization Act (FMSA) into law. With oversight by the FDA, the new law changed the focus of regulatory agencies from a reactionary to a preventative approach to food safety (FDA, 2017). In contrast to voluntary GAPs auditing and certification, FSMA is a federal regulation, and non-exempt farms must comply.

There are seven rules which are the foundational backbone of FSMA – Produce Safety, Preventative Controls for Human Food, Preventative Controls for Animal Food, Foreign Supply Verification Programs, 3rd Party Accreditation of Auditors, Mitigation Strategies to Protect Food Against Intentional Adulteration, and Sanitary Transportation of Human and Animal Food. These cover minimum guidelines for human and animal foods and produce, as well as transportation, prevention of adulteration, third party certification and foreign suppliers. The rules were proposed between 2013 and 2014, followed by a period of public review and comment. Following revision, rules became final in 2015 and 2016 (FDA, 2016a). One of the biggest changes to industry brought on by the passing of FSMA is the ability of the FDA to

institute mandatory recalls, a change for growers and manufactures who previously recalled food on a voluntary basis (FDA, 2017b).

Produce Safety Rule

The Produce Safety Rule, one of the seven pillars of FSMA, was proposed in 2013 and finalized in 2015 (Table 3). The final rule establishes minimum, research-driven standards for producers to ensure the safe growth, harvest, storage and delivery of fresh produce intended for human consumption. The key requirements to the final rule include specific measures based on scientific evidence, including management of agricultural water quality and testing, advisement on raw manure application, domesticated and wild animal management, and worker health and hygiene (FDA, 2017a). The FDA estimates that 332,000 foodborne illnesses annually will be prevented through grower compliance with the Produce Safety Rule (FDA, 2016a).

Table 3: Condensed Timeline of the FSMA Produce Safety Rule (PSA, 2017b).

Date	**Action**
January 2011	FSMA signed into law by President Obama.
January 2013	The proposed Produce Safety Rule was released by FDA and open to comments by the public.
September 2014	A supplemental document is added to the Proposed Rule based on feedback from the original comment period.
November 2015	The final Produce Safety Rule is published by the FDA.
January 2016	Initial compliance with the Produce Safety Rule begins.

Not all farms or crops are covered under the Produce Safety Rule or FSMA. Small and very small growers may be exempt from conforming to the new regulations (Laury-Shaw et al., 2015). This includes farms that produce non-covered crops (those that are rarely consumed raw, have a verifiable, average income from produce sales of less than $25,000 a year, and farms that grow produce for only personal consumption. Additionally, farms that have an average annual income greater than $25,000 but less than $500,000, and sell the majority of their produce directly to end-consumers within their state, or within 275 miles of their operation (including across state lines), are also eligible for a qualified exemption (FDA, 2017a).

In addition to farm size and income, certain crop types allow exemption from FSMA. Grains, such as barley, oats, and wheat, and dozens of commodities that FDA identifies as "rarely consumed raw," such as asparagus, some bean varietals, potatoes, beets, winter squash, and sweet corn are not covered under the Produce Safety Rule (NSAC, 2015). Produce crops that will receive a "kill step" through commercial processing may also be exempt (FDA, 2016).

Farm Food Safety

Hazard Analysis

Given the known risks to human health from contaminated produce, how does a grower begin to manage food safety practices on his/her farm? In a recent study, growers were asked to rank organizations in regards to which should be responsible for ensuring food safety. From most to least important, producers listed themselves as most important, followed by processors, retailers, consumers, and finally government agencies and university Extension

services (Ivey, 2012). This corroborates the viewpoint that the first line of action in implementing food safety on a farm is how growers interact with their land and other inputs to production and handling, beginning with analyzing potential risks and hazards.

Risk will always be an inherent part of any growing operation. The goal of a farmer is not to eliminate risk, but to reduce hazards that can lead to higher potential for an incident that could cause harm. Hazards on the farm include chemical, physical, and biological hazards. Chemical hazards include misuse of fertilizers or pesticides that could lead to human illness or injury, and physical hazards include objects such as small stones becoming incorporated into harvested produce. Biological hazards include human pathogenic bacteria such as *E. coli* strains or *Salmonella* serotypes, and are widely considered the most prevalent and important type of hazard to analyze and address. Biological hazards can be introduced into farm operations from contaminated irrigation water, unhygienic worker practices, or manure input, to name a few. Upon analyzing an operation for potential risk, growers should pay special attention to biological sources of contamination.

There are several methods of risk analysis that can be easily implemented for any growing operation. One practice is to construct a flow diagram, with simple steps for each area of the operation that may be supplemented with specific details for each step. At each step in the diagram, an assessment is performed for potential food safety hazards, including identification of the hazard, how likely it is to occur and why, and preventative measures for each hazard (Bradenberger). Figure 1 shows an example of a flow diagram. Decision trees are another example of risk assessment. The Produce Safety Alliance (PSA) offers several

resources, including checklists and decision trees, to help growers identify risks, and prioritize mitigation and management, given limited resources (PSA, 2017a).

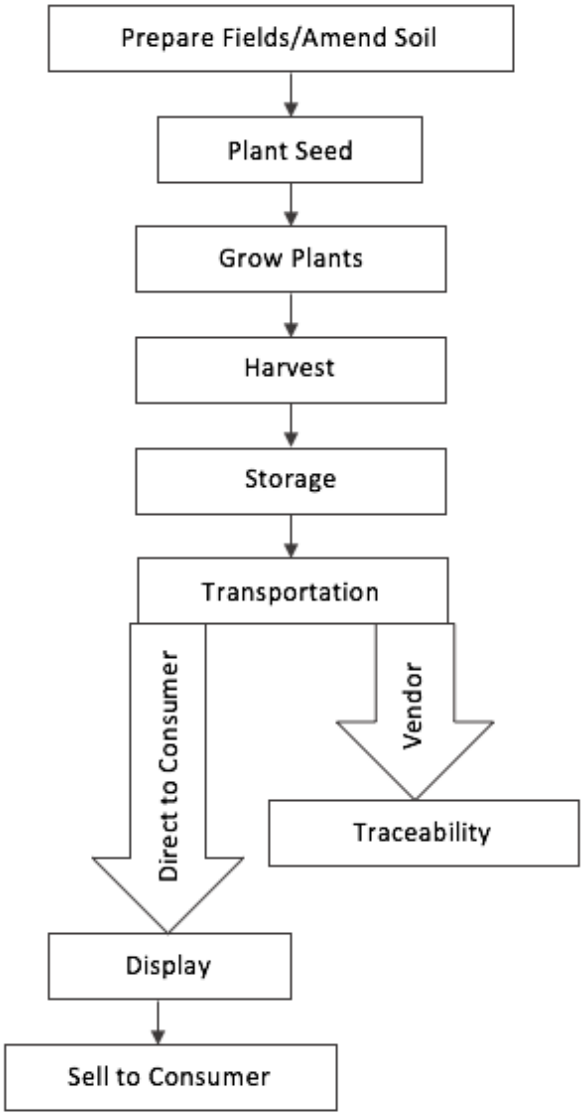

Figure 1. Example of a flow diagram for hazard analysis. Each section of the diagram can be expanded upon to show detail for process steps and risk potential (Bradenberger).

Farm Food Safety Plans

In most food processing facilities, the systematic approach to identifying hazards and reducing risk is through the implementation of a Hazard Analysis and Critical Control Point (HACCP) plan. According to the FDA's definition, HAACP "is a management system in which food safety is addressed through the analysis and control of biological, chemical, and physical hazards from raw material production, procurement and handling, to manufacturing, distribution and consumption of the finished product" (FDA, 1997). As the name and definition imply, one of the main components of a HAACP plan after hazard identification is the establishment of control points along the operational timeline to reduce risk. Unfortunately, many points of risk on a farm cannot be easily pinpointed or controlled, so this model does not translate well to an agricultural environment. For example, farmers cannot foresee when wildlife may enter their fields, nor can they predict unusual weather patterns or natural disasters that might heavily affect operations.

A more realistic approach for a farm is to set up an organized collection of best practices, Standard Operating Procedures (SOPs), test results, and training logs, known as a Farm Food Safety Plan (FFSP). Although FFSPs are not mandatory under FSMA, the Produce Safety Alliance (PSA) reports that written FFSPs have been identified by growers as a beneficial practice (PSA, 2017a). The PSA is a collaborative effort between Cornell University, FDA, and USDA, committed to helping growers and packers adhere to FSMA regulations. After several years of extensive research, including farmer focus groups, the PSA developed and began to implement training for growers based on compliance with the Produce Safety Rule requirements, helping farmers with organization and continued focus on food safety (PSAb,

2017). Small-scale growers have self-identified improvement in documentation as an area of need in recent studies (Laury-Shaw et al., 2015).

The PSA suggests that producers incorporate all areas of their growing operations that could potentially lead to a breakdown in produce food safety into their FFSP. These areas will have been analyzed by the grower as mentioned previously, and include worker health and hygiene; water (irrigation and post-harvest); soil amendments; wild and domestic animal control; harvest best practices; post-harvest handling, storage and transportation; and traceability (PSA, 2016a). Although GAPs and FFSPs are different approaches to produce safety, FFSPs as suggested by the PSA follow closely to GAP audit guidelines (USDA, 2014b).

An important concept for the creation and implementation of FFSPs for an operation is that it is an iterative process. Once an organized plan has been constructed, it should not become a finalized version that must be followed, nor should a grower wait until all suggested aspects be in operation before creating a plan or putting practices in place. The grower should develop and modify the FFSP as his/her operation evolves.

Campus Farms

Land Grant Universities

Signed into law by President Abraham Lincoln in 1862, the Morrill Act, officially titled "An Act Donating Public Lands to the Several States and Territories which may provide Colleges for the Benefit of Agriculture and the Mechanic Arts," set up Land Grant Universities, public colleges focused on agriculture and the mechanical arts (LOC, 2015). The mission of the Land Grant system was to provide a practical, higher education to working class citizens who could

not have otherwise afforded it. By bridging the educational gap between the common and wealthy classes, there was a hope to establish greater income equality, economic development, and social justice (Martin and Simms Hipp, 2016).

Creating Land Grant Universities was only part of the overall system. Soon after the Morrill Act was passed, Agricultural Experiment Stations were established on Land Grant University campuses to fund and conduct research that would lead to the nation having a food supply that not only provided caloric and nutrition needs for the people, but was also focused on food safety. Additionally, the Cooperative Extension service (originally the Agricultural Extension Service) was established in 1914, providing community outreach, education, and support in every county in the U.S. (Allen-Diaz, 2015). Land Grant Universities continue to provide agricultural education, and commonly include Campus Farms within their framework.

Campus Farm Program Growth

In 2012, the average age of a farmer in the United States was 58.3 years, which continues to increase every year (USDA, 2014a). Additionally, the number of farms in the U.S. has been in a state of decline in recent years (USDA, 2014a). With the growing world population, globalization of the world food system, climate change concerns, and increased urbanization, the need for young farmers entering the workforce is high (FAO, 2017). Fortunately, there has been more attention drawn to a younger generation seeing the benefits of entering a career in agriculture by media and educational sources (Mitchell, 2015).

Although campus farms have been a part of major universities in the United States for decades, they have gained popularity and attention in recent years (Hyslop, 2015). The

Sustainable Agriculture Education Association lists close to 60 campus farm programs in the United States, which is not an exhaustive list (Parr, 2016). These programs can range from small gardens to large-scale commodity research farms. There are now web resources and online articles outlining the "best" colleges to attend based on their farms and gardens, and organizations dedicated to connecting campus farm programs (Pershan, 2014; Campus Farmers Network, http://campusfarmers.org).

Campus farms take agricultural education beyond the traditional Land Grant models that are often set up on a platform of research-based education through conventional farming methodology. Campus farms, or campus agricultural projects as they are sometimes referred to in the literature, provide an alternative to the traditional model by focusing attention to sustainability initiatives and student leadership, as well as social dynamics such as food justice and community access to fresh produce (Lacharite, 2015). This model of learning not only allows for science-based education, but also for practicing "real-life" situations such as plot and soil preparation, irrigation techniques, integrated pest and weed management, and harvest practices.

Fostering farm skills at the college level is important because students are directly preparing for work after graduation. Campus farms serve as models for best practices and provide a space for students to learn about horticulture, land management, sustainable farming practices, produce safety, and organic production standards. Agricultural professionals entering the work force need to have an understanding of good practices, federal regulations, and requirements, and research has shown that training of young farmers is a necessary element for growth of local food systems (Harrison et al., 2013). By having quality programs,

universities with campus farms are ensuring the knowledge base of the future farming profession.

Food Systems Contribution

Campus farms contribute to their local food systems in multiple ways. In addition to providing fresh produce to the students and faculty involved in the operation, campus farms also employ direct marketing, such as Community Supported Agriculture (CSA), contribute to Dining Services on campus, and provide donations to local organizations such as food banks (Barlett, 2011). CSA programs operate by having members buy "shares" of the farm's harvest in advance to help cover anticipated operational costs for that season. In return, they are offered fresh produce on a weekly or bi-weekly basis depending on what type of share they purchased at the beginning of the season. Members also share in the risks associated with farming, such as poor harvests due to drought or pests (USDA NAL, 2017a). Dining services on campuses provide meals for students and faculty living on and off campus in the form of dining halls and restaurants.

The USDA's National Library of Agriculture listed 14 campus operations that offer a CSA, and one that contributed to dining services (USDA NAL, 2017b). However, results from a simple internet search of "Campus Farms with CSAs," show that number is vastly underreported, and just one just article in 2011 showed 22, or 73%, of the total campus farms interviewed for the study (n=30), had CSAs (Barlett, 2011). Direct community involvement with farming operations narrows the gap between consumers and producers, and can benefit both the farm, campus, students, faculty, and campus neighbors. A CSA set up by the students and members of North

Carolina State Greensboro even facilitated purchase and delivery of shares to low-income households in the community, furthering the reach of the program beyond the campus (Barlett, 2011).

Dining Services of any university have wide-reaching impact and a large audience base. For example, Colorado State University has six student dining locations in addition to the restaurants at the student center, serving 12,000 meals a day (Lahman, 2016). One campus that has made particularly large progress in connecting the campus farm and Dining Services is Hampshire College in Amherst, Massachusetts (https://www.hampshire.edu). Seventy-five of the 200 CSA shares offered by the farm are dedicated to Dining Services (Hampshire College, 2016). Although sourcing from a campus farm for Dining Services might provide the freshest produce a college or university can provide its students, campus farms must still meet the same standards as other vendors, including food safety practices. For the growth of relationships between student agriculture and Dining Services to continue across campuses, students must be prepared not only in growing practices, but in best practices for produce safety as well.

Curriculum Development

Skills-Based Experiential Learning

Working directly on a campus farm as a component of a traditional course or as a worker, volunteer, or apprentice provides skills-based experiential learning. Experiential education asks students to "solve problems inductively, actively use and explain knowledge through solving problems, and make connections and apply knowledge beyond the classroom and school, based on real-life problems" (Leis et al., 2011). There is evidence from multiple

studies showing that students in higher-education benefit from experiential learning incorporated into programs that require professional skills not readily learned in a conventional classroom setting (Baldwin and Rosier, 2017). Specifically, in the realm of agriculture education, recommendations have been made to make a shift towards experiential education, incorporating farm experience into learn real life skills and solidifying lecture material. Furthermore, students are given the opportunity to learn and practice capabilities in critical thinking, leadership, management, decision making, responsibility, and relationship building (Leis et al., 2011).

Application of experiential education for agricultural studies can easily integrate a campus farm or student education garden to learn multiple facets of the agricultural industry. Planning and prepping soil based on specific plots and recommendations allows students to think critically about soil amendments, pH and nutrient needs, and testing compost for microbial load. Food safety curriculum in an experiential setting offers the opportunity to create and follow SOPs for harvest and post-harvest best practices. Utilizing direct sales avenues to sell produce to the campus and community integrates business, marketing, and interpersonal skills.

Produce Safety Alliance Curriculum

As part of their commitment to assist growers, the Produce Safety Alliance (PSA), offers several training options for compliance with produce safety education, including a course specifically for growers, and a more extensive "Train the Trainer" course, which also includes "Principles of Adult Education & Training" and an overview of training competencies (PSA,

2016b). The curriculum and resources for these trainings are significant, as they were developed as part of the FDA's commitment to aiding the industry in becoming FSMA compliant (FDA, 2017a).

The Train-the-Trainer (TTT) course focuses on education and training specifically from a produce safety training prospective, as opposed to offering a broad-spectrum view of educating adults. Objectives of the TTT course include defining training goals, knowing the training audience, and organizing, delivering, and evaluating a successful training. Of significance is the section on "knowing your audience," which can have a notable impact on retention of information. As such, the topic of addressing an adult audience appropriately has been researched heavily.

Frequent sub-topics on the matter include finding out information on participants before the training day to be able to address them appropriately, and addressing all styles of learning (Mealor and Frost, 2012). For produce safety, understanding background information on participants includes inquiring about their position on the farm, level of education, history with food safety education, and the reason for attending the training. Attendees might not be farm workers at all, and may be regulatory agents or buyers (PSA, 2017b). This allows the educator to focus the training on audience need, including integrating multiple ways of learning and adapting the program as needed (Mealor and Frost, 2012). By staying participant focused, educators can provide a meaningful experience for adult learners.

Using Technology in Outreach

Although some industry members would prefer face-to-face training options, many growers live in rural areas and in-person continued education is not always a viable option. Fortunately, the vast majority of Americans has at least one form of internet access. As of 2016, 73% of all adults in the U.S. have a home broadband network, and 83% of adults use the internet in general (Pew, 2017). Combined with the fact that 63% of working adults have identified themselves as "professional learners," as demonstrated by seeking out coursework or training to improve job skills (Pew, 2016), the use of technology in outreach seems an obvious and powerful route. The use of technology as an educational tool provides a wide-reaching platform for distance and flexible learning, allowing people to access programs from rural or out-of-town areas, and at times that are adaptive to work and life schedules.

Included in the umbrella of technology are online webinars, web-based training modules and courses, and supplemental online resources. A webinar is simply a seminar that is conducted over the internet, and can cover any topic. Webinar hosts might also have the opportunity to ask polling questions on demographics and learning objectives, giving the added benefit of capturing information about participants. Web-based trainings range from printable presentations to narrated presentations with interactive quizzes, and supplemental resources include links to additional relevant websites, customizable templates, and infographics.

Of course technological resources are only useful if the target audience can and will be accessing them and utilizing the information. In 2015, the USDA's National Agricultural Statistics Service (NASS) reported that although 73% of farms have computers, only 43% are conducting farm business via the internet (NASS, 2015). Although limited in scope, a study of

orchard growers in the Pacific Northwest showed a significantly larger proportion of farmers using the internet for business and farming information, including 93% of Oregon pear growers (Jones et al., 2016). There is a need for both the use of technology as an outreach tool and encouragement of farmers to utilize it for business and continued education.

Research Objectives

The aim of this research was to address a lack of literature and a need for curriculum focused on produce safety on campus farms and small-scale produce farming operations. Research objectives were designed to concentrate on applicable solutions;

- To assess food safety practices and trainings that are currently in place at university and college campus farm programs in the United States.
- To deliver food safety curriculum to CSU horticulture students, and assess knowledge change through the implementation of a pre- and post-presentation questionnaire.
- To establish relevant best practices at the CSU Student Education Garden (SEG) through the development of Standard Operating Procedures, on-farm experiential student training, and a written farm food safety plan.
- To develop resources for small-scale Colorado growers to aid in creating or modifying a farm food safety plan for their operation, and deliver an instructional webinar on how to effectively utilize those resources.

CHAPTER III: MANUSCRIPT WITH EXPANDED METHODS AND MATERIALS

FARM FOOD SAFETY PLANS: EDUCATIONAL AND TRAINING RESOURCES FOR SMALL-SCALE GROWERS AND CAMPUS FARM PROGRAMS

Background

The passing of the Food Safety Modernization Act (FSMA) in 2011 changed the approach to food safety in the U.S. from reactionary to preventative (FDA, 2017). In particular, the Produce Safety Rule spotlighted the need for food safety to be applied to fresh produce. Under this rule, farms are required to follow mandated regulations to analyze hazards and reduce risk of human pathogen introduction into the production chain of fresh fruits and vegetables (FDA, 2017a). Before the passing of FSMA, farms were only accountable for the safety of their produce by buyer requirements, or voluntary participation in the United States Department of Agriculture's (USDA) Good Agricultural Practices (GAPs) program (USDA, 2017b).

Although the Produce Safety Rule will apply to many large agricultural operations, many small-scale and most campus-based farms could be exempt from compliance (Laury-Shaw et al., 2015). Small farms are defined by the USDA as having gross cash farm income as less than $350,000, but the latest census states that 75% of small farms sold less than $50,000 in agricultural products (USDA, 2015 and USDA, 2014a). These types of farms also generally lack the staffing, time, and resources to employ produce safety systems in the same way their larger counterparts would. What is more, they both tend to utilize direct-to-consumer marketing to sell their produce, including Community Supported Agriculture (CSA) shares, and farmers' markets (Barlett, 2011).

Small farms and campus-based, student-run farms continue to grow in popularity (USDA, 2016b and Hyslop, 2015), increasing the need to establish comprehensive produce safety practices as in integral part of the farming process. And yet, there remains a lack of literature, resources, and curriculum to aid in filling the gap. This study aimed to assess current practices on campus farms in the U.S., and to develop targeted curriculum, resources, and trainings for small growers and campus-based operations.

Specifically, the focus was on helping growers to develop and customize farm food safety plans for their operation. Farm food safety plans have been identified by growers as a beneficial tool for integrating produce safety into production practices (PSA, 2017a). These plans cover areas for potential risk of pathogen introduction, such as agricultural water management, animals and wildlife, and raw manure application (PSA, 2016a). By offering access to materials and resources, more small-scale and campus farms have the potential to establish produce safety programs for their operations.

Materials and Methods

Introduction

The purpose of this study was to develop, test, and evaluate food safety materials focused on improving pre- and post-harvest practices on campus-based farms and small to mid-sized produce operations. This was accomplished via three distinct components:

1) Campus farms were identified at universities and colleges located in 14 states. Farm managers or supervising faculty were recruited to participate in a 10-question survey to

determine whether food safety training was required for student workers or farm volunteers and how any type of food safety education or guidance was implemented.

2) Food safety training resources and curriculum were developed and delivered to 54 students enrolled in HORT 450B, Warm Season Vegetable Crop Production, a course offered by the Department of Horticulture and Landscape Architecture at Colorado State University (CSU), Fort Collins, CO. A 45-minute, 22-slide presentation addressing farm food safety was created and presented, and an analogous pre- and post-lecture questionnaire was developed, delivered and analyzed in conjunction with the lecture to assess learning outcomes of the participants. A comprehensive Farm Food Safety Plan, including Standard Operating Procedures (SOPs) and water and soil testing methods and results, was created, reviewed, and implemented for the Student Education Garden (SEG) and Research Fields at the CSU Horticulture Center. The SOPs were presented at the SEG to students enrolled in HORT 450B, and implemented by the students during harvest of crops grown to satisfy the requirements of an assigned project.
3) Multiple resources, including a series of three narrated online modules, a 1-hour recorded webinar, and a 27-page farm plan template were developed and targeted to Colorado growers to aid in the construction or revision of a Farm Food Safety Plan for their operations. The webinar was developed and delivered, in conjunction with the Colorado Fruit and Vegetable Growers Association, to Colorado growers and interested parties to teach them how to efficiently utilize the resources to create or revise a plan for their operations.

Study Design and Protocol

Data for this study were collected over an 8-month period (May 2016-January 2017). Approval and exemption status for this research project was obtained from the Institutional Review Board at Colorado State University (Appendix A).

1) Survey of Campus Farm Managers

Campus farms were identified at universities and colleges around the United States. A survey was taken by the farm managers or supervising faculty to find out what (if any) food safety training was being delivered to the workers and volunteers there. The survey was delivered via email, including a statement of voluntary participation and guarantee of anonymity. Additional incentives were not offered in exchange for completing the survey.

Recruitment and Population

Nineteen campus farm contacts were identified via internet search, word of mouth recommendations, and personal communication and networking. The desired population of the survey was campus farm managers or supervising faculty who worked directly with campus farms. Criteria excluded faculty who work in a research setting where produce was not grown for an end consumer. These criteria were communicated in the body of the email sent to contacts, asking recipients to forward the email to the appropriate contact for their operation (Appendix B).

The survey was emailed to contacts on 2 separate dates. The first attempt resulted in five responses (n=5). A follow up email was distributed 1 month later to the remainder of the

contacts who did not initially respond, resulting in an additional 5 responses (n=5). In total, 10 participants (n=10) responded to the campus farm survey from both email distributions.

Survey Design

A questionnaire (Appendix C) was designed to collect information on growing operations, worker and visitor demographics, end consumers, farm size, and food safety training practices. Content was developed through collaboration and reviewed by CSU faculty and research associates with questionnaire expertise. Before the email survey was sent to potential participants, several test emails were sent to supervising faculty at CSU and the CSU Horticulture Center to ensure correct delivery. The survey consisted of 10 multiple choice items, designed and entered using Qualtrics software (Qualtrics LLC, 2016). It was delivered via email, with an embedded link leading participants to the online survey on.

Questions 1 to 6 were designed to determine details related to supervising staff, farm size, worker and volunteer force demographics, and end consumer. Questions 7 to 9 addressed farm food safety procedures, training practices, and implementation for each campus farm operation. In Question 10, participants were asked if they would like to receive the final results of the survey.

Data collection

The Qualtrics survey results included access to data compilation from completed surveys and response information from each email recipient (i.e. email bounced, survey completed, opted out). Responses to each question were grouped, and these data was entered

into an Excel spreadsheet. Participant information was compiled and analyzed to determine geography and size of each campus farm.

2) Class Presentation, Pre- and Post-Questionnaire, and SEG Resources

A farm food safety lecture was created and presented to a class in the Horticulture and Landscape Architecture Department of Colorado State University (Appendix D). An analogous pre- and post-lecture questionnaire was developed, delivered and analyzed in conjunction with the lecture to assess learning outcomes of the participants (Appendix E).

Population

A convenience sample of 54 undergraduate students (n=54) enrolled in HORT 450B, Warm Season Vegetable Crop Production, participated in the study. Academic year of participants ranged from sophomore to graduate level. Participants primarily identified Horticulture as their major (72.5%), with additional majors including Soil and Crop Science and Food Science (15% and 2.5%, respectively). Participation in the study was included in the HORT 450B class curriculum but was voluntary and did not influence class grades. Verbal instruction regarding voluntary consent was provided before any study curriculum was delivered.

In-class presentation

A 45-minute, 22-slide presentation addressing farm food safety, *Food Safety is Fun and Cool*, was created and presented to students during normally scheduled lecture time. The presentation was developed using information from FSMA materials, food safety trainings, and faculty resources from other CSU courses on food safety. The aim of the presentation was to

deliver information on basic concepts of foodborne illness, produce safety, and farm food safety plans. Content included, but was not limited to, overview of regulatory agencies, agricultural water, wildlife management, flood plain concerns, worker health and hygiene, soil amendments, and harvest best practices.

Pre- and post-presentation questionnaire

Development

An identical pre-and post-presentation questionnaire was developed in collaboration with CSU faculty and food safety experts. The questionnaire was reviewed by additional research associates, and changes were integrated into the final version. Items consisted of 4 demographic questions, and 22 content-related questions. Of the 22 content questions, 3 were yes/no questions, 4 were 5-point Likert scale questions, 5 were true/false questions, and 10 were multiple choice. Students used a 5-digit code to ensure anonymity but allowed matching of the 2 questionnaires from each student for analysis. Pre-presentation questionnaires were printed on blue paper, and post-questionnaires were printed on yellow paper to differentiate after collection.

Delivery

The pre-questionnaire was distributed, completed, and collected during class time directly before the lecture was presented. The post-questionnaire was distributed, completed, and collected during the subsequent class meeting time, 2 days after the food safety lecture was presented. Before distribution, a verbal notice of consent was provided to confirm student

knowledge of voluntary participation. Questionnaires took approximately 10 minutes to complete.

Data collection and analysis of results

Questionnaires were returned at the end of the time allotted for completion. The pre- and post- version results were entered in to separate spreadsheets, and coded based on question type. A "key" was created with the correct answers to compare with completed questionnaires.

SEG Farm Food Safety Plan

A farm food safety plan was created for the CSU SEG, utilizing the Colorado Farm Plan 2.0 template, and is discussed in the following section. The plan was developed in collaboration with faculty, staff, research associates, and graduate students to specifically fit the SEG operation. Upon completion, the plan was reviewed and modified accordingly.

In developing the plan, collaborators performed a thorough walk-through of the SEG property, addressing explicit issues and potential hazards including growing areas, tool storage, wildlife management, irrigation, chemical use and storage, washing areas, harvested crop storage and coolers, and shared space management. Quantitative tests and results for the microbiological content of the soil, compost, and agricultural water used on site were included. SOPs for harvest and post-harvest best practices, and a Pre-Harvest Walk-through Checklist were developed and added to the plan (Appendix F and Appendix G).

SOP Development and Implementation

Prior to the development of the farm plan and training materials, the project collaborators participated in a trial harvest at the SEG to mimic student activity during the class crop harvest. This was used to guide the development of the Pre-Harvest Checklist, and Harvest SOP. In the tenth week of the fall semester, students (n=54) participated in a walk-through of the SEG, utilizing the Harvest SOP to guide expectations. During the last two weeks of the semester, students independently followed the SOP to safely harvest, clean, and store crops produced as a course requisite.

3.4 Colorado Grower Resources and Webinar Delivery

Several resources were developed for Colorado growers to aid in creating or revising a Farm Food Safety Plan for their operations. Following review by CSU faculty, research associates, and industry professionals, resources were distributed to the public via the Produce Safety Alliance at Cornell University (https://producesafetyalliance.cornell.edu), the Colorado Fruit and Vegetable Growers Association (https://coloradoproduce.org), and the Colorado State University Extension (http://farmtotable.colostate.edu). The target audience for this information included commercial growers, horticultural educators, and campus farm managers.

Farm Food Safety Plan Template

A pre-existing Colorado Farm Food Safety Plan created and posted online in 2012 was updated to parallel the sequence followed in USDA GAPs audit guidelines, and to align with new FSMA standards, including sections addressing food defense (Appendix H). The template was

rearranged and annotated to match the GAP audit order of questioning and additional sections were added to cover previously excluded material, lengthening the plan from 18 to 27 pages. The additional sections included: Previous Audits; Animals, Wildlife, and Livestock; Harvest and Packing; Facilities – Water, Chemical Storage and Training; and Food Defense Plan.

For each section, questions that would prompt the grower to consider current practices were included, and areas to write customizable policies specific for individual operations were provided. For each page, a number and letter code was provided to reference the corresponding USDA GAPs audit section and question.

Online narrated modules

Three narrated modules were created to assist growers in effectively utilizing the Farm Food Safety Plan Template (Appendix I). Each module was developed using presentation software, with narration explaining slide visuals and covering additional detail. Images were clipped directly from the template. The modules followed the order of the template for ease of use, and each module does not exceed 15 minutes to reduce viewer fatigue (Table 4).

Table 4: Detail of online narrated module content.

Module	# of Slides	Length (in min)	Topics Covered
1	31	~13	Introduction, FSMA, hazards, traceability, recall
2	22	~11	Agricultural and potable water, worker health and hygiene, animals, soil
3	31	~11	Pre-harvest, harvest, and post-harvest best practices, food defense, conclusion

Online interactive webinar

Development and Delivery

A 60-minute, 37 slide webinar, titled "Fundamentals of Creating a Food Safety Plan for Your Farm" was created and presented to members of the Colorado Fruit and Vegetable Growers Association (Appendix J). The webinar was marketed via email invitation using the following description:

> "Putting together a written food safety plan for your farm can help in understanding and managing possible risk but knowing where to begin and what to include in the plan can be challenging. This webinar will provide a basic overview, walk participants through a set of 3 online modules, and provide information about what should be included in a plan and how to use their plan as a tool to reduce potential risks and protect their operation. Participants will gain awareness that creating a plan is a long-term, dynamic process that needs to be revisited and updated as production and operating methods change and also learn about available resources to facilitate the process. This webinar will prove beneficial whether you are writing a farm plan for the first time or reviewing and updating an existing plan for your operation."

The webinar was hosted by the Colorado Fruit and Vegetable Growers Association, with a Colorado State University Extension agent moderating. The purpose of the presentation was to encourage and explain to participants how to effectively use the new food safety resources.

Participants

Thirty-three registered members participated in the webinar (n=33). The webinar was offered to members at no charge. Participants answered voluntary polling questions at the beginning and end of the webinar, and had the opportunity to ask any questions during a question-and-answer period at the end of the presentation. Table 5 details polling questions and possible answers asked before and after the webinar.

Table 5: Pre- and post-webinar polling questions and response choices.

Pre-Webinar Polling Questions	**Response Choices**
Which best describes you?	Grower; Ag Professional; Food Systems Enthusiast; Other
Indicate any food safety audits you have conducted on your farm in the last two years (check all that apply):	USDA GAP/GHP; USDA Harmonized GAP; Global GAP; Buyer-specific; Self-audit; I have not conducted an audit; NA, not currently farming
Do you have a completed food safety plan for your farm?	Yes; No; NA, I'm not currently farming
What is your primary source of information for your farm food safety questions? (choose one)	Colorado Fruit & Vegetable Growers Association; Colorado Department of Agriculture, Fruit & Veg Inspection Service; Online searches; CSU Extension; US Dept of Agriculture; Other
Please assess your current ability to create or modify a Farm Food Safety Plan for your operation:	1 = very little knowledge; 2 = limited knowledge; 3 = comfortable with my knowledge and ability to apply it; 4 = very comfortable in my knowledge and ability
Please check the type of food safety practices you currently use for your operation (check all that apply):	Good Agricultural Practices (GAPs); Good Handling Practices (GHPs); Commodity specific GAPs; Complying with the Food Safety Modernization Act; None at this time; NA, not currently farming

Post-Webinar Polling Questions	**Possible Answers**
Will you use some of the practices you learned today?	Yes; No

Will you share this info with other people?	1 - 3 people; More than 3 people; No one
Please assess your current ability to create or modify a Farm Food Safety Plan for your operation:	1 = very little knowledge; 2 = limited knowledge; 3 = comfortable with my knowledge and ability to apply it; 4 = very comfortable in my knowledge and ability
Did you learn something new today?	Yes; No

Statistical Analysis

Campus farm manager survey frequencies were collected via Qualtrics Data & Analysis output and were not further analyzed using statistical software. All other data were collected and organized in a Microsoft Excel spreadsheet, which was subsequently transferred to SPSS software data set. Version 24 of SPSS (IBM, 2009) was used to run frequencies, paired t-tests, and McNemar's tests. McNemar's tests utilize 2 x 2 contingency tables to compare frequencies on matched pairs. The McNemar's test results did not offer new information that was not already captured by paired t-tests, and were therefore excluded from the final data set.

Results and Discussion

Campus Farm Manager Survey

Campus farm managers were surveyed to obtain insight into the level of farm food safety training offered to students, employees, and volunteers working at student farms on college and university campuses in the U.S (participants n=12). Frequencies were analyzed for the responses to the 10 questions recorded from the respondents. Questions, responses, and response frequencies are shown in Table 6. All (100%) participants reported growing vegetables on their campus farms, and 50% reported raising animals or livestock.

Raising animals and vegetables within the same operation can run higher possible risk for microbiological contamination from animal reservoirs of human pathogens such as *E. coli* strains or *Salmonella* serovars. This can happen by means of runoff from animal pastures to irrigational water sources or directly to vegetable fields, or by workers in animal pens moving to vegetable growing areas without cleaning their hands, gloves, or shoes, tracking pathogens with them (Jung et al., 2014). Fifty percent of the farms in this study (n=6) were less than 5 total acres, and 17% (n=2) were less than one acre. This could potentially leave little room for proper separation of animal and vegetable areas. It is also possible that a small number of students perform multiple duties on the farm on any given day, increasing potential for cross-contamination by footwear, clothing, tools, or equipment.

Small farms with both animals and vegetable/fruit production often utilize animal manure as a preferred soil input and to decrease amendment costs. Studies have shown high microbial loads associated with raw animal manure applied to produce. The FDA currently addresses this issue within FSMA by stating that adherence to the National Organic Program's (NOP) best practice of the "90/120" rule is a "prudent step toward minimizing the likelihood of contamination" while additional research is conducted and a final standard is published on raw animal manure application (FDA, 2017a). The 90/120 rule states that raw manure is to be applied no less than 90 days to crops that do not come in direct contact with the soil (such as peppers), and no less than 120 days for crops that do have direct soil contact (such as lettuce or radishes) (FDA, 2016b). If campus farms are to use raw manure as part of their soil amendment program, these practices need to be followed to reduce risk for human pathogens.

In addition to 100% of participants reporting that students work on the campus farm, 83% (n=10) have volunteers working on the farm as well. Volunteers might not have the background or training on farm food safety best practices to keep hazards to a minimum. In combination with other factors, this leads to a high need for farm food safety training for anyone working on or visiting the farm over the course of the season. Eight (67%) campus farm managers reported having some variety of food safety training for their operation. Training ranged from 30 minute overviews to formal day long trainings. These findings imply a gap in consistent implementation of thorough training for employees, student workers, and volunteers.

Table 6. Statements and frequency of responses for online survey distributed to campus farm managers at colleges and universities in the U.S.

Statement/Response	**Frequency** (%)
What is your title/role at your campus farm?	**(n=12)**
Manager	**5** (42%)
Supervising faculty	**4** (33%)
Coordinator	**1** (8%)
Lead volunteer	**0** (0%)
Other[a]	**2** (17%)
How large is the farm?	**(n=12)**
Less than 1 acre	**2** (17%)
1-5 acres	**4** (33%)
More than 5 acres	**6** (50%)
What is grown/raised on your farm? (click all that apply)	**(n=12)**
Vegetables	**12** (100%)
Fruit	**5** (42%)
Grain	**4** (33%)
Poultry/Livestock[b]	**6** (50%)
Who else works on the farm besides you? (click all that apply)	**(n=12)**
Paid employees	**10** (83%)
Students	**12** (100%)
Volunteers	**10** (83%)

Other[c]	**2** (17%)
How many people work on the farm throughout the season?	**(n=12)**
Less than 10	**3** (25%)
10-50	**6** (50%)
50-100	**0** (0%)
More than 100	**3** (25%)
Who are the end consumers of your products? (click all that apply)	**(n=12)**
Campus Dining Service	**9** (75%)
CSA	**8** (67%)
Farm Stand	**6** (50%)
Worker consumption	**8** (67%)
Commercial sale	**6** (50%)
Donation	**8** (67%)
Other	**1** (8%)
Have specific food safety procedures been implemented for the operation?	**(n=11)**
Yes	**7** (64%)
No	**1** (9%)
No, but plan to in the future	**1** (9%)
Some/In progress (please explain)	**2** (18%)
Do workers, students, or volunteers receive any food safety training prior to working on the farm?	**(n=11)**
Yes	**6** (55%)
No	**2** (18%)
No, but plan to in the future	**3** (27%)
If yes, will you briefly describe how the material is presented, and how long the training takes to complete?	**(n=8)**
- GAP principles; 30 minutes - We have one hour trainings every quarter. - ServSafe certification. Day long training. - Paid students receive training mostly in harvest and post-harvest handling related more to produce quality and some basic food safety, as opposed to food safety-focused training. We hope to formalize more curriculum about food safety (i.e. contaminants, curing storage, etc.) in the future and would appreciate consulting with others' templates. - 1.5 hour lecture style presentation - 1-3 hours, appropriate for the commodity - Formally, about an hour. And then ongoing hands-on instruction. - Presented in person, walk through and (in class) quiz/activity sheet	
Would you like to know the results from the survey about campus farm food safety training?	**(n=11)**
Yes	**11** (100%)
No	**0** (0%)

Footnotes for customizable responses:
[a]Other: Assistant Manager
[b]Poultry/Livestock: cattle; beef, pork, eggs; beehives (expected 6 by spring 2017); pork, chicken
[c]Others: Interns for credit; 3 full-time staff, 7 paid work-study students who work 8-10 hours/week, and about 900 volunteers per year who put in an average of 1.5hours work

Class Presentation, Pre- and Post-Questionnaire, and SEG Resources

A pre- and post- questionnaire was given to students (n=54) enrolled in HORT 450A before and after a 45-minute presentation on farm food safety. The purpose of the questionnaire was to gather demographic information on the sample population and to test learning outcomes from the presentation. Results are a complete case analysis of the 40 students who participated in both surveys (n=40), based on matching student codes. Participation was voluntary, and n values for each response frequency were based on valid percentages to reflect changes in response rate. The term valid percentage is used to mirror SPSS software verbiage.

Demographics

Frequency values for the demographics (Table 7) indicated that the sample population was mostly male, upper-class (junior and senior year), and majoring in horticulture. Although 90% (n=36) of students have worked or are currently working on a farm, and 85% (n=34) of students plan to work on or own their own operation in the future, only 42.5% (n=17) students have received any kind of food safety training (Table 8). This indicates that CSU students are receiving food safety training at a similar rate to other campus farms across the U.S. when compared to campus farm manager survey results above.

Table 7: Frequencies of student responses to demographic questions on the pre-questionnaire.

Question/Response	**Frequency** (valid %)
Gender	**(n=39)**
Male	**22** (56%)
Female	**17** (44%)
School Year	**(n=34)**
Freshman	**0** (0%)
Sophomore	**1** (3%)
Junior	**10** (29%)
Senior	**20** (59%)
Graduate	**3** (9%)
Age	**(n=40)**
<18	**0** (0%)
18-25	**30** (75%)
26-35	**9** (22.5%)
36-45	**0** (0%)
>45	**1** (2.5%)
Major	**(n=39)**
Horticulture	**29** (72.5%)
Food Safety	**0** (0%)
Food Science	**1** (2.5%)
Animal Science	**0** (0%)
Nutrition	**0** (0%)
Soil and Crops Science	**6** (15%)
Other	**3** (7.5%)

Table 8: Frequencies of student responses to true/false questions on the pre-questionnaire. Questions were intended to gather relevant personal information on the population.

Statement/Response	**Frequency (valid %)**
I have worked or volunteered on a farm or garden in the past, or currently am.	
Yes	**36** (90%)
No	**4** (10%)
I have had food safety training in the past.	
Yes	**17** (42.5%)
No	**23** (57.5%)
I have heard of FSMA before.	
Yes	**34** (85%)
No	**6** (15%)

I plan to own or work on a farm operation someday.	
Yes	**34** (85%)
No	**6** (15%)

Likert Scale

The third section for the questionnaire consisted of four Likert scale questions. Questions were attitudinal in nature, and did not test knowledge or learning objectives. Results were analyzed using paired t-tests on SPSS software, and 2-tailed significance was used. All four questions changed from pre- to post- results and displayed statistical significance ($p < 0.05$).

Shifts in response means for all questions trended toward a greater agreement (5= strongly agree, 1=strongly disagree) (Table 9). All questions involved attitudes toward the importance of food safety and training. The results were in agreement with the hypothesis that students would become more "invested" after listening to a presentation on farm food safety and the necessity of its emphasis on a growing operation. These findings suggest that farm food safety may become intertwined with the importance of traditional growing knowledge to a younger generation of potential farmers.

Table 9: Likert scale attitudinal questions with before (pre-questionnaire) and after (post-questionnaire) means, standard deviations, and 2-tailed significance values.

Question	**Before** ± S.D	**After** ± S.D	**Sig.** (2-tailed)
Farm workers should receive food safety training.	**4.63** ±0.540	**4.93** ±0.267	**p=0.001**
Food safety is a concern in America.	**4.28** ±0.877	**4.70** ±0.564	**p=0.001**
Having a written farm food safety plan is important to any farm operation.	**4.43** ±0.712	**4.70** ±0.516	**p=0.014**

Volunteer farm workers should receive food safety training.	**4.23** ±0.577	**4.63** ±0.586	**p=0.000**

True/False

Responses to true/false questions on the questionnaires showed no significant changes in mean values from correct or incorrect answers (Table 10). Correct answers were coded with a value of 1, and incorrect values were coded with a value of 2. Overall, the responses in the true/false section show that students believe that food safety is an issue in America, and there is value in preventive measures.

Table 10: True/false questions with before (pre-questionnaire) and after (post-questionnaire) means, standard deviations, and 2-tailed significance values.

Question	**Before** ± S.D	**After** ± S.D	**Sig**. (2-tailed)
More foodborne illness outbreaks occur each year with animal products than fresh produce.	**0.700** ±0.464	**0.700** ±0.464	**p=1.000**
Record keeping is an important aspect of a food safety plan.	**1.00** ±0.000	**1.00** ±0.000	**-**
Farm tools and equipment don't need to be cleaned because they are going to get dirty again the next time they are used.	**1.00** ±0.000	**0.920** ±0.270	**p=0.083**
Farm food safety plans work to keep both consumers and growers safe.	**1.00** ±0.000	**1.00** ±0.000	**-**

Multiple Choice

The aim of the multiple-choice questions was to test learning outcomes from the students, based on listening to the presentation on farm food safety. For each question, paired t-tests were used to analyze changes in means for answers. Correct answers were coded with a value of 1, and incorrect values were coded with a value of 2. In Table 11 below, correct

responses are shown in bold, and means, standard deviations, and 2-tailed significance values are only shown for those choices.

Two of the 10 questions resulted in responses that showed significant changes in mean values from pre- to post- questionnaire. The first, "Hands should be washed with soap and warm water for:" addressed the issue of how many seconds hand should be washed for proper hand washing technique, and had a significance of $p \leq 0.0005$. The correct answer was 20 seconds. This topic was addressed heavily in the presentation, as worker health and hygiene is a major part of preventing foodborne illness outbreaks. Not only can bacterial cross-contamination occur, but viruses such as Hepatitis A have been implicated in outbreaks involving fresh produce. The risk of viral contamination can be reduced using proper hand washing techniques (CDC, 2006-2016).

The second significant change was from the response to "Appropriate methods of managing wildlife presence in a flood plain include:" with a 2-tailed value of 0.001. This was covered in the section of the presentation on animals and wildlife. At the CSU SEG, there had been seasonal issues with non-migratory geese nesting and feeding on the fields. This is an obvious food safety issue, as geese feces is dropped and distributed throughout the growing area. Wildlife feces has been implicated in foodborne illness outbreaks, and the FSMA Produce Safety Rule calls for growers not to harvest crops that have become contaminated (FDA, 2017a). Additionally, the geese were feeding on low laying crops such a lettuce, decreasing harvestable yields.

The CSU SEG resides in a flood plain. Because of this, certain measures such as permanent fencing that some operations would be able to employ are not viable options for

managing animals. The questionnaire and presentation focused specifically on animal and wildlife management practices within a flood plain to bring continuity between the presentation and hands-on learning throughout the semester. Noise makers was the only appropriate response to the question, as all other possible answers would not be allowed within a flood plain growing space.

Although reviewed, the question "The following operations need to have a FSMA compliant farm plan:" was flawed. None of the responses represented a correct possible answer. As such, results from this question will not be included in future publication, and the question will be removed from the questionnaire in future application.

Table 11: Multiple choice questions with before (pre-questionnaire) and after (post-questionnaire) means, standard deviations, and 2-tailed significance values.

Question/Correct Responses	**Before** ± S.D	**After** ± S.D	**Sig**. (2-tailed)
Food Safety hazards on the farm can be:			
Biological			
Chemical			
Physical			
All of the above	**1.00**±0.000	**1.00**±0.000	**-**
None of the above			
Hands should be washed with soap and warm water for:			
10 seconds			
20 seconds	**0.23**±0.423	**0.95**±0.221	**p≤0.0005**
30 seconds			
60 seconds			
Soil Inputs include:			
Shovels			
Seeds			
Compost	**0.62**±0.493	**0.51**±0.506	**p=0.210**
Irrigation Water			
The following operations need to have a FSMA compliant farm plan:			

Farms that are certified organic			
Farms that are selling to a buyer that require a third-party audit	**0.13**±0.335	**0.10**±0.304	**p=0.660**
Farms that sell directly to consumers at the farmers' market			
Farms that generate >$25,000 annual revenue			
The source of agricultural water that should be tested at least once per year include:			
Municipal water			
Well water			
Surface water			
Both B and C			
All of the above	**0.63**±0.490	**0.73**±0.452	**p=0.210**
Where can microbiological contamination originate from:			
Soil/organic matter			
Water			
Humans			
Animals and wildlife			
All of the above	**1.00**±0.000	**1.00**±0.000	**-**
Hands should be washed:			
After using the restroom			
Before starting work			
After taking a break			
Before washing produce			
All of the above	**1.00**±0.000	**1.00**±0.000	**-**
What does FSMA stand for:			
Farm Safety Alliance Movement			
Food Safety Modernization Act	**0.92**±0.270	**0.95**±0.223	**p=0.570**
Food Security Modernization Alliance			
Farm Security Management Act			
Appropriate methods of managing wildlife presence in a flood plain include:			
Permanent fencing			
Poison traps			
Noise makers	**0.15**±0.362	**0.50**±0.506	**p=0.001**
All of the above			
Farm food safety plans should include:			
Test results			
SOPs			
Manager contact information			
Traceability			

All of the above	**0.98**±0.158	**1.00**±0.000	**p=0.323**

The pre- and post- questionnaire, although valuable in measuring learning outcomes from a traditional, lecture-style classroom presentation, does not necessarily represent overall student learning on food safety throughout the semester. It does not take into account the experiential learning that occurred at the SEG, outlining harvest and post-harvest best practices to prevent contamination. As the literature shows, it has been recommended to incorporate farm experience to solidify lecture material and relay it to real life experiences (Leis et al., 2011). There is a need for a more standardized farm food safety curriculum to be incorporated at universities and colleges, and specifically those with campus farms and gardens. Students involved in these programs may become produce growers, and should be prepared to enter the profession armed with extensive food safety knowledge.

Colorado Grower Resources and Webinar Delivery

Farm Food Safety Plan Template and Narrated Modules

The revised Farm Food Safety Plan Template (FFSPT) was posted to the CSU Extension website, http://farmtotable.colostate.edu, upon completion and made available to consumers. Google Analytics was used to analyze site visits, and reported that the FFSPT and the fillable pdf version were each visited one time between December 1, 2016 and April 30, 2017. However, total downloads of the pdf were not displayed on Google Analytics, and so a complete analysis of use could not be calculated.

Comparably, the Grow section of the site received 1401 visits within that same time-period, and the Grower Resources subsection was visited 407 times. When compared to the previous five month period - July 1, 2016 to November 30, 2016 – site visits increased more than 50%. During that previous period, the Grow section received only 881 visits, and the Grower Resources subsection received 211 visits. Moreover, December 1, the day of the webinar, was the fourth highest day in page views for farmtotable.colostate.edu in 2016, and the highest day in page views in the last quarter.

The FFSPT and modules reside on the Grower Resources page. These findings indicated a need for marketing efforts to expand consumer knowledge of resources to ensure utilization of the template and modules. After all, resources are only helpful if consumers use them to their advantage.

CFGVA Webinar

A total of 33 CFVGA members participated in the online webinar. The results of voluntary pre-webinar polling questions showed that 47% (n=9) of respondents had not conducted any sort of food safety audit on their farm to date, and that 53% (n=10) did not have a farm food safety plan in place at their operation (Table 12). Additionally, before the webinar began, 64% (n=12) of poll responses indicated that participants had either “very little knowledge” or “limited knowledge” when assessing their ability to create or modify a farm food safety plan for their operations.

Post-webinar polling indicated positive learning outcomes and increased confidence in farm food safety knowledge. When asked again about their ability to create or modify a farm

food safety plan, no participants responded with "very little knowledge," and 47% (n=10) responded as comfortable or very comfortable with their ability. There was also a 100% "yes" response when asked if participants had learning something new and if they will used the practices they learned during the webinar.

Table 12: Pre- and post-webinar questions, responses, and frequencies for each response rate.

Pre-Webinar

Questions/Responses	Frequency (%)
Which best describes you?	**(n=20)**
Grower	9 (45%)
Ag Professional	3 (15%)
Food Systems Enthusiast	3 (15%)
Other	5 (25%)
Indicate any food safety audits you have conducted on your farm in the last two years (check all that apply):	**(n=19)**
USDA GAP/GHP	1 (5%)
USDA Harmonized GAP	2 (10.5%)
Global GAP	1 (5%)
Buyer-specific	1 (5%)
Self-audit	1 (5%)
I have not conducted an audit	9 (47%)
NA, not currently farming	7 (37%)
Do you have a completed food safety plan for your farm?	**(n=19)**
Yes	2 (10%)
No	10 (53%)
NA, I'm not currently farming	7 (37%)
What is your primary source of information for your farm food safety questions? (choose one)	**(n=19)**
Colorado Fruit & Vegetable Growers Association	4 (21%)
Colorado Department of Agriculture, Fruit & Veg Inspection Service	3 (16%)
Online searches	4 (21%)
CSU Extension	6 (32%)
US Dept of Agriculture	1 (5%)
Other	1 (5%)
Please assess your current ability to create or modify a Farm Food Safety Plan for your operation:	**(n=19)**
1 = very little knowledge	6 (32%)

2 = limited knowledge	6 (32%)
3 = comfortable with my knowledge and ability to apply it	4 (21%)
4 = very comfortable in my knowledge and ability	3 (16%)
Please check the type of food safety practices you currently use for your operation (check all that apply):	**(n=19)**
Good Agricultural Practices (GAPs)	6 (32%)
Good Handling Practices (GHPs)	3 (16%)
Commodity specific GAPs	1 (5%)
Complying with the Food Safety Modernization Act	3 (16%)
None at this time	8 (42%)
NA, not currently farming	2 (11%)

Post-Webinar

Questions/Responses	Frequency (%)
Will you use some of the practices you learned today?	**(n=21)**
Yes	21 (100%)
No	0 (0%)
Will you share this info with other people?	**(n=21)**
1 - 3 people	9 (43%)
More than 3 people	11 (52%)
No one	1 (5%)
Please assess your current ability to create or modify a Farm Food Safety Plan for your operation:	**(n=21)**
1 = very little knowledge	0 (0%)
2 = limited knowledge	11 (52%)
3 = comfortable with my knowledge and ability to apply it	7 (33%)
4 = very comfortable in my knowledge and ability	3 (14%)
Did you learn something new today?	**(n=21)**
Yes	21 (100%)
No	0 (0%)

Conclusions

For this study, we aimed to target both current and future growers. The campus farm manager survey provided invaluable insight into the food safety practices of other university and college campus growing projects, and working with the CSU horticulture students and CFVGA members provided a chance to get participants invested in food safety as an integral

part of a growing operation. Both populations – students and small Colorado growers – displayed a greater understanding of food safety concepts after participating in the training components of the study.

Although the limitations of this research provided for a restricted timeframe to interact with students and professionals, a solid foundation was laid for future impact. The campus-oriented food safety presentation should be developed into an online narrated module, and university and college farms should have a platform to share such food safety curriculum between institutions. By continuing to keep farm food safety on the forefront of continuing education, both current and future growers can set up operations that safely contribute to local food systems.

CHAPTER IV: LIMITATIONS AND RECOMMENDATIONS FOR FURTHER STUDIES

Just as creating a comprehensive food safety plan for any growing operation is continuous and iterative, so is developing the resources to aid farmers in doing so. For this study, we targeted both current and future growers. The scope and timeline created some limitations in what we were able to achieve, but many opportunities were identified for future work in this area.

The campus farm manager survey provided invaluable insight into the food safety practices of other university and college campus growing projects. Many of the respondents were interested in obtaining the results of the study, and expanding the food safety training programs they provide. Results should be emailed out at the conclusion of the study. A future public platform for universities and colleges to share farm food safety resources and materials would be beneficial.

Working with the CSU HORT 450A class provided a chance to get students invested in farm food safety before they enter the workforce professionally. We were only able to provide a presentation and create resources for the SEG over the course of one semester, which did not allow for revisions of the material. In academia, honing a lecture to a specific class takes a few tries, and most presenters don't get it just right the first time. In the future, the "Food Safety is Fun and Cool" presentation should be reviewed and edited to remove details on specific areas of creating a farm plan, and should focus more heavily on a food safety overview and information that is appropriate for the SEG, such as planting and harvesting best practices

Presenting in HORT 450A took 2 full class periods – a substantial amount of time for a 2-credit class. In the future, the farm food safety curricula could be offered as voiced over modules, similar to the training modules created for agriculture professionals. These modules could be an outside-of-class requirement, assigned as a pre-cursor to on-site training at the SEG. The modules could potentially be made available to other interested parties through CSU as well.

The SEG farm food safety plan should continue to be expanded to cover all area of student involvement and production. Partnering with CSU Dining Services should continue to be explored, with a buyer-specific plan written to cater to their needs. Students should be trained for production for Dining Services, and desired crops should be integrated into the HORT 450A experiential curriculum. The SEG is located within a flood plain system, and the farm plan and chosen crops should express this risk.

Results of access of the online narrated modules and farm food safety template did not correlate with the interest in resources and public information expressed by webinar participants. Continuous marketing efforts need to be employed by the CFVGA and CSU Extension to promote these resources and make the growing community more readily aware of their existence. The non-production months provide growers with time to plan for the next season, and would be an appropriate time to utilize social media, email communication, and additional webinars to the community to promote the resources created for this study. Moreover, for future webinars small-scale growers should be targeted and provided with specific training opportunities. The CFVGA webinar did not differentiate between sizes of operation.

Although the limitations of this research provided for a restricted timeframe to interact with students and professionals, a solid foundation was laid for future impact. The farm food safety plan template, online modules, and CSU student curriculum can continue to be modified to meet evolving regulations and guidance from federal and state organizations. By continuing to keep farm food safety on the forefront of continuing education, both current and future growers can set up operations that safely contribute to local food systems.

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APPENDIX A:
CSU IRB EXEMPTION STATUS

Colorado State University

Research Integrity & Compliance Review Office
Office of Vice President for Research
Fort Collins, CO 80523-2011
(970) 491-1553
FAX (970) 491-2293

Date: September 9, 2016

To: Marisa Bunning, Ph.D., Food Science & Human Nutrition
Rachael Morris, Food Science & Human Nutrition

From: IRB Coordinator, Research Integrity & Compliance Review Office (RICRO_IRB@mail.colostate.edu)

Re: Farm Food Safety Plans for Student Growers: FSMA Compliant Revisions and Campus Farm Based Case Study

Funding: Unfunded

IRB ID: 191 -17H **Review Date:** September 9, 2016
This project is valid from three years from the review date.

The Institutional Review Board (IRB) Coordinator has reviewed this project and has declared the study exempt from the requirements of the human subject protections regulations with conditions as described above and as described in 45 CFR 46.101(b):

Category 2 - Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

The IRB determination of exemption means that:

- **This project is valid for three years from the initial review.** After the three years, the file will be closed and no further research should be conducted. If the research needs to continue, please let the IRB Coordinator know before the end of the three years. You do not need to submit an application for annual continuing review.
- You must carry out the research as proposed in the Exempt application, including obtaining and documenting (signed) informed consent if stated in your application or if required by the IRB.
- Any modification of this research should be submitted to the IRB through an email to the IRB Coordinator, prior to implementing any changes, to determine if the project still meets the Federal criteria for exemption.
- Please notify the IRB Coordinator (RICRO_IRB@mail.colostate.edu) if any problems or complaints of the research occur.

Please note that you must submit all research involving human participants for review by the IRB. **Only the IRB or designee may make the determination of exemption**, even if you conduct a similar study in the future.

APPENDIX B:
PRE-SURVEY PARTCIPATION EMAIL TO CAMUS FARM MANAGERS

Good Morning!

My name is Rachael Morris and I am a graduate student at Colorado State University. My research revolves around farm produce safety, with a specific case study implementing a produce safety plan at our Student Education Garden on campus. It would be incredibly beneficial to have some information on what other campus farms are doing, and I am hoping you could take a few minutes to participate in an informal survey about your operation. Your involvement will help in the creation of food safety resources and curriculum for growers and campus farms to use in the future. Results will be compiled with other participants, and all identifiers will be excluded.

Follow the link below to take the survey, which should less than 5 minutes to complete. Your answers are anonymous, and results will be compiled with other participants.

${l://SurveyLink?d=Take the survey}

Or copy and paste the URL below into your internet browser:
${l://SurveyURL}

If you are not the best contact for your garden/farm, please let me know who to contact or pass this email on the appropriate person. Specifically, we are looking for the manager or person who heads the campus farm operation (as opposed to horticultural research field studies).

Participation is voluntary. Choosing to fill out the survey implies consent. If you change your mind and decide not to participate, you may withdraw your consent at any time without consequence.

Should you have any questions about this survey, please contact Rachael Morris at rachael.morris@colostate.edu or Marisa Bunning, 970-491-7180, marisa.bunning@colostate.edu.

Thank you in advance for your time and involvement!

Sincerely,
Rachael Morris

APPENDIX C:
CAMPUS FARM MANAGER SURVEY

Campus Farm Manager Interview

Q1 What is your title/role at your campus farm?
- ❍ Manager (1)
- ❍ Supervising Faculty (2)
- ❍ Coordinator (3)
- ❍ Lead Volunteer (4)
- ❍ Other (5) _____

Q2 How large is the farm?
- ❍ Less than 1 acre (1)
- ❍ 1 - 5 acres (2)
- ❍ More than 5 acres (3)

Q3 What is grown/raised on your farm? (click all that apply)
- ❑ Vegetables (1)
- ❑ Fruit (2)
- ❑ Grain (3)
- ❑ Poultry/Livestock (specify animals) (5) _____

Q4 Who else works on the farm besides you? (click all that apply)
- ❑ Paid employees (1)
- ❑ Students (2)
- ❑ Volunteers (3)
- ❑ Other (4) _____

Q5 How many people work on the farm throughout the season?
- ❍ Less than 10 (1)
- ❍ 10 - 50 (2)
- ❍ 50 - 100 (3)
- ❍ More than 100 (4)

Q6 Who are the end consumers of your products? (click all that apply)

- ❑ Campus dining services (1)
- ❑ CSA (2)
- ❑ Farm Stand (3)
- ❑ Worker consumption (4)
- ❑ Commercial sale (5)
- ❑ Donation (6)
- ❑ Other (7) _____

Q7 Have specific food safety procedures been implemented for the operation? (i.e. a written food safety plan or standard operating procedures)

- ❍ Yes (1)
- ❍ No (2)
- ❍ No, but plan to in the future (3)
- ❍ Some/ In Progress (please explain) (4) _____

Q8 Do workers, students, or volunteers receive any food safety training prior to working on the farm?

- ❍ Yes (1)
- ❍ No (2)
- ❍ No, but plan to in the future (3)

Q9 If yes, will you briefly describe how the material is presented, and how long the training takes to complete?

Q10 Would you like to know the results from this survey about campus farm food safety training?

- ❍ Yes (1)
- ❍ No (2)

APPENDIX D:
FARM FOOD SAFETY PRESENTATION

Food Safety is Fun and Cool

Rachael Morris
Graduate Student – Colorado State University, Food Safety
Fall 2016

Food Science & Human Nutrition | Colorado State University Extension

Agenda

- Quick project overview
- Questionnaire
- Why should we care?
- Alphabet Soup
- How to apply this information to CSU and SEG
- Resources for you!

Food Science & Human Nutrition | Colorado State University Extension

Project and Questionnaire

- Creating a FSMA compliant Farm Food Safety Template
- Creation and implementation of training and curriculum
- Case Study – SEG
- Questionnaire:
  - Assess learning objectives
  - VOLUNTARY
  - Does not have impact on your performance or grade in this class
  - Short and easy!

Food Science & Human Nutrition | Colorado State University Extension

Why Should We Care?

- Foodborne illness is a real issue in the U.S.
- Most recent estimates:
  - 48 million cases per year
  - 128,000 hospitalizations
  - 3,000 deaths
- It's Expensive
  - $152 billion dollar cost to public health sector
  - $1,814/case per year in CO

Food Science & Human Nutrition | Colorado State University Extension

Why Should We Care?

2016 Multistate Foodborne Outbreak Investigations

- Frozen Strawberries – Hep A
- Alfalfa Sprouts – *Salmonella* Reading and *Salmonella* Abony
- Flour – *E. coli* 0121 and 026
- Frozen Vegetables – *Listeria monocytogenes*
- Pistchios – *Salmonella* Montevideo
- Alfalfa Sprouts – *E. coli* 0157
- Alfalfa Sprouts – *Salmonella* Muenchen and *Salmonella* Kentucky
- Packaged Salads – *Listeria monocytogenes*

Food Science & Human Nutrition | Colorado State University Extension

Why Should We Care?

- Produce – 46%
- More than poultry, beef, or seafood

From 1998-2010, Source:
http://wwwnc.cdc.gov/eid/article/19/3/11-1866_article.htm

Food Science & Human Nutrition | Colorado State University Extension

Why Should We Care?

- Expectations have increased
- Buyers want to know that growers have food safety measures in place, and many require it.
- Accountability



Alphabet Soup

- USDA – U.S. Dept of Agriculture
  - Develop and execute federal laws related to farming, agriculture, forestry, and food
- FDA – Food and Drug Administration
- GAPS – Good Agricultural Practices
- GHPS – Good Handling Practices
- FSMA – Food Safety Modernization Act

FSMA

- Considered the most sweeping reform to food safety laws in more than 70 years.
- Regulated by FDA
- Shift from reaction to prevention
- Final rule on Produce Safety
- PSA – Produce Safety Alliance

Produce Safety ALLIANCE

A Bit of Context

- GAP/GHP
  - Certifications are voluntary
  - Driven by the buyers market
- FSMA
  - Mandatory, uniform minimum requirements
  - Might not meet standards of some buyers

Who needs to Follow the Rules?

- All produce that isn't on exemption list
- Exempt:
  - Farms that gross less than $25,000 per year in produce sales alone
  - Is not a raw agricultural commodity
  - Is rarely consumed raw
  - Is used for personal or on-farm consumption
- CSU SEG is exempt!

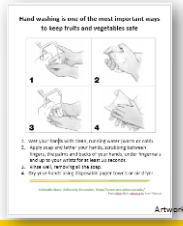
Types of Hazards

- Physical
- Chemical
- Biological



Worker Health & Hygiene

- One of the easiest ways to prevent contamination
- NEVER WORK WITH PRODUCE WHEN YOU'RE SICK!



Artwork by Anni Matsick courtesy of Penn State University

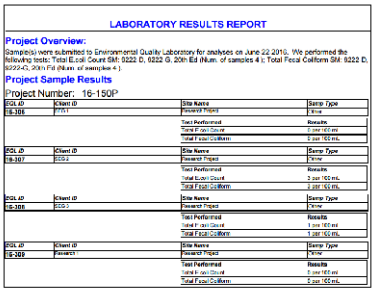
Biological Soil Amendments

- Raw Manure
  - Benefits?
  - FDA conducting a risk assessment
  - 90/120 Rule for now
- Composted Manure
- Vegetable Compost
- Others?

Water

- Agricultural
  - Risk dependent on watering method
  - FSMA Rule:
    - Geometric Mean (GM): >126 CFU/100mL generic E. coli
    - Statistical Threshold (STV): >410CFU/100mL generic E. coli
- Post-Harvest
  - Must be potable!
  - Produce rinse, hand washing, ICE
- Testing
  - Untreated surface water
  - Untreated ground water
  - Public water (municipal)

SEG Water Test Results



LABORATORY RESULTS REPORT

Project Overview:

Sample(s) were submitted to Environmental Quality Laboratory for analyses on June 22 2010. We performed the following tests: Total E.coli Count SM: 9222 D, 9222 G, 20th Ed (Num. of samples 4); Total Fecal Coliform SM: 9222 D, 9222-G, 20th Ed (Num. of samples 4).

Project Sample Results

Project Number: 16-150P

EQL ID	Client ID	Site Name	Samp Type
16-106	[illegible]	Research Project	Brine

Test Performed	Results
Total E.coli Count	0 per 100 mL
Total Fecal Coliform	0 per 100 mL

EQL ID	Client ID	Site Name	Samp Type
16-107	[illegible]	Research Project	Brine

Test Performed	Results
Total E.coli Count	3 per 100 mL
Total Fecal Coliform	3 per 100 mL

EQL ID	Client ID	Site Name	Samp Type
16-108	[illegible]	Research Project	Brine

Test Performed	Results
Total E.coli Count	1 per 100 mL
Total Fecal Coliform	1 per 100 mL

EQL ID	Client ID	Site Name	Samp Type
16-109	Research	Research Project	Brine

Test Performed	Results
Total E.coli Count	0 per 100 mL
Total Fecal Coliform	0 per 100 mL

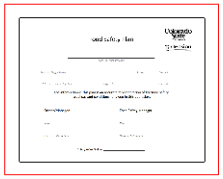
Animals & Wildlife

- Pertains to livestock, wildlife, and pets
- Prevent contamination:
  - Pre-Harvest Assessment
  - Do not harvest contaminated produce
  - Do your best!
- At the SEG?
- What methods can we use?

Harvest & Post Harvest Best Practices

- Simple and easy to follow
- Clean tools and equipment
- Potable water – this includes ice!
- Pre-sale storage
- Clean transportation

Creating a Farm Plan



- Will include:
  - All of your test results
  - SOPs
  - Training documentation
  - Contact Info
  - Traceability and Mock Recall
  - Any other pertinent info specific to your farm
- Use available resources – don't reinvent the wheel!
- Remember… it's an iterative Process!

Resources

- CSU Extension
  http://farmtotable.colostate.edu/grower-resources.php#.WAe05vkrIdU
- FDA
  http://www.fda.gov/Food/GuidanceRegulation/FSMA/
- USDA
  https://www.ams.usda.gov/services/auditing/gap-ghp/audit
- Produce Safety Alliance
  https://producesafetyalliance.cornell.edu/
- SEG Safety Plan

Questions?

References

- https://www.ams.usda.gov/services/auditing/gap-ghp/audit
- http://www.fda.gov/Food/GuidanceRegulation/FSMA/ucm359436.htm
- Produce Safety Alliance
  https://producesafetyalliance.cornell.edu/alliance
- Background Information on FSMA and the FDA
  http://www.fda.gov/Food/GuidanceRegulation/FSMA/ucm239907.htm
- FSMA Key Facts
  http://www.fda.gov/Food/GuidanceRegulation/FSMA/ucm237934.htm
  http://www.fda.gov/downloads/Food/GuidanceRegulation/FSMA/UCM472887.pdf
- Biological Soil Amendments
  https://extension.unh.edu/resources/files/Resource002114_Rep3119.pdf
  http://www.fda.gov/Food/GuidanceRegulation/FSMA/ucm482426.htm

Thank You!

Colorado State University Extension

APPENDIX E:
STUDENT PRE- AND POST-LECTURE QUESTIONNAIRE

Student Code ___ ___ ___ ___ ___

Student Food Safety Training Questionnaire

Demographics (circle)

Gender: Male Female

School Year: Freshman Sophomore Junior Senior Graduate

Age: <18 18-25 26-35 36-45 >45

Major: Horticulture Food Safety Food Science Animal Science Nutrition Soil and Crops

Other: _____

Y/N Questions (circle Y for yes, N for no)

1) I have or worked or volunteered on a farm or garden in the past, or currently am. Y / N
2) I have had food safety training in the past. Y / N
3) I have heard of FSMA before. Y / N

Scale Questions

All questions will be answered on a 5-point scale: (5) strongly agree, (4) agree, (3) neutral, (2) disagree, (1) strongly disagree. Fill in the blank provided with your numerical answer.

4) Farm workers should receive food safety training. _____
5) Food safety is a concern in America. _____
6) Having a written farm food safety plan is important to any farm operation. _____
7) Volunteer farm workers should receive food safety training. _____

True/False Questions (circle T for true, F for false)

8) I plan to own or work on a farm operation someday. T / F
9) More foodborne illness outbreaks occur each year with animal products than fresh produce. T / F
10) Record keeping is an important aspect of a food safety plan. T / F
11) Farm tools and equipment don't need to be cleaned because they are going to get dirty again the next time they are used. T / F
12) Farm food safety plans work to keep both consumers and growers safe. T / F

Multiple Choice

13) Food Safety hazards on the farm can be:
    A) Biological
    B) Chemical
    C) Physical
    D) All of the above
    E) None of the above

14) Hands should be washed with soap and warm water for:
    A) 10 seconds
    B) 20 seconds
    C) 30 seconds
    D) 60 seconds

15) Soil inputs include:
    A) Shovels
    B) Seeds
    C) Compost
    D) Irrigation water

16) The following operations need to have a FSMA compliant farm plan:
    A) Farms that are certified organic
    B) Farms that are selling to a buyer that require a third party audit
    C) Farms that sell directly to consumers at the farmers' market
    D) Farms that generate >$25,000 annual revenue

17) The source of agricultural irrigation water that should be tested at least once per year include:
    A) Municipal water
    B) Well water
    C) Surface water
    D) Both B and C
    E) All of the above

18) Where can microbiological contamination originate from:
    A) Soil/organic matter
    B) Water
    C) Humans
    D) Animals and wildlife
    E) All of the above

19) Hands should be washed:
    A) Using the restroom
    B) Before starting work
    C) After taking a break
    D) Before washing produce
    E) All of the above

20) What does FSMA stand for?
    A) Farm Safety Movement Alliance
    B) Food Safety Modernization Act
    C) Food Security Modernization Alliance
    D) Farm Security Management Act

21) Appropriate methods of managing wildlife presence in a flood plain include:
    A) Permanent fencing
    B) Poison traps
    C) Noise makers
    D) All of the above

22) Farm food safety plans should include:
    A) Test results
    B) SOPs
    C) Manager contact information
    D) Traceability
    E) All of the above

APPENDIX F:
CSU SEG HARVEST BEST PRACTICES SOP

SOP: Harvest Best Practices

Facility: Student Education Garden (SEG), CSU Horticulture Center
Address: 1707 Centre Ave, Fort Collins CO 80526
Operator/Manager(s): Dr. Mark Uchanski, Natalie Yoder
Last Revision: 9/28/2016

Scope:
This SOP details the best practices for harvesting crops from the SEG. Included in this plan are instructions for conducting a pre-harvest assessment, as well as proper methods for crop handling for all steps from field to sale.

General:
Addresses proper methods for safely handling a crop during harvest to prevent product damage and contamination. This procedure is specific to the CSU SEG, for crops grown and harvested by students for sale to multiple vendors, including CSU Housing and Dining Services. A pre-harvest assessment is included in this section and will be properly and completely filled out before every harvest. Completed past assessments will be filed for 2 years. This procedure also outlines in detail the best practices pertaining to: worker hygiene, field practices, harvest tools, harvest containers, harvest carts, washing a crop, crop storage, and post-harvest cleaning.

Tools and Equipment:
Clean footwear
Clean gloves
Pre-Harvest Checklist
Pen
Harvest knife
Harvest buckets
Harvest containers
Harvest cart
Potable water source
Cleaning tubs
Clean storage containers
Cooler
Detergent
Sanitizer

Procedures:

1. Pre-Harvest Assessment
    a. Get a new pre-harvest checklist from the "Harvest Day" binder and a pen, and bring to field that is to be harvested that day.
    b. Perform a walk-through of the harvest area, taking note of any potential hazards or points of contamination.
    c. If applicable, flag any contaminated areas as "Do Not Harvest."
    d. Complete pre-harvest checklist, and return to "Harvest Day" binder.
    e. Return to main building to complete remaining tasks.
2. Harvest Carts
    a. Do not use carts that have been used to transport trash or animals.
    b. Inspect all harvest carts to ensure they are clean and in good working order.
    c. If carts are in field, bring up to main building to transport harvest tools and containers to field.
3. Harvest Tools and Containers
    a. Inspect all tools and harvest containers to ensure they are in good working order. Set aside and mark any broken equipment and inform a supervisor.
    b. Ensure all tools have been washed and sanitized from previous use.
    c. Gather all tools and containers needed for harvest.
    d. Place all tools and containers in harvest cart for transport to field.
4. Washing Station Pre-Check
    a. Inspect washing station to make sure it is organized and free of hazards and potential contaminants, including sink, countertops, and shelves above both.
    b. Ensure access to potable water, including hooking up hoses, if applicable.
    c. Set up any additional equipment needed, including tables.
5. Worker Hygiene
    a. Perform worker assessment BEFORE entering harvest area.
    b. Ensure all workers are not sick. If they show signs of illness, send them home or assign them to an assignment that does not involve food handling.
    c. Make sure all workers have on clean clothes, clean footwear, have hair restrained, and are provided with clean gloves, if applicable.
    d. Before harvest, all workers MUST wash their hands. Refer to hand washing SOP for details on proper hand washing techniques.
6. Harvesting the Crop
    a. Gather all necessary harvest equipment from main building and transport to field.
    b. At the field, open shed to gather any additional tools needed.
    c. Communicate with all workers their area to harvest.
    d. Distribute harvest tools.
    e. Set up harvest containers so they do not tough the ground. If applicable, have workers use buckets to harvest on each row, and transfer produce from bucket to harvest container held on carts at end of field.
    f. Pack produce in harvest containers in a way that minimizes damage.
    g. Stack harvest containers in a way that minimizes contamination and damage.

7. Post-Harvest Field Check
    a. Once area has been harvested, double check for any missed produce.
    b. Ensure all harvest tools and containers are accounted for.
    c. If applicable, return tools to shed in organized manner and close and lock shed.
8. Washing Produce
    a. Transport harvested produce back to main building.
    b. Set harvest containers with produce on countertop next to sink.
    c. Place a stack of clean containers on a table on other side on sink to put clean produce into.
    d. Rinse field soil off of produce under cool running water, making sure to get all areas of the plant.
    e. Place washed produce into clean containers in a single layer to promote air circulation and air drying.
    f. Allow produce to air dry.
    g. Label containers of produce with harvest date, worker, field, and crop information.
9. Pre-Sale Storage
    a. If need be, move clean produce to coolers for storage before sale.
    b. Inspect cooler shelves and ensure they are clean.
    c. Place containers of clean produce first in a single layer, then stacking if need be with older produce on top or in front.
    d. Place organic produce above conventional produce, if applicable.
10. Post-Harvest Cleaning and Sanitation
    a. Run a hose from the potable water source to outside the main building.
    b. Fill wash and sanitation tubs with potable water.
    c. Add detergent to wash tub to recommended dilution.
    d. Add sanitizer to sanitation tub to recommended dilution.
    e. Spray harvest tools, containers, and carts with hose to remove excess field soil.
    f. Submerge and scrub all equipment using wash tub and detergent.
    g. Rinse with potable water.
    h. Dunk clean equipment into sanitizer.
    i. When all tools, containers, and carts are cleaned and sanitized, properly dispose of detergent and sanitizer from tubs and rinse them out with potable water.
    j. Allow all equipment and tubs to air dry.
    k. Return all equipment to designated storage area once dry.

APPENDIX G:
CSU SEG PRE-HARVEST CHECKLIST

Pre-Harvest Checklist: CSU Student Education Gardens and Hort. Center	
Completed by:	Date:
Crop(s) to be harvested:	
Worker/Student Names:	Field Location:
Workers have clean clothes, boots (i.e. no fecal material present), and gloves?	Y / N
Evidence of animal activity or significant pest damage?	Y / N
If so, has area been flagged as "Do Not Harvest"?	Y / N
Animal/Pest Activity:	Action Taken:
Harvest tools in working order?	Y / N
Harvest tools cleaned and sanitized?	Y / N
Harvest containers in good repair?	Y / N
Harvest containers cleaned and sanitized?	Y / N
Harvest carts in good repair?	Y / N
Notes on harvest tools maintenance:	
Washing station area organized and clear of potential contaminants?	Y / N
Washing station set up?	Y / N
Cooler Temps:	
Additional Notes:	
	Updated Oct. 2016

APPENDIX H:
FARM FOOD SAFETY TEMPLATE

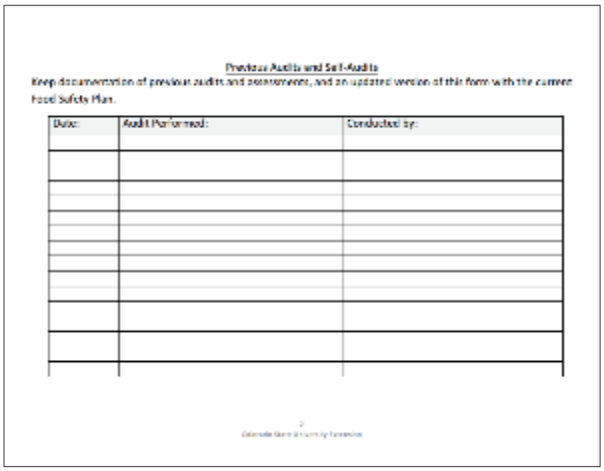
Food Safety Plan

Colorado State University Extension

The information in this plan is an accurate representation of the food safety practices and conditions followed in this operation.

Owner/Manager:

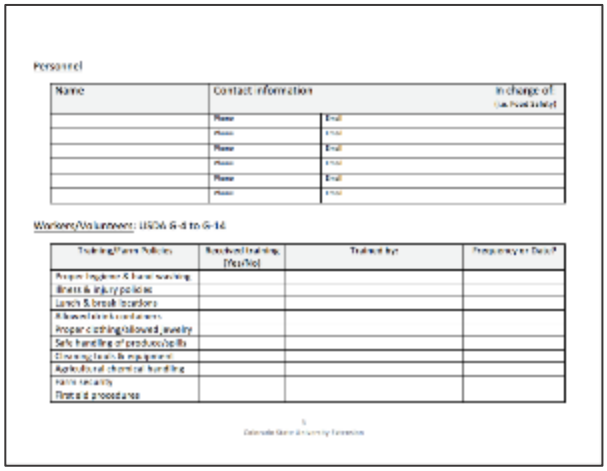
Food Safety Manager:



Previous Audits and Self-Audits

Keep documentation of previous audits and assessments, and an updated version of this form with the current Food Safety Plan.

Date:	Audit Performed:	Conducted by:

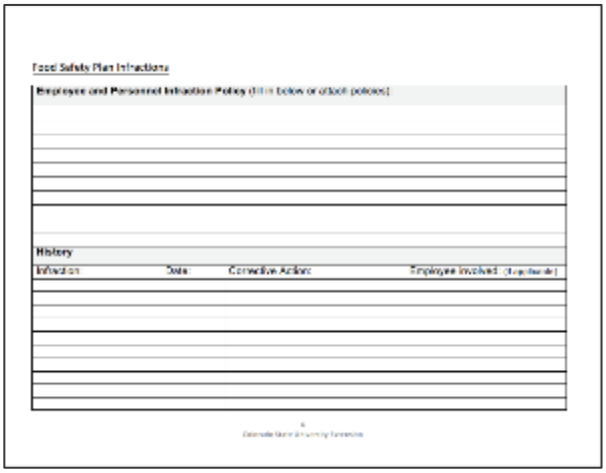


Personnel

Name	Contact information		In charge of food safety plan?
	Phone	Email	
	Phone	Email	
	Phone	Email	
	Phone	Email	
	Phone	Email	
	Phone	Email	

Workers/Volunteers: USDA G-8 to G-14

Training/Farm Policies	Received training (Yes/No)	Trained by:	Frequency or Date?
Proper hygiene & hand washing			
Illness & injury policies			
Lunch & break locations			
Prohibited conditions: Proper clothing/allowed jewelry			
Safe handling of produce/spills			
Drinking/tobacco use/gum			
Agricultural chemical handling			
Farm security			
First aid procedures			

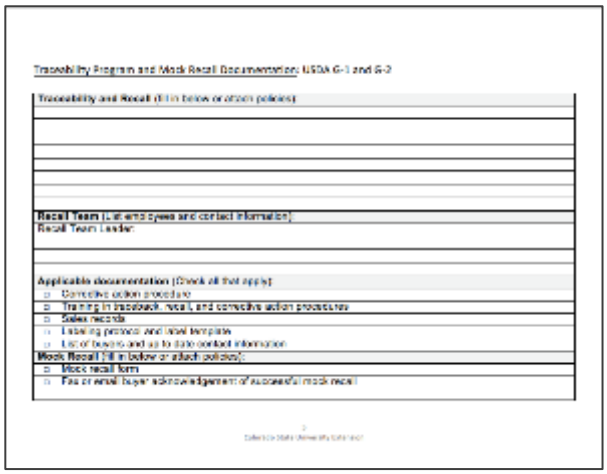


Food Safety Plan Infractions

Employee and Personnel Infraction Policy (Fill in below or attach policies)

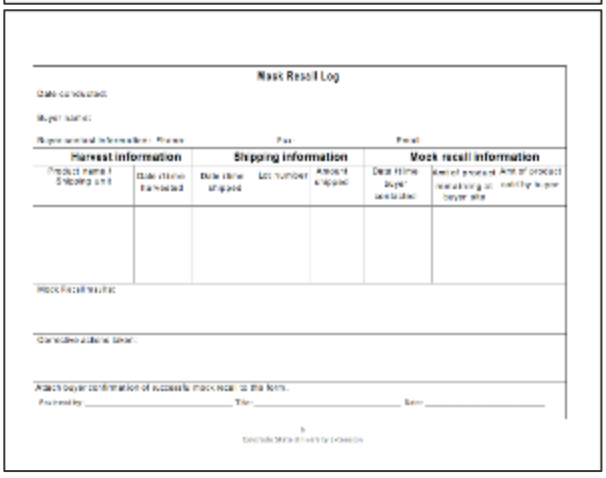
History

Infraction	Date	Corrective Action	Employee Involved (Supervisor)



Traceability Program and Mock Recall Documentation: USDA G-1 and G-2

Traceability and Recall (Fill in below or attach policies)
Recall Team (List who does and contact information)
Recall Team Leader:
Applicable documentation (Check all that apply)
☐ Corrective action procedure
☐ Training in traceback, recall, and corrective action procedures
☐ Sales records
☐ Labeling protocol and label template
☐ List of buyers and up to date contact information
Mock Recall (Fill in below or attach policies):
☐ Mock recall form
☐ Fax or email buyer acknowledgement of successful mock recall



Mock Recall Log

Date conducted:

Buyer called:

Buyer contact information: Phone: Fax: Email:

Harvest information		Shipping information			Mock recall information	
Product name / Shipping unit	Date of/time harvested	Date/time shipped	Lot number	Amount shipped	Date/time buyer contacted	Amount of product recalled (e.g., cases) by buyer site

Mock Recall results:

Corrective actions taken:

Attach buyer confirmation of successful mock recall to this form.

Reviewed by: _____ Title: _____ Date: _____

Potable Water Availability: USDA G-3

Potable Water Use and Source (check all that apply)			
Use/Source	Municipal/City	Private Well	Surface Water
Drinking	☐	☐	Not permitted

Drinking water policy:

Applicable documentation:
- ☐ Water testing documentation
- ☐ Well water treatment record

Worker Facilities: sinks (soap, water, disposable towels), signs, toilets, drinking water: USDA 2-3 to 2-5

Facility Locations:

Policy and procedures related to hand washing:

Applicable documentation
- ☐ Hand washing signs posted in all facilities

Worker Health, Hygiene, and Sanitary Practices Policy (fill in below or attach policy):

Applicable documentation (Check all that apply):
- ☐ Verification checklist (for compliance with hand washing and other appropriate hygiene practices)
- ☐ Training log (for proper procedure and frequency of hand washing)

Toilet Facilities (check all that apply):
- ☐ Indoor facilities ☐ Portable units ☐ None on site

Availability of Toilet Facilities:

Maximum number of employees on site every one/two	Number of toilet facilities within 1/4 mile walk	Ratio of employees to toilet facilities

Applicable documentation (Check all that apply):
- ☐ Additional information sheet
- ☐ Verification checklist (for condition, maintenance, use by workers)
- ☐ Map indicating location of field sanitation units and handwashing stations
- ☐ Toilet sanitation service and cleaning contract/service report
- ☐ Spill response plan
- ☐ Training log (for notification of reasonable access and proper use)

Policy for Visitors and Applicable documentation (Check all that apply):
- ☐ Visitors must sign in and receive a verbal or print copy of pertinent farm policies
- ☐ Visitor/GAA member policy
- ☐ Signs posted for important visitor information

Farm and Field Map(s)

Agricultural activities conducted at this site:

☐ Crop production only	☐ Both crop and animal production	☐ Animal production only

Crop(s)/Livestock grown on this property: (acres owned, leased, contracted, or consigned for each crop)
☐ Additional crops documented on separate sheet

Crop(s)/Livestock	Area under cultivation/livestock production (acres)
1)	
2)	
3)	
4)	
5)	
6)	
7)	
8) 9) 10)	

Field Map

Sketch or attach maps that indicate production fields, packing, staging areas, field sanitation units, active wells, flood water diversion, history of recent flooding areas, nature's drainage features and water systems on site and adjacent properties.

Water: USDA 1-3 to 1-5

Water Use and Source (check all that apply)			
Use/Source	Municipal/City	Private Well	Surface Water
Drinking	☐	☐	Not permitted
Hand Washing	☐	☐	☐*
Cleaning food contact surfaces	☐	☐	☐
Irrigation: ☐ None ☐ Overhead sprinkler	☐	☐	☐
☐ Drip ☐ Furrow ☐ Flood	☐	☐	☐
Fertilizer application	☐	☐	☐
Pesticide/fungicide application	☐	☐	☐

*Water used for hand washing in field sanitation units is not required to meet GAA potability standards. Chlorine or other acceptable sanitizers are also required to minimize the possibility of microbial cross-contamination.

Water source:	Applicable documentation: (check all that apply)
☐ Municipal water City: _____	☐ Annual water bill with analysis results ☐ Laboratory analysis
☐ Private well water Number: _____	☐ Laboratory analysis ☐ Monitoring checklist Well condition & maintenance documentation:
☐ Surface water Source: _____	☐ Laboratory analysis ☐ Treatment procedure and schedule

Water Quality (fill in or attach policy):
Documentation
☐ Attach documentation for annual water risk assessment

Animals, Wildlife, Livestock: USDA 1-6 to 1-13

Animals, Wildlife, Livestock (fill in or attach policy):

Question:	Y/N	Correction Action Taken If Necessary
Are domestic animals, livestock or wildlife regularly observed in the field?		
Signs of droppings or other animal activity in fields?		
Are measures taken to limit livestock, domestic & wild animals from entering production areas?		
Production & handling areas monitored for domestic & wild animals (including birds, rodents)?		
Are measures taken to restrict livestock and wildlife access to crop irrigation water source or delivery system?		

Sewage and Manure: USDA 1-6 to 1-7, 1-44 to 1-22

Sewage, Manure and Biosolids		
Sewage Treatment (check all that apply):		
☐ Municipal	☐ Septic System	☐ Portable containment system
Cleaning and Maintenance of Portable Toilets:		
☐ Performed by grower	☐ Contracted service	☐ No Portable Toilets at this site
Manure and Municipal Biosolids If no animal manures or biosolids are used as soil amendments, check the box below, no further action is needed in this section. ☐ Raw or composted animal manure IS NOT used or stored at this site.		
Soil Amendments used at this location (check all that apply):		
☐ No manure or municipal biosolids are applied to soil	☐ Raw manure is applied to soil	☐ Composted manure or municipal biosolids are applied to soil
Manure handling and storage:		
☐ No manure or municipal biosolids are stored on the premises	☐ Raw manure is stored at this location	☐ Municipal biosolids are stored at this location
Practice(s) followed at this site (Check all that apply): ☐ Raw animal manure is used as a soil amendment at this site; ☐ Animal manure is composted at this site using an active process; ☐ Animal manure is composted at this site using an passive process; ☐ Municipal biosolids are applied to soil at this site		

Policy (fill in or attach policy for handling of manure and biosolids):
Raw Materials (list source and additional information; including soil amendments, mulches, seeds, etc.)
Applicable documentation (Check all that apply):
☐ Verification checklist (for safe storage and handling practices)
☐ Raw manure application procedures (date, source, timing, rate)
☐ Onsite compost preparation procedure (composition temperature, time, duration)
☐ Compost/biosolids certificate of analysis (if purchased from outside vendor)
☐ Map indicating location of manure/biosolids storage and/or composting areas, manure lagoons, livestock/dairy facilities on this property

Soils' Previous Land Use: USDA 1-23 to 1-25

Previous Land Use (check all that apply for area under cultivation)			
Has the current crop(s) been grown at this location for LESS THAN 5 years? Yes ☐ No ☐	Has there been any expansion into previously unused land within the last 5 years? Yes ☐ No ☐	Has the current crop(s) been grown at this location for MORE THAN 5 years? Yes ☐ No ☐	
If all or part of the crop has been grown at this location for LESS THAN 5 years, describe previous land use:			
Adjacent Properties (check all that apply):			
☐ Crop production ☐ Dairy or livestock operation		☐ Watershed (river, stream, pond, lake)	☐ Manure dumping or storage
☐ __________ Other ☐ Residential with operating septic system		☐ Commercial or industrial development	☐ Municipal or private dumping site
Adjacent and Previous Land Use Policy (fill in below or attach policy):			
Applicable documentation (check all that apply):			
☐ Additional information sheet (for previous and adjacent land use)			
☐ Map indicating adjacent properties presence of manure/biosolids storage areas, manure lagoons, livestock/dairy facilities, grazing areas, and flooding areas			
☐ Verification checklist (for evidence of flooding, presence of domestic or wild animals			
☐ Soil chemical and/or microbiological test results (if previous land use indicates potential hazards)			

Harvest and Packing: USDA 2-1, 2-6 to 2-22

Harvesting, Field Packing, and Transportation Policies (fill in below or attach policies):
Document pre-harvest assessment made on crop production areas, including possible sources of contamination.
Are harvest containers stored in a manner that prevents contamination prior to use? Yes ☐ No ☐
Are harvest containers one-time use or re-useable?
If reusable, are harvest containers cleaned and sanitized accordingly? Yes ☐ No ☐
Have harvest containers have been inspected to be free from signs of contamination? Yes ☐ No ☐
Equipment, machinery and tools are clean and in good repair? Yes ☐ No ☐
Applicable documentation (Check all that apply):
☐ Additional information sheet (for harvesting policies)
☐ Verification checklist (for evidence of safe harvest, handling, and transportation practices
☐ Training policy and log (sanitary harvesting and handling instructions)
☐ Contamination plan (for glass, plastic, chemicals, etc.)

Facilities: USDA 3-15 to 3-26

Preparation/Shed Packing/Storage Areas and Facilities (Fill in below or attach policy)

Applicable documentation (Check all that apply):

- ☐ Additional information sheet (for preparation, packing, storage area policies)
- ☐ Verification checklist (for evidence of packing and storage area cleaning and maintenance practices)
- ☐ Training policy and log (cleaning/sanitizing packing area and equipment)
- ☐ Cull plan/debris/trash removal policy

Facilities – Water: USDA 3-3 to 3-11

Preparation/Washing/Packing Line (Fill in below or attach policy)

Source water used is potable Yes ☐ No ☐

Water used for cooling/ice is potable Yes ☐ No ☐

Water applied to produce has been tested and is microbially safe. Yes ☐ No ☐

Applicable documentation (Check all that apply):

- ☐ Additional information sheet (for preparation, packing, storage area policies)
- ☐ Water treatment verification
- ☐ Cleaning, temp, pH and exposure time policy and log

Chemical Storage and Application: USDA G-15, 4-11

Agricultural Chemical Storage and Application (Fill in below or attach policies)

☐ Agricultural chemicals are not stored or used on this site.

Agricultural chemicals are stored:

- ☐ In an area dedicated only to agricultural chemicals
- ☐ In a clearly identified location (sign on door)
- ☐ In a locked or controlled access location
- ☐ In a covered, clean, dry location that is temperature appropriate (above freezing)
- ☐ With labels/identification: intact and legible (product name, active ingredient, manufacturer)
- ☐ In a manner that maintains the integrity of the container and prevents spoilage (closed bag, container with lid)
- ☐ With material safety data sheets (MSDS) for appropriate products available for ease access

Applicable documentation (Check all that apply):

- ☐ Additional information sheet (for policies related to application of pre-harvest treatments)
- ☐ Verification checklist (for evidence of safe pre-harvest practices)
- ☐ Training policy and log (sanitary harvesting and handling instructions)
- ☐ Chemical Application Training Documentation

Chemical Application Training: USDA G-15

Employees or contracted personnel that apply pre- or post-harvest chemicals must be licensed or trained on specific application and use.

Farm Employees

Name	Contact Information		Training Type/Date
	Phone	Email	
	Phone	Email	
	Phone	Email	
	Phone	Email	
	Phone	Email	
	Phone	Email	

Contracted Personnel

Name	Contact Information		Training Type/Date
	Phone	Email	
	Phone	Email	
	Phone	Email	
	Phone	Email	
	Phone	Email	

Pest Control: USDA 3-30 to 3-33, 4-13 to 4-18

Pest Control Management (Fill in below or attach policies):

Applicable documentation (Check all that apply):

- ☐ Additional information sheet (for manure/compost/temperature policies)
- ☐ Service Reports for pest control program

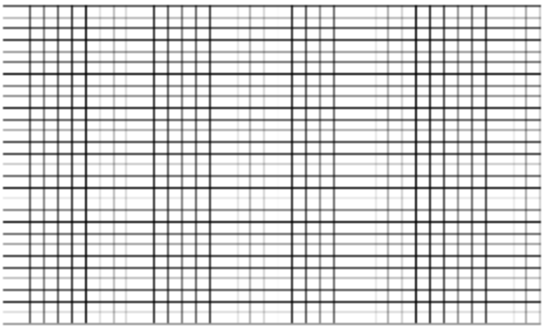
Cold Chain Management: USDA 4-17 to 4-23, 6-8 to 6-14

Cold Chain Management (Fill in below or attach policies)

Applicable documentation (Check all that apply):

- ☐ Additional information sheet (for cold chain/temperature policies)
- ☐ Verification checklist (for evidence of safe harvest, handling, and transportation temperatures)
- ☐ Training policy and log (temperature management)
- ☐ Policies addressed for cooling and ice
- ☐ Cooling schedule (refrigeration equipment, storage and use) and costs only)

Parking Flow Diagram



Food Defense Plan: USDA 7-1 to 7-36

The food defense plan is created separately from your food safety plan. An employee is designated to oversee the plan, and all employees must be provided with training. The FDA provides several resources to help you build a food defense plan for your farm. For more information, visit

http://www.fda.usda.gov/type/portal/fda/topic/food-defense-and-emergency-response

Areas of Consideration:
Visitor policy (check in, ID, access areas, parking, supervised for visit)
Employee access and ID (during workday, after termination)
Computer safety (restricted access, transaction traceability)
Security of fields (restricted public access, perimeter fence)
Security of facilities (locks on windows and doors, key accountability)
Security of vehicles
Deliveries (schedule, supervised, delivery ejection)
Emergency response

Applicable documentation (Check all that apply):
Registration with the FDA (registration number)
Mock Recall
Employee identification (and background checks if applicable)

Acknowledgements

This curriculum was adapted from Penn State Extension's and Cornell University's National GAPs Farm Plans.

Assistance is gratefully acknowledged from:

[redacted]

For questions, please contact:

[redacted]

Colorado State University Extension

APPENDIX I:
NARRATED TRAINING MODULES (3)

MODULE 1

Guide to Colorado
Farm Food Safety Plan

Steps to documenting your farm's policies and procedures for managing contamination risk

Colorado State University Extension

3 Modules

- Module 1 – Intro, FSMA, Hazards, Recall
- Module 2 – Water, Hygiene, Animals, Soil
- Module 3 – Harvest, Post Harvest Best Practices, Food Defense

Module 1

- Overview
- Foodborne illness
- FSMA
- GAPs
- Hazards
- Traceability
- Mock Recalls

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Overview

- Why does your farm need a food safety plan?
- What information is included in the plan?
  - Personnel
  - Product mock recall
  - Water
  - Hygiene and sanitation practices
  - Crops and livestock
  - Field map
  - Manure use
  - Previous and adjacent land use
  - Harvest, packing, transportation practices
  - Buildings/facilities
  - Chemical use, storage, application, and documentation practices
  - Pest control management
  - Cold chain management
  - Food defense plan

Benefits of having a plan

- Can help identify potential issues
- Helps prepare for farm audits
- Protects your business
- Helps maintain and expand market access
- Increases your confidence

Having a plan makes me feel like I have better control.

U.S. Foodborne Illness Outbreaks Linked to Produce, 1998-2008

Produce: 45.9%
- Leafy greens: 22.3%
- Fruits-nuts: 11.7%
- Vine-stalk: 12.0%
- Roots: 3.6%
- Sprouts: 0.3%

Painter et al. 2013

Produce Related Outbreaks

713!

Source: Pew Charitable Trusts

The landscape has changed

- Expectations of accountability have increased
  - Buyers need/want to know food safety practices are in place
- Detection methods for foodborne illness have improved
  - Cause can be traced to a single farm, processing plant, restaurant, or event
- FDA has more authority
  - Can initiate a product recall

What is FSMA?

Food Safety Modernization Act

- Signed into law on January 4, 2011
- Reform of US food safety laws affecting domestically grown and imported foods (for human and animal foods), through 7 major rules, plus guidance, including:
  - Produce Safety
  - Preventative Controls

List of all FSMA rules and guidance:
http://www.fda.gov/Food/GuidanceRegulation/FSMA/ucm253380.htm

Produce Safety Rule

- Focuses on prevention, not detection
- New standards for growing, harvesting, packing, and holding produce
- Applies to fruits and vegetables normally consumed raw

Built on Good Practices

GAPs (Good Agricultural Practices): Agricultural industry's guide to minimize and prevent contamination of fresh fruits and vegetables on the farm

GHPs (Good Handling Practices): Focuses on best practices for packing and storing facilities, cleaning and sanitation, and transportation

Key Factor: Written Farm Plan

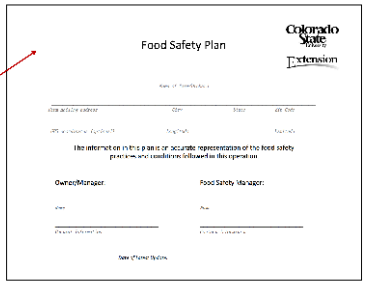
Produce Safety ALLIANCE

Traceability Program and Mock Recall Documentation: USDA G-1 and G-2

Traceability and Recall (fill in below or attach policies):
Recall Team (List employees and contact information):
Recall Team Leader:
Applicable documentation (Check all that apply):
☐ Corrective action procedure
☐ Training in traceback, recall, and corrective action procedures
☐ Sales records
☐ Labeling protocol and label template
☐ List of buyers and up to date contact information
Mock Recall (fill in below or attach policies):
☐ Mock recall form
☐ Fax or email buyer acknowledgement of successful mock recall

Cover Page

- Personalize with
  - Your farm's name
  - Location
  - Logo, photo
  - FS Manager


Food Safety Plan

Colorado State University Extension

Owner/Manager:

Food Safety Manager:

This plan is unique to your farm and outlines the policies and procedures that are in place to keep the food you produce as safe as possible.

Page 1

Potential Food Safety Hazards

To assess risk, you need to:

Thoroughly evaluate all processes from field prep through transportation, by:

1. Walking your property
2. Observing animal, human, plant interactions
3. Questioning/understanding practices used by farm managers & workers

*Remember, some risks occur naturally, others result from human actions. You need to be aware of both!

Seasonal Differences

Audits

Previous Audits and Self-Audits

Keep documentation of previous audits and assessments, and an updated version of this form with the current Food Safety Plan.

Date:	Audit Performed:	Conducted by:

Page 2

Employee and Personnel Information

- Detailed personal and contact information for every employee and all personnel on the farm.
- Note information such as background checks, completed training requirements, and which employees are in charge of different policies.

There has to be an employee in charge of:

- Food Safety Plan
- Recall and Traceability
- Food Defense

Personnel

Name	Contact Information	In charge of: (i.e. Food Safety)
	Phone / Email	
	Phone / Email	
	Phone / Email	
	Phone / Email	
	Phone / Email	

Workers/Volunteers: USDA G 4 to G 14

Training/Farm Policies	Received training (Y/N)?	Trained by:	Frequency or Date:
Proper hygiene & hand washing, illness & injury policies			
Farm & farm food use			
Allowed drink containers			
Proper clothing/allowed jewelry			
Safe handling of produce/splits			
Cleaning tools & equipment			
Agricultural chemical handling			
Farm security			
First aid procedures			

Page 3

Food Safety Plan Infractions

Employee and Personnel Infraction Policy (fill in below or attach policies):

History

Infraction:	Date:	Corrective Action:	Employee involved: (if applicable)

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Page 4

Traceability Program

- A leader and a team will need to be identified to be in charge of both the program and performing mock product recalls

Traceability Program and Mock Recall Documentation: USDA G 1 and G 2

Traceability and Recall (fill in below or attach policies)

Recall Team (List employees and contact information):
Recall Team Leader

Applicable documentation (Check all that apply):
- ☐ Corrective action procedure
- ☐ Training in forecheck, recall, and corrective action procedures
- ☐ Sales records
- ☐ Labeling protocol and label template
- ☐ List of buyers and up to date contact information

Mock Recall (fill in below or attach policies)
- ☐ Mock recall form
- ☐ Fax or email buyer acknowledgement of successful mock recall

Page 5

One Step Forward, One Step Back

Keep organized records in a way that works for your farm operation

Traceability and Tracking System

- Create a system that works for your farm
- Include code on packing containers, invoices and shipping labels

Example:

Package ID#
EF SW 172 M K

EF = Equinox Farms
SW = Southwest Field
172 = June 21, Julian Date
M = Morning Shift
K = Kale

Mock Recall

- Verify Contact information and communication methods
- Test product traceability
- Protect your farm by being prepared

Customize the log based on your farm's products and operations!

Mock Recall Log

Date conducted:

Buyer name:

Buyer contact information: Phone: Fax: Email:

Harvest information		Shipping information			Mock recall information	
Product name / Shipping unit	Date(s) product harvested	Date / time shipped	Lot number	Amount shipped	Date / time buyer contacted	Amt of product remaining at buyer site / Amt of product sold by buyer

Mock Recall results:

Corrective actions taken:

Attach to your confirmation of harvest/mass recall to this form

Reviewed by: _____ Title: _____ Date: _____

Example of simplified mock recall

- Contact the buyer
- Let them know you are performing a mock recall
- Identify chosen lot number
- Request information on how much of lot has been sold, and how much remains in stock
- Obtain written documentation of exchange

Conduct mock recalls AT LEAST once per year!

End of Module 1

Recap:

- Foodborne Illness
- FSMA
- GAPs
- Hazards
- Traceability

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Next Up

- Module 2
  - Potable Water and Water Testing
  - Facilities
  - Worker Hygiene
  - Farm Maps
  - Animals and Livestock
  - Soil

MODULE 2

Guide to Colorado
Farm Food Safety Plan

Steps to documenting your farm's policies and procedures for managing contamination risk

Module 2

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Module 2

- Potable Water
- Facilities
- Worker Hygiene
- Farm Maps
- Water Testing
- Animals and Livestock
- Soil

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Potable Water

Potable Water Availability, USDA C-3

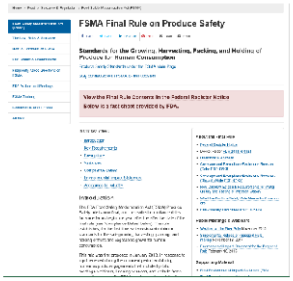
Potable Water Use and Source (check all that apply):			
Use/source	Municipal/City	Private Well	Surface Water
Drinking	☐	☐	Not permitted

Drinking water policy

Applicable documentation
- ☐ Water testing documentation
- ☐ Well water treatment record

Page 7

Water Testing

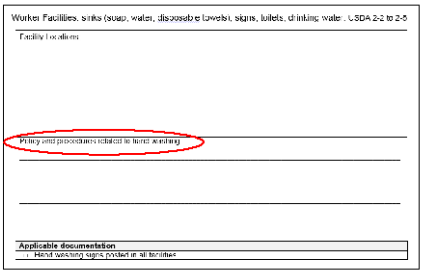


http://www.fda.gov/Food/GuidanceRegulation/FSMA/ucm334114.htm

Facilities

Policy should include information on:

- Facility locations
- Hand washing
- Maintenance



Page 8

Worker Health, Hygiene, and Sanitary Practices Policy (fill in below or attach policy):		
Applicable documentation (Check all that apply):		
☐ Verification checklist (for compliance with hand washing and other appropriate hygiene practices)		
☐ Training log (for proper procedure and frequency of hand washing)		
Toilet Facilities (check all that apply)		
☐ Indoor facilities	☐ Portable units	☐ None on site
Availability of Toilet Facilities:		
Maximum number of employees on site at any one time	Number of toilet facilities within ¼ mile walk	Ratio of employees to toilet facilities
Applicable documentation (Check all that apply):		
☐ Additional information sheet		
☐ Verification checklist (for condition, maintenance, use by workers)		
☐ Map indicating location of field sanitation units and handwashing stations		
☐ Field sanitation service and cleaning contract/service report		
☐ Spill response plan		
☐ Training log (for notification of reasonable access and proper use)		
Policy for Visitors and Applicable documentation (Check all that apply).		
☐ Visitors must sign in and receive a verbal or print copy of pertinent farm policies		
☐ Visitor/CSA member policy		
☐ Signs posted for important visitor information		

Page 9

Hand Washing Signs

Artwork by Anni Matsick courtesy of Penn State

Farm and Field Map(s)

Agricultural activities conducted at this site:

☐ Crop production only ☐ Both crop and animal production ☐ Animal production only

Crop(s)/Livestock grown on this property: (acres owned, leased, contracted, or consigned for each crop):
☐ Additional crops documented on separate sheet

Crop(s)/Livestock	**Area under cultivation/livestock production** (acres)
1)	
2)	
3)	
4)	
5)	
6)	
7)	
8)	
9)	
10)	

Page 10

Field Map

Sketch or attach map that includes production, field packing, staging areas, field sanitation units, active wells, surface water sources, regular or recent flooding areas, manure storage sites, and septic systems on site and adjacent properties.

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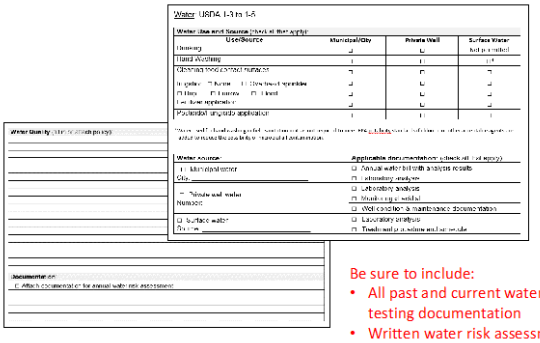
CSU Horticulture Center

Water Sources and Irrigation



Water: USDA 1-1 to 1-5

Use/Source	Municipal/City	Private Well	Surface Water (not permitted)
Drinking	☐	☐	☐
Hand Washing	☐	☐	☐
Chemical application/contact surfaces	☐	☐	☐
Irrigation: ☐ Furrow ☐ Low-level sprinkler ☐ Drip ☐ Overhead ☐ Flood	☐	☐	☐
Pre-harvest applications	☐	☐	☐
Postharvest/product application	☐	☐	☐

Water Quality (attach all testing policy):

Water source:

☐ Municipal/other
City: _____

☐ Private well water
Number: _____

☐ Surface water
Ditch: _____

Applicable documentation (check all that apply):

☐ Annual water bill with analysis results
☐ Laboratory analysis
☐ Laboratory analysis
☐ Monitoring well(s)
☐ Well construction & maintenance documentation
☐ Laboratory analysis
☐ Treatment (i.e. chlorination)

Documentation of:
☐ Attach documentation for annual water risk assessment

Be sure to include:

- All past and current water testing documentation
- Written water risk assessment
- Water systems map

Page 12 & 13

Animals, Wildlife, Livestock

Animals, Wildlife, Livestock: USDA 1-8 to 1-13

Animals, Wildlife, Livestock (fill in or attach policy):

Question:	Y/N	Correction Action Taken If Necessary
Are domestic animals, livestock or wildlife regularly observed in the field?		
Signs of droppings or other animal activity in fields?		
Are measures taken to limit livestock, domestic & wild animals from entering production areas?		
Production & handling areas monitored for domestic & wild animals (including birds, rodents)?		
Are measures taken to restrict livestock and wildlife access to crop irrigation water sources or delivery system?		

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Sewage and Manure

Sewage and Manure: USDA 1-6 to 1-7, 1-44 to 1-22

Sewage, Manure and Biosolids

Sewage Treatment (check all that apply):

☐ Municipal ☐ Septic System ☐ Portable containment system

Cleaning and Maintenance of Portable Toilets:

Performed by grower ☐ Contracted service ☐ No Portable Toilets at this site

Manure and Municipal Biosolids

If no animal manures or biosolids are used as soil amendments, check the box below, no further action is needed in this section.

☐ Raw or composted animal manure IS NOT used or stored at this site.

Soil Amendments used at this location (check all that apply):

☐ No manure or municipal biosolids are applied to soil ☐ Raw manure is applied to soil ☐ Composted manure or municipal biosolids are applied to soil

Manure handling and storage:

☐ No manure or municipal biosolids are stored on the premises ☐ Raw manure is stored at this location ☐ Municipal biosolids are stored at this location

Practice(s) followed at this site (Check all that apply):

- Raw animal manure is used as a soil amendment at this site
- Animal manure is composted at this site using an active process
- Animal manure is composted at this site using an passive process
- Municipal biosolics are applied to soil at this site

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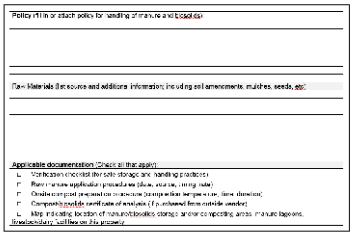

A few additional resources:

- National Organic Program composting standards
https://www.ams.usda.gov/sites/default/files/media/Compost_FINAL.pdf

- Research from Cornell University
http://www.reeis.usda.gov/web/crisprojectpages/0202285-detecting-and-monitoring-human-pathogens-in-vermicompost-and-compost-teas.html

Page 16

Soils/ Previous Land Use: USDA 1-23 to 1-25

Previous Land Use (check all that apply for area under cultivation)

Has the current crop(s) been grown at this location for LESS THAN 5 years?	Has there been any excavation into previously unused land within the last 5 years?	Has the current crop(s) been grown at this location for MORE THAN 5 years?
Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐

If all or part of the crop has been grown at this location for LESS THAN 5 years, describe previous land use:

Adjacent Properties (check all that apply):

☐ Crop production	☐ Dairy or livestock operation	☐ Watershed (river, stream, pond, lake)	☐ Manure dumping or storage
☐ Other	☐ Residential with operating septic system	☐ Commercial or industrial development	☐ Municipal or private dumping site

Adjacent and Previous Land Use Policy (fill in below or attach policy):

Applicable documentation (check all that apply):

- ☐ Additional information sheet (for previous and adjacent land use)
- ☐ Map indicating adjacent properties presence of manure/biosolids storage areas, manure lagoons, livestock/dairy facilities, grazing areas, and flooding areas
- ☐ Verification checklist (for evidence of flooding, presence of domestic or wild animals
- ☐ Soil chemical and/or microbiological test results (if previous land use indicates potential hazards)

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Tests and Documentation

- Water
- Compost
- Manure
- Soil

End of Module 2

Recap:

- Potable Water
- Facilities
- Worker Hygiene
- Farm Maps
- Water Testing
- Animals and Livestock
- Soil

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Guide to Colorado Farm Food Safety Plan

Steps to documenting your farm's policies and procedures for managing contamination risk

Module 3

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Module 3

- Harvest best practices
- Packing facilities
- Chemical storage and training
- Pest control
- Cold Chain
- Packing flow
- Food Defense

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Harvest Best Practices

Harvest and Packing: USDA 2-1, 2-6 to 2-22

Harvesting, Field Packing, and Transportation Policies (fill in below or attach policies):

Document pre-harvest assessment made on crop production areas, including possible sources of contamination.

Are harvest containers stored in a manner that prevents contamination prior to use? Yes ☐ No ☐

Are harvest containers one time use or re-useable?

If reusable, are harvest containers cleaned and sanitized accordingly? Yes ☐ No ☐

Have harvest containers have been inspected to be free from signs of contamination? Yes ☐ No ☐

Equipment, machinery and tools are clean and in good repair? Yes ☐ No ☐

Applicable documentation (Check all that apply):

- _ Additional information sheet (for harvesting policies)
- ¯ Verification checklist (for evidence of safe harvest, handling, and transportation practices
- _ Training policy and log (sanitary harvesting and handling instructions)
- ¯ Contamination plan (for glass, plastic, chemicals, etc)

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Pre-Harvest Assessment

- First point of contact with field
- Look for potential hazards
- Flag animal droppings
- Flag insect damage

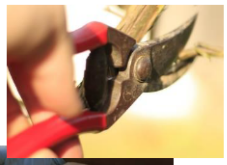
Pre-Harvest Checklist

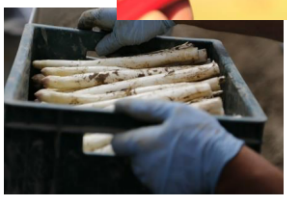
Pre-Harvest Checklist

Completed by:	Date:
Crop:	
Worker Name and Field Location	
Worker:	Field:
Machinery in working order?	Y / N
Machinery cleaned and sanitized?	Y / N
Harvest tools needed:	
Harvest tools cleaned and sanitized?	Y / N
Harvest containers checked, in good repair?	Y / N
Harvest containers washed and sanitized?	Y / N
All workers have clean clothes, boots, and gloves?	Y / N

Harvest Tools and Containers

- Check if broken or damaged
- Cleaned/sanitized before every harvest
- Use new liners





Harvest Tools and Containers

- Keep harvest containers off the ground

Facilities

Facilities: USDA 3-15 to 3-26

Preparation/Shed Packing/Storage Areas and Facilities (Fill in below or attach policy)

Applicable documentation (Check all that apply) :

- ☐ Additional information sheet (for preparation, packing, storage area policies)
- ☐ Verification checklist (for evidence of packing and storage area cleaning and maintenance practices)
- ☐ Training policy and log (cleaning/sanitizing packing area and equipment)
- ☐ Quality defect or plant removal policy

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Facilities

Post Harvest Water

Facilities – Water: USDA 3-3 to 3-11

Preparation/Washing/Packing Line (Fill in below or attach policy)

Source water used is potable. Yes ☐ No ☐

Water used for cooling/ice is potable. Yes ☐ No ☐

Water applied to produce has been tested and is microbially safe. Yes ☐ No ☐

Applicable documentation (Check all that apply) :

- ☐ Additional information sheet (for preparation, packing, storage area policies)
- ☐ Water treatment verification
- ☐ Cleaning, temp, pH and exposure time policy and log

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Cooling Water and Ice

Facilities – Water: USDA 3-3 to 3-11

Preparation/Washing/Packing Line (Fill in below or attach p

Source water used is potable. Yes ☐ No ☐

Water used for cooling/ice is potable. Yes ☐ No ☐

Water applied to produce has been tested and is microbially safe. Yes ☐ No ☐

Applicable documentation (Check all that apply) :

- ☐ Additional information sheet (for preparation, packing, storage area policies)
- ☐ Water treatment verification
- ☐ Cleaning, temp, pH and exposure time policy and log

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Let Produce Air Dry

Chemical Storage

Chemical Storage and Application: USDA G-15, 4-11

Agricultural Chemical Storage and Application (fill in below or attach policies):

☐ Agricultural chemicals are not stored or used on this site.

Agricultural chemicals are stored:

- ☐ In an area dedicated only to agricultural chemicals
- ☐ In a clearly identified location (sign on door)
- ☐ In a locked or controlled-access location
- ☐ In a covered, clean, dry location that is temperature appropriate (above freezing)
- ☐ With labels/identification intact and legible (product name, active ingredient, manufacturer)
- ☐ In a manner that maintains the integrity of the container and prevents leakage (closed bag, container with lid)
- ☐ With material safety data sheets (MSDS) for appropriate products available for easy access

Applicable documentation (Check all that apply):

- ☐ Additional information sheet (for policies related to application of pre-harvest treatments)
- ☐ Verification checklist (for evidence of safe pre-harvest practices)
- ☐ Training policy and log (sanitary harvesting and handling instructions)
- ☐ Chemical Application Training Documentation

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Chemical Application

Chemical Application Training: USDA G-15

Employees or contracted personnel that apply pre or post-harvest chemicals must be licensed or trained on specific application and use.

Farm Employees

Name	Contact information	Training Type/Date
	Phone Email	
	Phone Email	
	Phone Email	
	Phone Email	

Contracted Personnel

Name	Contact information	Training Type/Date
	Phone Email	
	Phone Email	
	Phone Email	
	Phone Email	

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Pest Control

Pest Control: USDA 3-30 to 3-33, 4-13 to 4-16

Pest Control Management (fill in below or attach policies):

Applicable documentation (Check all that apply):

- ☐ Additional information sheet (for maintaining temperature policies)
- ☐ Service Reports for pest control program

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Keep Rodents at Bay

- Keep grass and plants cut short
- Check doors, walls, and window seals

Deter Birds

Cold Chain

Cold Chain Management: USDA 4-17 to 4-23, 6-8 to 6-14

Cold Chain Management (fill in below or attach policies):

Applicable documentation (Check all that apply):

- ☐ Additional information sheet (for maintaining temperature policies)
- ☐ Verification checklist (for evidence of safe harvest, handling, and transportation temperatures
- ☐ Training policy and log (temperature management)
- ☐ Potable water used for cooling and ice
- ☐ Cleaning schedule (refrigeration equipment, storage shelves and containers)

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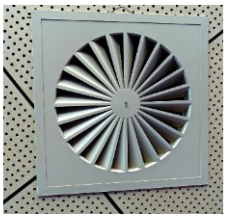
Cold Chain

- Keep clean:
  - Floors
  - Walls
  - Fans
  - Cooling Units
- Trap and run off condensation



Packing Flow Diagram

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Transportation

- Inspect trucks
- Check history for possible sources of contamination
- Pre-cool produce for cooler truck transport

Food Defense

Food Defense Plan: USDA 7-1 to 7-36

The food defense plan is created separately from your food safety plan. An employee is designated to oversee the plan, and all employees must be provided with training. The FDA provides several resources to help you build a food defense plan for your farm. For more information, visit:

http://www.fsis.usda.gov/wps/portal/fsis/topics/food-defense-and-emergency-response

Areas of Consideration:

- Visitor policy (check in, ID, access areas, parking, purposed for visit)
- Employee access and ID (during workday, after termination)
- Computer safety (restricted access, transaction traceability)
- Security of fields (restricted public access, perimeter fence)
- Security of facilities (locks on windows and doors, key accountability)
- Security of vehicles
- Deliveries (schedule, supervised, delivery rejection)
- Emergency response

Applicable documentation (Check all that apply):

- ☐ Registration with the FDA (registration number)
- ☐ Mock Recall
- ☐ Employee identification (and backgrounds checks if applicable)

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Wrap Up

- Testing
  - Water
    - Irrigation
    - Post-Harvest
  - Soil
  - Compost
  - Manure
- Documents
  - Test Results
  - Pest Control
  - SOP's
  - Cleaning Logs
  - Incident Reports
  - Training Logs
  - Mock Recall

Wrap Up

1. Know what risks are present on your farm:
   a. By location/source (use your farm map!)
   b. Time of year
   c. Practice (production, packing, harvesting)
2. Think of risks as those you can:
   a. Avoid
   b. Mitigate or manage in some way

End of Module 3

Recap:

- Harvest best practices
- Packing facilities
- Chemical storage and training
- Pest control
- Cold Chain
- Packing flow
- Food defense

Colorado State University Extension

Acknowledgements

- This template was adapted from Pennsylvania State University and Cornell University National GAPs Farm Plans.
- **Assistance is gratefully acknowledged from:**
- Elisa Shackelton, Extension Assistant, Dept. of Food Science & Human Nutrition, CSU
- Luke LaBorde, Ph.D., Assoc. Professor, Dept. of Food Science, Penn State University
- Produce Safety Alliance & National Good Agricultural Practices Program, Cornell University
- Tracy Vanderpool, Fruit & Vegetable Inspection, Colorado Department of Agriculture
- **For questions, please contact:**
- Marisa Bunning, Ph.D., Assoc. Professor and Ext. Specialist, Dept. of Food Science & Human Nutrition, CSU
- Martha Sullins, Extension Regional Specialist, Agriculture and Business Management, CSU Extension

Resources

- Colorado Department of Agriculture: Fruit and Vegetable Inspection Service (http://www.colorado.gov/cs/Satellite/ag_Markets/CBON/1251624911853)
- USDA GAP&GHP Audit Program User's Guide (http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=stelprdc5097151)
- USDA GAP&GHP Audit Checklist: (http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRDC5091326)
- Painter et al. 2013. Attribution of foodborne illnesses, hospitalizations, and deaths to food commodities by using outbreak data, United States, 1998–2008. Emerging Infection Diseases. DOI: 10.3201/eid1903.111866
- Produce Safety Alliance (http://producesafetyalliance.cornell.edu)
- CSU Extension food safety web site (www.farmtotable.colostate.edu)
- Food safety & direct marketing regulations (www.cofarmtomarket.com)
- Food Defense (http://www.fsis.usda.gov/wps/portal/fsis/topics/food-defense-and-emergency-response)

Resources on FSMA

- Standards for the Growing, Harvesting, Packing, and Holding of Produce for Human Consumption (http://www.fda.gov/downloads/Food/GuidanceRegulation/FSMA/UCM360734.pdf)
- Current Good Manufacturing Practice and Hazard Analysis and Risk-Based Preventive Controls for Human Food (factsheet: http://www.fda.gov/Food/GuidanceRegulation/FSMA/ucm334115.htm#summary)
- Toolkit for Farmers (http://www.fda.gov/downloads/Food/GuidanceRegulation/FSMA/UCM360295.pdf)
- FSMA Updates to subscribe to email updates from FDA (https://public.govdelivery.com/accounts/USFDA/subscriber/new?topic_id=USFDA_206)

References

Painter JA, Hoekstra RM, Ayers T, Tauxe RV, Braden CR, Angulo FJ, et al. Attribution of foodborne illnesses, hospitalizations, and deaths to food commodities by using outbreak data, United States, 1998–2008. Emerg Infect Dis [Internet]. 2013 Mar [*date cited*]. http://dx.doi.org/10.3201/eid1903.111866

Pew Charitable Trust. A Look Into Multistate Foodborne Outbreaks. Available from: http://www.pewtrusts.org/en/multimedia/data-visualizations/2014/a-look-into-multistate-foodborne-outbreaks

This Presentation was created and last edited September 2016.

APPENDIX J:
COLORADO FRUIT AND VEGETABLE GROWERS ASSOCIATION WEBINAR

Fundamentals of Creating a Food Safety Plan for Your Farm

December 1, 2016

Colorado State University Extension

COLORADO FRUIT & VEGETABLE GROWERS ASSOCIATION

History and Updates

- First Farm Safety Plan Webinar: March 2012

Marisa Bunning, Assoc. Prof. & Extension Food Safety Specialist
Adrian Card, Boulder County Agriculture/Natural Resources Extension Agent
Martha Sullins, Food Systems & Business Management Extension Specialist

FDA FOOD SAFETY MODERNIZATION ACT

Produce Safety ALLIANCE

PSA Training Courses

USDA

A Farm Food Safety Plan

- Gets you thinking about YOUR farm and practices
- Keeps you organized so you can focus your time and resources more effectively
- Gives you a plan to follow and assure everyone is involved
- Documents your progress
- Is required by third part audits and some buyers
- Is not required by the FSMA Produce Safety Rule, but is a good idea!

Get Organized

Produce Safety ALLIANCE

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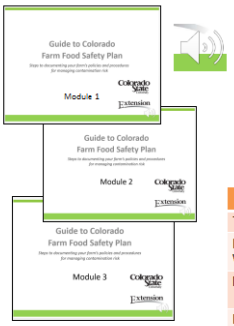
Farm Food Safety Plan 2.0



	2012	2016
Template	18 pages	27 pages
Recorded Webinar	Ag Ed Class/Extension	CFVGA
Narrated guides		Three on-line modules
Resources		+ PSA/FDA

Template, Slides & Resources

- Three online modules were designed to be used as a guideline for completing the Colorado Farm Plan template, which may be printed or filled out on a computer.
- The Colorado Farm Plan Template, webinar slides, module links, and other resources will be available from the CSU Extension Farm to Table Food Safety website: http://farmtotable.colostate.edu/

Today's Objectives

- Identify the value of a food safety plan in reducing the risk of on-farm contamination
- Develop an understanding of materials available for use in creating or revising a farm food safety plan

It's about what you are doing to address food safety and how that can be documented.

Fundamentals of Creating a Food Safety Plan for Your Farm

Rachael Morris

Colorado State University Extension

3 Modules

- Module 1 – Intro, FSMA, Hazards, Recall
- Module 2 – Water, Hygiene, Animals, Soil
- Module 3 – Harvest, Post Harvest Best Practices, Food Defense

Traceability Program and Mock Recall Documentation: USDA G-1 and G-2

Traceability and Recall (fill in below or attach policies):

Recall Team (List employees and contact information):
Recall Team Leader:

Applicable documentation (Check all that apply):
- ☐ Corrective action procedure
- ☐ Training in traceback, recall, and corrective action procedures
- ☐ Sales records
- ☐ Labeling protocol and label template
- ☐ List of buyers and up to date contact information

Mock Recall (fill in below or attach policies):
- ☐ Mock recall form
- ☐ Fax or email buyer acknowledgement of successful mock recall

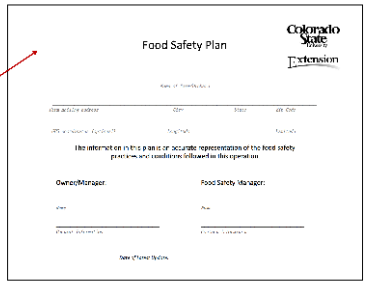
Potential Food Safety Hazards

Risk Assessment

Seasonal Differences

Cover Page

- Personalize with
  - Your farm's name
  - Location
  - Logo, photo
  - FS Manager


Food Safety Plan

Colorado State University Extension

the internet on in this plan is an accurate representation of the food safety practices and conditions followed in this operation

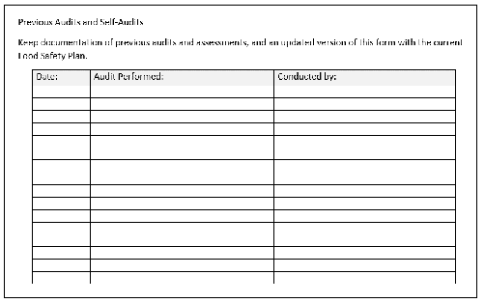
Owner/Manager:

Food Safety Manager:

This plan is unique to your farm and outlines the policies and procedures that are in place to keep the food you produce as safe as possible.

Page 1

Audits


Previous Audits and Self-Audits

Keep documentation of previous audits and assessments, and an updated version of this form with the current Food Safety Plan.

Date:	Audit Performed:	Conducted by:

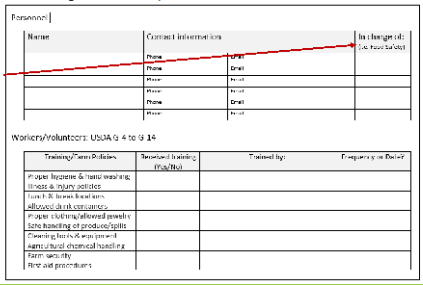
Page 2

Employee and Personnel Information

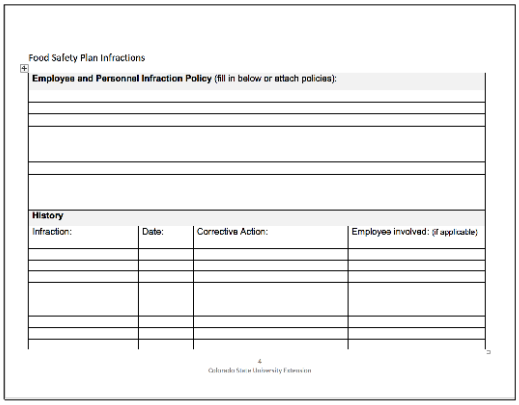
- Detailed personal and contact information for every employee and all personnel on the farm.
- Note information such as background checks, completed training requirements, and which employees are in charge of different policies.

There has to be an employee in charge of:

- Food Safety Plan
- Recall and Traceability
- Food Defense



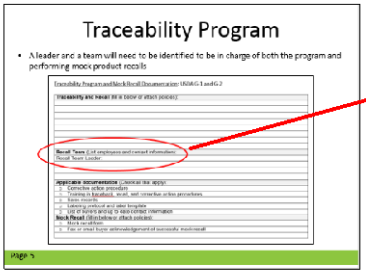
Page 3

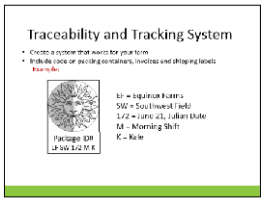


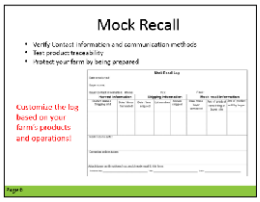
Page 4

Traceability Program

- A leader and a team will need to be identified to be in charge of both the program and performing mock product recalls.
- The team should be able to act quickly and accordingly!



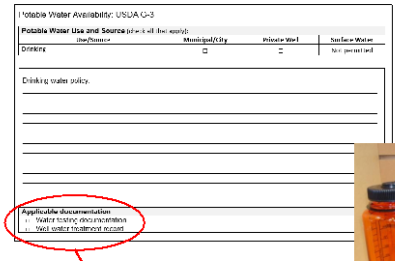




Example of simplified mock recall

- Contact the buyer
- Let them know you are performing a mock recall
- Identify chosen lot number
- Request information on how much of lot has been sold, and how much remains in stock
- Obtain written documentation of exchange

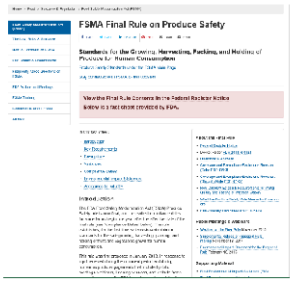
Potable Water



Make sure to include potable water tests results!

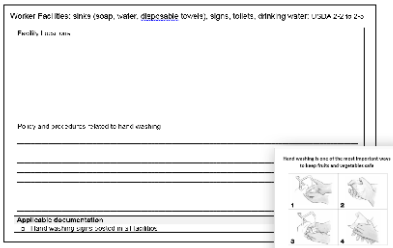
Page 7

Water Testing

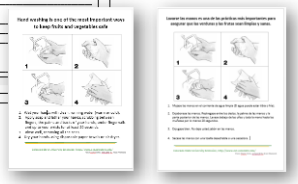


http://www.fda.gov/Food/GuidanceRegulation/FSMA/ucm334114.htm

Facilities



- Facility locations
- Hand washing
- Maintenance



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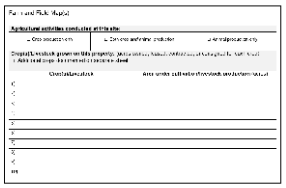
Artwork by Anni Matsick courtesy of Penn State University

Worker Health, Hygiene, and Sanitary Practices Policy (fill in below or attach policy):		
Applicable documentation (Check all that apply):		
☐ Verification checklist (for compliance with hand washing and other appropriate hygiene practices)		
☐ Training log (for proper procedure and frequency of hand washing)		
Toilet Facilities (check all that apply)		
☐ Indoor facilities	☐ Portable units	☐ None on site
Availability of Toilet Facilities:		
Maximum number of employees on site at any one time	Number of toilet facilities within ¼ mile walk	Ratio of employees to toilet facilities
Applicable documentation (Check all that apply):		
☐ Additional information sheet		
☐ Verification checklist (for condition, maintenance, use by workers)		
☐ Map indicating location of field sanitation units and handwashing stations		
☐ Field sanitation service and cleaning contract/service report		
☐ Spill response plan		
☐ Training log (for notification of reasonable access and proper use)		
Policy for Visitors and Applicable documentation (Check all that apply):		
☐ Visitors must sign in and receive a verbal or print copy of pertinent farm policies		
☐ Visitor/CSA member policy		
☐ Signs posted for important visitor information		

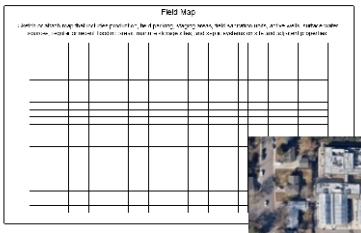
Page 9

Describing Your Farm

- What crops are grown
- Is there also livestock?
- What areas?
- Amend as the operation changes
  - But keep only current practices in your plan

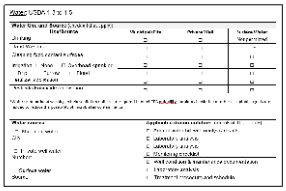


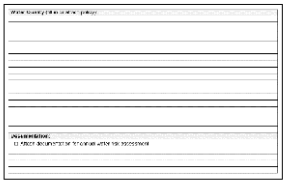
Page 10

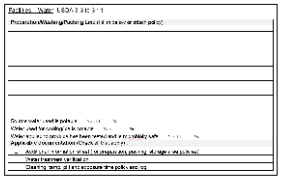


- Hand drawn farm map or aerial photo
- Google maps!

Page 11





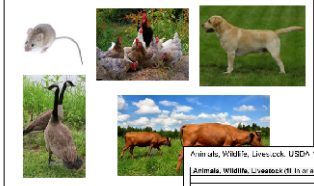


Water

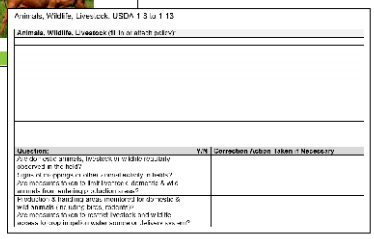
- Agricultural
- Post Harvest
- Facilities
- Cooling and Ice

Page 12, 13 & 20

Animals, Wildlife, Livestock



- Wildlife and domestic animals addressed similarly
- Create protocol for contaminated produce



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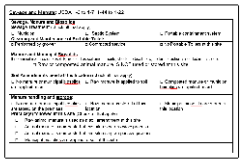
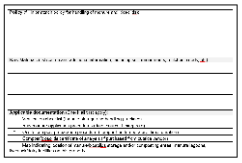
Sewage, Manure, Soil Amendments





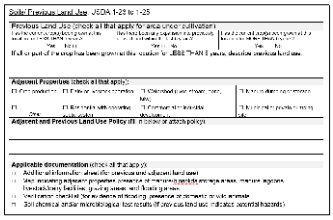
A few additional resources:

- National Organic Program
  https://www.ams.usda.gov/sites/default/files/media/Compost_FINAL.pdf
- Cornell University – Compost Tea
  http://www.reeis.usda.gov/web/crisprojectpages/0202285-detecting-and-monitoring-human-pathogens-in-vermicompost-and-compost-teas.html

Page 15 & 16

Previous Land Use

- Check Google Earth for past pictures of your property
- Talk with your neighbors about your land's history



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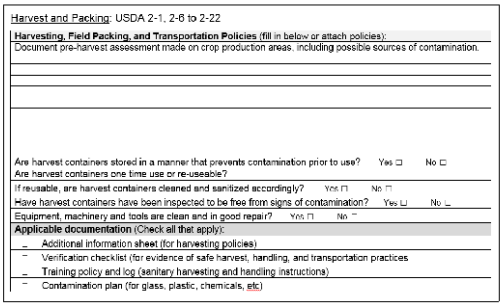
Harvest Best Practices



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Pre-Harvest

Pre-Harvest Assessment

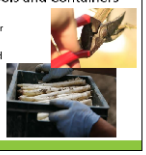
- First point of contact with field
- Look for potential hazards
- Flag animal droppings
- Flag insect damage

Pre-Harvest Checklist

Harvest

Harvest Tools and Containers

- Check if broken or damaged
- Cleaned/sanitized before every harvest
- Use new liners

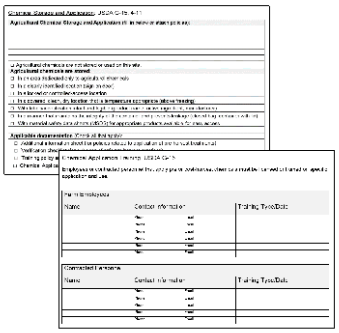


Harvest Tools and Containers

- Keep harvest containers off the ground

Documentation of Chemicals

Image: https://flic.kr/p/3dbg7P



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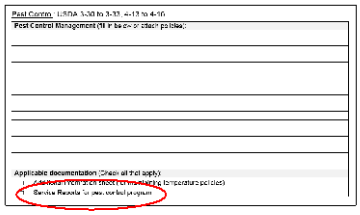
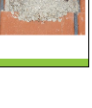
Pest Control

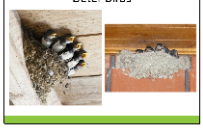


Keep Rodents at Bay

- Keep grass and plants cut short
- Check doors, walls, and window seals



Deter Birds



- Service Reports from pest control professionals
- Annual pest log
  - Type of pest
  - Amount and frequency
  - Location

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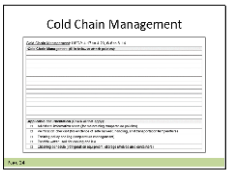
Post Harvest

Facilities

Cold Chain Management



Transportation

- Inspect trucks
- Check history for possible sources of contamination
- Pre-cool produce for cooler truck transport

Food Defense

Food Defense Plan: USDA 7-1 to 7-36

The food defense plan is created separately from your food safety plan. An employee is designated to oversee the plan, and all employees must be provided with training. The FDA provides several resources to help you build a food defense plan for your farm. For more information, visit:

http://www.fsis.usda.gov/wps/portal/fsis/topics/food-defense-and-emergency-response

Areas of Consideration:
Visitor policy (check in, ID, access areas, parking, purposed for visit)
Employee access and ID (during workday, after termination)
Computer safety (restricted access, transaction traceability)
Security of fields (restricted public access, perimeter fence)
Security of facilities (locks on windows and doors, key accountability)
Security of vehicles
Deliveries (schedule, supervised, delivery rejection)
Emergency response

Applicable documentation (Check all that apply):
☐ Registration with the FDA (registration number)
Mock Recall
☐ Employee identification (and backgrounds checks if applicable)

Page 26

- Testing
  - Water
    - Irrigation
    - Post-Harvest
  - Soil
  - Compost
  - Manure
- Documents
  - Test Results
  - Pest Control
  - SOP's
  - Cleaning Logs
  - Incident Reports
  - Training Logs
  - Mock Recall

Thank You!

Colorado State University Extension

COLORADO FRUIT & VEGETABLE GROWERS ASSOCIATION

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- Luke LaBorde, Ph.D., Professor, Dept. of Food Science, Penn State University
- Produce Safety Alliance & National Good Agricultural Practices Program, Cornell University
- Tracy Vanderpool, Fruit & Vegetable Inspection, Colorado Department of Agriculture

- **For questions, please contact:**
- Marisa Bunning, Ph.D., Assoc. Professor and Ext. Specialist, Dept. of Food Science & Human Nutrition, CSU
- Martha Sullins, Extension Regional Specialist, Agriculture and Business Management, CSU Extension

Resources

- CSU Extension Food Safety
  - www.farmtotable.colostate.edu
    - Colorado Farm Plan Template
    - Modules
    - Webinar slides
- CO Fruit and Vegetable Growers
  - https://coloradoproduce.org/

References

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