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Ordering People and Nature through Food Safety Governance

By

Patrick Francis Baur

A dissertation submitted in partial satisfaction of the

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in

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in the

Graduate Division

of the

University of California, Berkeley

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Abstract

Ordering People and Nature through Food Safety Governance

by

Patrick Francis Baur

Doctor of Philosophy in Environmental Science, Policy and Management

Designated Emphasis in Science and Technology Studies

University of California, Berkeley

Professor Alastair T. Iles, Chair

We are constantly reminded that eating fresh fruits and vegetables is healthy for us. But in the face of repeated outbreaks of foodborne illness linked to fresh produce, whether these foods are *safe* for us has become an entirely different, and difficult to answer, question. In the name of food safety, both government and industry leaders are adopting far-reaching policies intended to prevent human pathogens from contaminating crops at the farm level, but these policies meet friction on the ground. Through a case study of the California leafy greens industry, this dissertation examines the web of market, legal, technological, and cultural forces that shape how food safety policy is crafted and put into practice in fields.

Controlling dangerous pathogens and protecting public health are not the only goals served by expanding food safety regulation—food safety also serves to discipline and order people and nature for other purposes. Private firms use the mechanisms of food safety governance to shift blame and liability for foodborne pathogens to other sectors or competitors and to secure a higher market share for themselves. Food safety experts, capitalizing on the lack of available science upon which to base standards, carve out for themselves a monopoly in setting and interpreting food safety standards. And government agents wield their expanded policing powers primarily to make examples of a few bad actors in order to shore up public confidence in the food system and the government’s ability to protect its citizens, but fail to address underlying structural causes.

Zealous fixation with driving risk of microbial contamination toward an always out-of-reach “zero” draws attention away from the systemic risks inherent in the food system status quo and stifles alternative pathways for growing and distributing food, raising thorny complications for diversifying—ecologically, economically, or culturally—our country’s food provisioning system. The narrow scope of existing food safety policy must be broadened and developed holistically with other societal goals if the future of US agriculture is to be sustainable and resilient in the long term.

To Maureen,
whose patient love and support
sustained me throughout.

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1. INTRODUCTION

“Eat your vegetables.” Once the clichéd refrain of parents to children at the dining table, this exhortation to pile more produce on our plates has become a public health catchphrase. Eating more fruits and vegetables, we are told, wards off chronic diseases, infuses our bodies with vital nutrients, and generally makes people and the planet healthier. Government officials have set ambitious targets for Americans, especially children, with the United States Department of Agriculture (USDA) recommending a varied mix of five to nine servings of fruits and vegetables a day (USDA and HHS 2010). Although it remains unclear whether American diets have changed significantly in response to these recommendations—overall fruit and vegetable consumption in the US declined from 2003 to 2013, but consumption of nutrient-rich leafy greens went up (Lin and Morrison 2016)—the basic message is widely accepted: fruits and vegetables are good for us. After all, what could feel healthier than biting into a crisp, green salad?

That fruits and vegetables are healthy is now incontrovertible. But whether they are *safe* has become an entirely different question. The US Centers for Disease Control (CDC) estimates that foodborne pathogens cause approximately 48 million illnesses, 128,000 hospitalizations, and 3,000 deaths each year in the US (Scallan, Hoekstra, et al. 2011; Scallan, Griffin, et al. 2011). While the cause of many of these illnesses is never determined—some illnesses are never even documented, which is why the previous statistics are an extrapolation—evidence collected from investigating major outbreaks of foodborne illness suggests that vegetables, fruits, and nuts are a major vehicle for human pathogens and may become contaminated in the farm field (Markland and Kniel 2015). From 1996 to 2010, the US Food and Drug Administration (FDA) counted over 14,000 illnesses, 1,300 hospitalizations and 34 deaths that resulted from 131 outbreaks related to produce (FDA 2014) and another 4,451 illnesses and 47 deaths resulting from 42 additional produce-related outbreaks from 2011 to 2015 (Gubernot et al. 2016). A separate analysis of 4,589 US outbreaks with known cause of disease from 1998 to 2008 estimated that 46% of illnesses, 38% of hospitalizations, and 23% of deaths resulting from those outbreaks were attributable to produce, and 22%, 14% and 6%, respectively, to leafy greens specifically (Painter et al. 2013). The latter statistic is particularly salient in light of the deadly 2006 outbreak that arguably launched produce safety into the public, industry and regulatory limelight.

On August 27, 2006, an 81-year old woman “sick with nausea, vomiting, abdominal cramps and diarrhea”, as an investigative report by *USA Today* would later tell her story, was rushed to the hospital. When she died five days later amidst hallucinations and seizures, she became the first casualty of a 26-state outbreak of *E. coli* O17:H7 that would claim another four lives and hospitalize over one hundred victims, thirty-one of whom developed kidney failure from the shiga toxin produced by the bacteria (Weise and Schmit 2007; CDC 2006). In mid-September FDA identified bagged spinach as the culprit, and took the unprecedented step of issuing a national advisory warning consumers not to eat fresh spinach. Supermarkets and restaurants took immediate notice, and spinach “vanished from grocery shelves, salad bars and menus” (Weise and Schmit 2007). By October, public health officials had traced the source of the pathogen to a farm in San Benito County, California, where it was presumed (though never definitively proven) that fecal matter from feral pigs or nearby livestock, both of which were found to harbor *E. coli* O157:H7, had contaminated the plants growing in the fields (CDHS and

FDA 2007). Ultimately, the outbreak cost the industry an estimated \$350 million in lost sales (Weise and Schmit 2007), scaring consumers enough that nationwide spinach consumption dropped by 25% for nearly half a year (Calvin 2007). The specific companies involved—Dole, Natural Selection Foods, and Mission Organics—also faced at least 76 lawsuits from victims of the outbreak (Marler 2008).

Repeated “food scares” such as the 2006 spinach outbreak have catalyzed a widespread assault on dangerous contamination in fresh produce agriculture, focusing both government and industry attention on a new frontier: the farm field.¹ While 2006 marked neither the first nor the last to be attributed to the farm environment, this outbreak uniquely reverberated throughout leafy greens agriculture and the produce industry, producing ripple effects that have spread with unintended ecological and social consequences from the nation’s capital to farm fields across the country (Karp et al. 2015). The result is that the safety of fresh produce—the very foods we are told to eat as often as possible if we want to be healthy—can no longer be taken for granted. Safety must be continuously maintained but, as I will show, not for free.

California at the Vanguard of Reform

Farmers in California grow more than half of the nation’s vegetables and over two-thirds of its fruits and nuts by value (CDFA 2015). This prominent economic position has frequently put the state’s produce growers and handlers, especially those selling to the fresh market², at the vanguard of national reform for produce agriculture. Due to the 2006 spinach scare, no one sector has been as central to reform efforts as leafy greens. California growers provide the vast majority of greens such as spinach (66%), leaf lettuce (86%), romaine (77%), and cabbage (20%) to the US market

(CA LGMA 2016a). Within California, growers operating in the Central Coast, particularly the Salinas Valley region, dominate the statewide industry with approximately two-thirds of the production. Many of these growers maintain production year-round by shifting their operations to the desert regions of southern California and Arizona during the winter. Adding winter production from the fields of the Imperial Valley and Yuma, Arizona and small spring and fall harvests from the Central (San Joaquin) Valley to their Salinas harvests, this group of growers produces year-round (Figure 1). Together, they account for nearly 95% of leafy greens grown in the US (CA LGMA 2016a).



Figure 1. Growing regions and seasons for leafy greens in California. Source: www.lgma.ca.gov.

Immediately following the 2006 outbreak, Salinas leafy greens handlers—the businesses, also referred to as “packer-shippers”, that aggregate and distribute produce from farmers to retail or foodservice companies—initiated a collaboration with the California Department of Food and Agriculture (CDFA) to draft best practice standards for safely growing leafy greens.

By March 2007, they had finalized the California Leafy Greens Marketing Agreement (LGMA) with 71 initial signatories representing 99% by volume of leafy greens production in the state (Calvin 2007); Arizona followed suit with its own AZ LGMA in September. Both agreements are in principle voluntary for handlers. However, once handlers sign on, they are legally required to ensure that they and the growers they work with comply with the LGMA standards.³ State government officials ensure compliance through periodic audits (CA LGMA 2016b).

In addition to the food safety controls required under the LGMA, the 2006 spinach scare exposed Salinas growers to new food safety requirements imposed by their buyers, who were themselves reacting to increased liability resulting from food scares. Leveraging their concentrated purchasing power, large retail and food-service companies began to contractually oblige handlers to comply with stricter food safety standards of their own design and relayed through purchasing specifications. These private standards are known colloquially as “super-metrics” (Hardesty and Kusunose 2009; Endres and Johnson 2011), reflecting their reported tendency to demand additional measures of hazard control above and beyond LGMA guidelines. The precise content of such metrics has been difficult to gauge, however, as they are considered trade secrets and are rarely made public (Starmer and Kulick 2009).

Enforceable food safety regulation at the farm level emerged more slowly, but with potentially far greater reach. The Federal government did not weigh in until President Obama signed the Food Safety Modernization Act (FSMA, P.L. 111-353) into law in 2011.⁴ It was a major piece of legislation, representing the most sweeping overhaul of federal food safety law since the Great Depression. FSMA greatly expands the mission of FDA, extending its regulatory oversight to include primary production for the first time. The law orders FDA to set compulsory, risk-based regulatory standards for produce farmers, handlers and processors nationwide (and internationally if they export to US markets).

It took until 2015 for FDA to finalize its Produce Safety Rule (80 Fed. Reg. 74353), which is written in general terms to provide growers with the flexibility to adopt the food safety measures that they deem most appropriate for their farm. For example, with respect to how growers should manage animal intrusion, the rule only requires that growers visually monitor the growing area prior to harvest and take “measures reasonably necessary” in case an animal does find its way into the field. It leaves precise interpretation of what those measures should entail open to the discretion of growers, inspectors, auditors, and produce buyers. FDA, USDA, state agencies, and various partner organizations in the private sector are actively developing additional guidance and training resources to assist growers in interpreting and implementing the rule. In addition, many specifics—including how actively and regularly FDA will be able to monitor and enforce compliance among the tens of thousands of farms covered by the rule nationwide—remain to be determined. The development of precise technical specifications is also hampered by a dearth of sound scientific evidence upon which to prioritize risks and evaluate interventions (Stokstad 2011).

California growers must operate in this sprawling, multi-scalar patchwork of initiatives to improve food safety, and sorting out the myriad threads is no simple task. To that end, and rooted in field work conducted among farmers and food safety experts and in farm fields, packing houses and processing facilities in California, I follow these interrelated policy and technical standard developments from their genesis to the point they manifest as new material configurations of growing, harvesting and distributing fresh produce. In essence, tracing standards through the supply chain and across the larger regulatory landscape of food safety is a method to elicit comparisons, an approach through which I allow “different, actual ‘somewheres’

to be brought into productive contrast, revealing patterns and persistences which might otherwise remain unperceived” (Jasanoff 2012, 7). Throughout this examination, I tie the multiple emergent comparisons together through a common set of questions posed to standards: Precisely how are food safety standards put to work, or worked out, in fresh produce supply chains? To what ends and by whom? And, finally, upon what (or whom) is food safety work performed?

A Framework for Decentered Analysis

Under the blanket imperative to safeguard the nation’s food supply, agribusiness leaders and government regulators in the US are seeking to further rationalize the growing and harvesting of fruits and vegetables under a technocratic bureaucracy focused on preventing hazardous contamination. However, while setting technical standards and formulating sweeping policy pose significant challenges in their own right, interpreting and implementing new food safety standards, guidance, and regulations on the highly diverse ground of produce agriculture is even more complex.

This is a quintessentially “wicked” problem (Rittel and Webber 1973), as illustrated by Robert Whitaker, Chief Science and Technology Officer for the Produce Marketing Association, in his 2012 editorial for the *The Packer*, a weekly periodical for the fresh fruit and vegetable industries, titled “Turning food safety knowledge into action”. In it, he argued:

After all, when it comes to food safety, everything's a priority... Without quantitative risk assessment, everyone's left with everything as a No. 1 priority. When everything's a No. 1 priority, nothing gets done. Fourteen-year-old Dana Dziadul, who contracted *Salmonella Poona* from eating contaminated cantaloupe as a 3-year-old and still suffers side effects, reminded [us] that chasing our tails is not acceptable. Scientific data must be our guide to safeguarding the supply of fresh produce. Never lose sight that food safety is about people. When our systems don't work, people get sick. (Bob Whitaker, Produce Marketing Association, *The Packer*, July 16, 2012).

In this brief passage, Whitaker captures the essence of the food safety problem: individual illnesses are proximally caused by pathogens, but an unsafe food supply is caused by people and our systems. In many ways, this dissertation is a story of how industry and government have sought to bridge this fundamental scalar and causal divide, how they have woven together science, technology, rhetoric, and law to order people and nature in the name of “safeguarding the supply of fresh produce”. But in relating this story, I also offer a critique of a different type of story, the one that frames the very ways we judge setbacks and progress when it comes to food safety.

This dominant story tells us that “Our food safety system is a patchwork with big holes” (Gerlock 2015) because it has developed chaotically “in fits and starts as the nation’s attention turned to one crisis after another” (FSWG 2009). The solution, the story continues, is to buckle down on rational policy and institutional design: a “[model food safety system] should be science-based, with a strong emphasis on risk analysis, thus allowing the greatest priority in terms of resources and activity to be placed on the risks deemed to have the greatest potential impact” (IOM 1998). Scholars have pointed out that rational response to real foodborne dangers has been corrupted by special interests that have blocked adoption of the “best available science” when it does not suit their personal advantage and profit (Thomas 2014, xiv): “food companies often place commercial interests above those of consumer protection, and... government agencies often support business interests over those of public health” (Nestle 2003, 272).

Reform, then, requires political action to bring these special interests to heel. By removing their obstructionist manipulation of the regulatory process, we can open the pathway to rational policy that implements the best technical and scientific capacity we already have to reduce foodborne illness. In this story, the route to a better world is for truth to speak to power, and for power to listen. Politics—and the policies and institutions that political process produces—must be shaped to reflect the underlying scientific truths and respond to the objective threat of foodborne pathogens.

That story is insufficient and incomplete, beginning the narrative in the second act and with only half the actors on stage. Missing are the first act, in which those ‘underlying scientific truths’ are made, and the third act, in which people on the ground grapple with the ‘objective threat’ on a daily basis. Whereas the dominant story proceeds from the assumption that “changes in ontologically real risks unilaterally affect societal dynamics and institutional change”, I start from the premise, borrowing from Loeber et al. (2011), that “risks are constructed in the interplay between the natural, technical and social order.” In other words, I attempt to decenter the food safety story from the realist focus on why power—‘industry’ and ‘government’—ignores or accepts ‘truth’. In so doing, I also decenter the story in time and place, expanding the cast dramatically. The range of actors with crucial roles ranges far beyond the simple categories of ‘industry’ and ‘government’ to encompass farmers, scientists, activists, lawyers, consultants, environmentalists, and many others. Some work in the local setting of their farm fields or packing houses, others in the abstract domain of national policy or scientific research. Relationships are not one-way, but rather more akin to non-linear feedback loops. Even the setting of the play is not a mere stage upon which all of the human action happens—rather, farm fields, microbes, ecosystems and technologies all emerge as actants in their own right which may shift and warp the very ground upon which the actors perform their politics.

Food safety, whatever else we might say about it, is spread across a wide web of people, places, times, institutions, and ideas. The story unfolds simultaneously across many nodes at once, and to assume in its telling the primacy of any one of the myriad nodes of confluence would be to miss the proverbial forest for the tree. But amidst this forest, how can we, as a society and as a nation, know with surety whether the broad policies and technical standards set to better protect us from dangerous pathogens work the way we expect them to? How can we know with certainty whether or not putting those policies into practice on farm fields and produce handling facilities across the country will lead to unintended yet harmful side effects for people and nature?

To better understand these questions requires that I lay out a theoretical framework that itself is decentered, which can assist in organizing and making sense of the sprawling and often turbulent landscape over which food safety operates without adhering too strongly to any one central locus. In this section, I will cover the important guideposts through which I relate the story of the food safety problem, and analyze its consequences, across its many-stranded web.

Governance and Networks

As may already be apparent, food safety’s sprawling landscape is populated by numerous actors working in various capacities with diverse, and sometimes divergent, motivations. No one individual or group maintains food safety. Rather, many people dispersed at different scales—national, regional and local—and with access to different information, resources, and political leverage all participate; each contribution is necessary but insufficient on its own. Whether a farmer outside of Watsonville, California or the chief scientist for the nation’s largest produce

trade association, whether a packer-shipper in Salinas or the director of the national Center for Food Safety and Applied Nutrition at FDA, each actor has a role to carry out. Political scientists use the term “governance” to describe this sort of situation, where responsibility for preventing foodborne illness is dispersed across a heterogeneous, multi-scalar, and decentralized network (e.g. National Research Council 2010). In general, the line between government and civil society is blurring in many areas of public policy as large federal agencies, previously devoted to central planning and oversight, delegate and devolve their authority.

With this devolution, the role of government is evolving in theory and practice to allow greater autonomy and freedom for the private sector to manage and administer policy on behalf of the general public and ostensibly in the public interest, an arrangement that Levi-Faur calls “regulatory capitalism” (Levi-Faur 2009; Levi-Faur 2006). Within regulatory capitalism, the sovereign nation-state (e.g. the U.S. government) is re-conceptualized as a meta-governor (Sørensen 2006; Sørensen and Torfing 2009), responsible for defining a broad framework of acceptable processes through which sub-state actors should self-govern.⁵ Sub-state actors are left to self-organize, within the meta-governance framework, into diffuse governance networks that bear primary responsibility for regulation, i.e. setting policy goals, monitoring progress toward those goals, and adjusting the practices and behavior of their members accordingly (Sørensen and Torfing 2003; Sørensen and Torfing 2005; Hajer and Versteeg 2005; Klijn and Skelcher 2007). These decentralized networks comprise actors as well as more abstract institutions, understood as “the humanly devised constraints that shape human interaction” (North 1990). Such institutions can span the “private-public” continuum (Garcia Martinez et al. 2007) to include, for example, supply chain management, liability rules, best practice guidelines, or informal, locally shared community norms. The sovereign state primarily serves to facilitate the coordination of such networks and provide benchmarks for what good self-regulation should look like; these benchmarks are referred to as meta-regulation (Parker 2006; Gilad 2010).

Agrifood systems have seen a marked rise in meta-regulatory activity for assuring consumer-citizens of the quality of food, a loose bundle of attributes which includes ‘safety’. In particular, a new type of governance network, known as a “tripartite standards regime” (Loconto and Busch 2010), has developed for global food provisioning networks. This type of regime encompasses setting technical standards for the food industry (e.g. growers, packer-shippers, retailers, etc.), certifying that industry meets those standards, and accrediting the certifying bodies to the aforementioned meta-regulatory benchmarks. Altogether, this new type of network governance has resulted in the previously ‘private’-sector taking on a much larger proportion of responsibility for overseeing and enforcing ‘public’ policy for agriculture and food (Busch and Bain 2004; Hatanaka, Bain, and Busch 2005; Henson and Reardon 2005; Bain et al. 2013; Ransom, Bain, and Higgins 2013; Marsden 2010).

The apparent privatization of food safety regulation has led numerous scholars to question whether this reformed regime can be trusted to actually lower the risk of foodborne illness (Freidberg 2004; DeLind and Howard 2008; Demortain 2008; Stuart 2010; Stuart 2011; Stuart and Worosz 2012). These criticisms stem from a more general critique that governance networks are too diffuse to be held properly accountable for the real outcomes of their members’ actions. Lack of accountability means that their governance network claims to serve and protect the public interest are often met with skepticism because those claims may rest on “rituals of verification” (Power 1997) that produce an illusion of effective oversight and mask hidden agendas. Doubts about the true effectiveness of food safety reform, therefore, entangle deeper concerns over the democratic legitimacy of governance networks (Sørensen 2002; Klijn and

Skelcher 2007). According to some views, governance distributed across a network is incompatible with democracy because it breaks down the idealized divide between the state, the market and civil society which in theory protects against conflicts of interest. Without clear roles, boundaries and accountability, entrenched powerful interests might simply ‘colonize’ and subvert networks, for example by manipulating funding to ‘starve’ oversight bodies or by manipulating the criteria for including or excluding members. However, it has also been argued that governance networks will always operate under nation-states’ “shadow of hierarchy” (Héritiera and Lehmkuhl 2008)—the ultimate power of a sovereign government to forcibly control people and groups within its territorial boundaries—which will keep special interests at least partially in check.

While there is debate about whether governance networks undemocratically distribute power in such a way that undermines both the effectiveness and legitimacy of food safety policy, a more immediate concern arises in that we barely know how to conceptualize, let alone study or evaluate, these novel forms of governing. The very nature of democracy—and associated concepts like representation, public interest, public/private separation, or accountability—may be changing (Hajer and Versteeg 2005), but the process is opaque when it comes to institutions. As Levi-Faur cautions, “Regulatory expansion is creating a thick institutional design that might shape the governance of capitalism in ways that cannot be anticipated or controlled in advance” (Levi-Faur 2009). Within deterritorialized governance networks, there may be no universal norms or procedures to fall back on, and even the terms on which different members of the network interpret the purpose of policy and value the public interest can diverge widely (Hajer and Versteeg 2005).

Before a convincing argument can be made about whether network governance can live up to democratic ideals, let alone whether governance networks can effectively serve the public interest, it is thus necessary to first understand *how these networks work* and *what work they do*. A theoretical lacuna emerges: Where does power lie, or more accurately who wields power over whom in networks, and in what ways?

Co-production and the Apparatus

Agriculture rests on a foundation of natural processes that are entangled with human industry through technology and knowledge, both tacit and scientific. Any analysis of governing safety in agrifood systems is incomplete without consideration for the techno-ecological materiality of growing, harvesting and distributing. Applying the literature on actor network theory (ANT) to the literature on governance networks helps in this regard by expanding the analytical focus to include interactions that fall outside the realm of what is traditionally considered “the social” (Law 1992; Latour 2005). As Busch and Juska (1997) eloquently describe:

[T]he actor network approach asks how production, distribution and consumption networks are extended across localities, regions and nations to include new actors, products and technologies. Moreover, the notion of network includes the relationships between and among human as well as non-human elements (knowledge, technological artifacts, living organisms) that make production, processing and distribution of commodities possible.

This expanded focus also attends to the ways in which actors position themselves as spokespersons for other actors (human or not) (Callon 1986) and interpreters of empirical

observations about the natural world (Latour 1987). All the activity, strategy and work that goes into assembling networks “proceed[s] simultaneously with the process of production and distribution of wealth, status and power” (Busch and Juska 1997)—the classic topics of interest for social scientists. A widely observed trend in critical social science analysis is for the pathways of power to recede into the background. As historian Richard White observes, “In a modern state much real power is suffused with boredom” (White 1995). He meant that acts of power—the exertion of energy and labor but also the allocation of responsibility and privilege, burdens and benefits—though exercised in plain sight, are so banal, so ingrained in habits and things-as-they-are, that most people most of the time take acts of power for granted. The power relations flowing through the changing landscape of food safety governance are similarly suffused with this type of boredom, hiding in plain sight because they are too tedious to trace through all their capillary pathways.

To overcome this challenge and better track down self-effacing power relations as they flow nimbly through discursive, material, and social linkages, I turn to Sheila Jasanoff’s powerful idiom of *co-production* (Jasanoff 2004), the most helpful summary of which I have come across I quote here at length:

Co-production refers to a theoretical framework that investigates the mutual constitution of scientific and social orders. Its theoretical premise lies in the thoroughly symmetrical scrutiny of the natural and the social, the scientific and the normative. These dichotomies, all too often assumed as neutral categories in the analysis of techno-scientific developments, are instead treated as points of arrival rather than departure, as resources and results rather than as causes of new settlements. Thus, in the analysis of how techno-scientific ingenuity encounters social legitimation, co-production does not assign an a priori causality in the generation of new settlements. Rather, it probes how these encounters shape new scientific and social orders, and investigates the technological, institutional, and discursive resources used to develop them. The strength of this approach lies in its emphasis on the mutual constitution of arrangements and closures that are epistemic as much as normative. In turn, this symmetry moves analysis beyond the relatively shallow acknowledgement that any techno-scientific development is inevitably the result of scientific and social factors. It provides the analytical tools to grasp how science and society do not simply allow the circulation of objects that bear the stamps of their respective authorities. They co-produce instead each other’s settlements to the effect that that circulation is as much a statement about epistemic criteria or technical solutions as it is an assertion – and at times a moment of revelation – of the norms and institutional arrangements that enabled it. (Curnutte and Testa 2012).

While powerful, co-production remains an idiom, more a mindset from which to pose critical questions than a structured method of analysis. For that reason, throughout this work, I draw on Foucault’s notion of the apparatus (*dispositif*) to structure my analysis of the co-production of “the natural and the social, the scientific and the normative” (Curnutte and Testa 2012) in the food safety case. According to Agamben (2009), Foucault uses the term apparatus to refer to a strategic formation of both discursive and material elements:

I mean a kind of a formation, so to speak, that at a given historical moment has as its major function the *response to an urgency*. The apparatus therefore has a *dominant strategic function*... which means that we are speaking about a certain manipulation of forces... either so as to develop them in a particular direction, or to block them, or to stabilize them, and to utilize them” (Foucault 1977, quoted in Agamben 2009, 2, emphasis added).

The elements entangled in this strategic manipulation “includes virtually anything”—institutions, discourses, infrastructure, regulations, administrative measures, scientific statements, philosophical propositions, and so forth—but “the apparatus itself is the network that is established between these elements” (Agamben 2009, 3). In speaking of both urgency and strategy, Foucault highlights that the apparatus is “located in a power relation,” or more properly, as Agamben summarizes, “appears at the intersection of power relations and relations of knowledge” (ibid). Inasmuch as I am motivated to identify and reveal the consequences of food safety governance, I therefore adopt Agamben’s reinterpretation of the term: “I shall call an apparatus literally anything that has in some way the capacity to capture, orient, determine, intercept, model, control, or secure the gestures, behaviors, opinions, or discourses of living beings” (ibid, 14). I refer to all of these aspects in shorthand as the *food safety apparatus*.

Mastery and Control

I use the term *mastery* to describe the strategic orientation of the food safety apparatus. While I delve into the historical development of what I call the *hazard mastery paradigm* at length in Chapter 3, I will here offer a brief discussion of the term mastery, which I borrow from Christopher Henke’s work on the deep connections between agricultural science and industrial agriculture in California (Henke 2008). He writes that “science and agriculture share a practical interest in a kind of mastery of the world, disciplining and systematizing it into a form that reduces but does not quite eliminate uncertainty” (ibid, p. 6). Mastery, in Henke’s framework, is industrial agriculture’s strategic rejoinder to “the unpredictability of farming”—the problems identified, the techniques and tools brought to bear, and the solutions sought are all framed through an overarching lens that seeks to keep the farm environment, crops, and operation the same from year to year. The only dimension of truly desirable change, Henke suggests, is yield⁶. If the primary purpose of industrial agriculture is to maximize the transformation of locally specific land, labor, climate, and knowledge into abstracted food commodities that can be freely and broadly circulated, then mastery serves to “repair” disruptions to the optimized production of those commodities and the accumulation of capital and power this production affords (ibid, p. 7). Mastery is thus the strategy to maintain an extractive and hierarchical status quo.

A program of mastery focuses primarily on techniques of *control*.⁷ Although the term may appear obvious in meaning, it is frequently used in both academic literature and industry parlance without ever being treated to a formal definition. The modern English word *control* originated from the Medieval Latin word *contrarotulum*, literally translated as “counter-roll”, which referred to the duplicate record of accounts kept by a third-party for comparison against the treasurer’s official record in order to prevent fraudulent book-keeping.⁸ It is evident from this original meaning that control rested on a belief in the power of comparison to provide assurance. In modern usage, that belief still underlays the meaning of control in the sense of a *control group* in an experiment. Scientists compare their observations of the experimental group to the control group, which they distinguish in the ideal case by altering a single attribute, or variable. All other extraneous variables are said to be controlled because the two groups can be checked against one another. If the desired effect is observed in the experimental group but not the control group, the scientists can assure themselves that *they caused the effect to happen* by altering the experimental variable, rather than another force (i.e. an uncontrolled variable) causing the effect.

This example clarifies the connection between the older meaning of control as comparing or checking and the more common meaning of control today: “to cause (something) to act or function in a certain way” or “to do what you want”, namely “to have power over (something)”

(*Merriam-Webster Dictionary*, online www.merriam-webster.com). Something (or someone) is understood to be under control if it functions (or that person behaves) as expected with reference to an implicit expectation of the right function or behavior. The “counter-roll” is no longer the duplicate material record, but rather the imaginary or mental model of what is supposed to or desired to happen. The depoliticized meaning of control as *regulation*—for example “to reduce the incidence or severity of [e.g. a disease, a pest infestation] to innocuous levels” or “to keep within bounds” (ibid)—thus can be interpreted to arise from normalizing that imaginary. The implicit expectation of what is supposed to happen is no longer perceived as an ‘ought’ but as an ‘is’. Thus control as a technique is well-suited to mastery as a strategy for ensuring that the industrial agricultural system maximizes yield each year while keeping relations of power and their material manifestations the same, or ‘normal’.

Standards

In considering techniques of control and mastery, I give special weight to the role played by *standards* in setting the terms of what is normal and thus the target for control. Standards also crystallize expectations about the way things *should be*—they define desirable behaviors that may not exist in the present, but are imagined for a more desirable future. Inscribing these definitions into a fixed form conflates the envisioned future with the actual present, setting up a path-dependency scenario and painting subsequent societal change with a gloss of inevitability. Standards are thus a vehicle for translating imagined control into material control.

Yet, despite the many power relations they may embed, standards are a novel and as yet little studied subject of social science research (Timmermans and Epstein 2010). Scholars in the fields of STS and political economy are beginning to identify standards, and their auxiliary regimes for compliance-verification, as an increasingly ubiquitous technique of governing the control of hazards in the food supply (Busch 2000; Demortain 2008; Stuart 2010). Standards are not simply convenient tools for organizing markets and reducing transaction costs, but rather “reflect much more fundamental social/technical relations that are essential to the establishment and regulation of social and ethical behavior in capitalist markets” (Busch 2000). Standards for good agricultural and manufacturing practices act to delimit the contours and shape of food safety work, and in particular to stabilize a particular relationship of that work to responsibility and accountability for the consequences of that work—in other words, standards are a means for ‘fixing’ power relations in place. Standards might be conceived as working to form subjectivities for actors from fields to supermarkets to kitchens to tables that can be orchestrated, or conducted, to follow a relatively stable pattern.

The coherence of the food safety apparatus emerges in large part through general acceptance (or possibly manufactured consent) of legal, normative, technical or accounting standards. Standards do not just “reflect” social organization or natural facts, but are coproduced along with power relations and scientific knowledge. They exist both in documents and in practice. As such, standards are a process that purify, “doing the ever local, ever partial work of making it appear that science describes nature (and nature alone) and that politics is about social power (and social power alone)” (Busch 2000). Standards are always a work in progress, for as Latour has shown, purification of this sort is mirrored by a proliferation of hybrid networks, phenomena rendered invisible because they cross ontological categories—nature/culture, technical/political, fact/value—but which nevertheless perform tangible work with tangible outcomes (Latour 1993).

The proliferation of hybrid, or ‘unpurified’, actor networks helps explain the persistence of a critical logical paradox: “On the ground, every standard is simultaneously overdetermined and incomplete... [The work of] tinkering, repairing, subverting, or circumventing prescriptions of the standard are necessary to make standards work” (Timmermans and Epstein 2010). In other words, as standards catalyze work to separate the world into compliant and noncompliant segments—or in the context of food safety, safe and dangerous farms and foods—they also invite more gray areas.

The paradox poses a problem for the actors, and actants, situated within a zone of ambiguity. Even though standards never work perfectly, they are effective to the extent that they can claim to; there is thus strong pressure to make gray areas ‘go away’. “The spread or enforcement of categories or standards involves negotiation or force,” and “Someone, somewhere, must decide and argue over the minutiae of classifying and standardizing” (Bowker and Star 1999). The more the arguments over minutiae can be marginalized—delegated to the boring footnotes, technical appendices, or further—the more effective the standards will be. But this also means that the people engaged directly in those arguments, and the places and milieu in which they are situated, are marginalized, or even made to ‘go away’, as well. Through this means, standards exert “anonymous power” to organize—or control—people and nature through an implicit moral economy that sorts people, places, and practices into ‘good’ and ‘bad’ (Busch 2000).

Standards can appear increasingly natural, self-evident, and apolitical the more effective they are in ordering the world in their image. The pathways and nodes of power that food safety standards reinforce can slip from view, and along with them the possibilities for envisioning sustainable, just, and democratically legitimate ways of governing agrifood systems. Reopening these possibilities requires detailed examination of the hidden control work performed by standards, which in turn requires tracing the power and knowledge relations within heterogeneous networks that form the substance of the food safety apparatus. Throughout this dissertation, I seek to connect elements of the apparatus across scales and across forms by following the thread linking abstract standards for hazard control to the particular day-to-day performance of work through which they materialize.

Work and Power

Lastly, to connect the high-level abstractions discussed above to material outcomes on the ground that impact real people and places, I employ and develop the concept of *work* to provide an empirical point of purchase through which to observe power in action. While expanding the notion of governance networks with ANT helps draw attention to otherwise out-of-sight power relations, and co-production puts those power relations in symmetric relationship to relations of knowledge and normativity, the combined framework still falls short of providing a basis for applying this sort of analysis in practice. In part, this is because each framework thoroughly deconstructs the notion of an actor without reassembling a positive theory of agency or power. As Callon acknowledges, “the ANT actor may, alternatively and indiscriminately, be a power which enrolls and dominates or, by contrast, an agent with no initiative which allows itself to be enrolled” (Callon 2007). Such an ambiguous understanding of actor offers scant purchase for imagining interventions of the sort advocated by Jasanoff in her critique of ANT, in which she argues that ANT avoids “the very questions about people, institutions, ideas and preferences that are of greatest political concern. Who loses and who wins though the constitution of networks? How are benefits and burdens (re)distributed by or across them? How willing or unwilling are

participants to change their behavior or beliefs because of their enrollment into networks?” (Jasanoff 2004). In response to these shortcomings, and in an effort to productively apply STS methods to questions of salient public concern such as the safety and sustainability of food, this dissertation seeks to rediscover agency, and through agency find purchase for reimagining relations of power.

Turning again to an observation by White, “To be powerful is to be able to accomplish things, to be able to turn the energy and work of nature and humans to your own purposes” (White 1995). While trying to identify purpose leads back to the same philosophical ambiguity over agency discussed above (Wilson and Shpall 2012), identifying operations of energy and work is a concrete empirical task. Work on and for food safety can be seen throughout the leafy greens network: a farmer takes a water sample from a well, a database stores trace-back records for a crate of head lettuce, a fence stops a deer from entering a field, a sign on the bathroom door warns workers to wash their hands, an auditor takes up her clipboard upon stepping out of the truck, an attorney examines a claim of food poisoning, a primer hybridizes with its complementary sequence on a strand of microbial DNA.⁹ However, these many acts of work are fragmented and stretched out across long and complex supply chains, and the conditions and sites of work are influenced by myriad histories, texts, laws, models, and cultures. Food safety work is thus often hidden, as Susanne Freidberg observed in her work on the international supply network that brings fresh French beans from African farms to European consumers: “What consumers largely did not see was the work that went into providing them with food as certifiably pure as it was pretty” (2004, 5). To overcome this conceptual blind spot and tackle Jasanoff’s questions of “greatest political concern” directly requires additional conceptual development of and methodical attention to the many-faceted types of work that go into in assembling, expanding, and reproducing these networks.

Taking a cue from Annemarie Mol, I approach food safety work, specifically, as a distributed form of *bodily protective work*. Mol has theorized that bodily digestive work—the actions and agencies by which outside matter is taken inside and transformed into our bodies—can be conceptualized as distributed across many spatial and temporal landscapes. Such work might include cutting and cooking in the kitchen, harvesting in the field, or selective breeding by past generations. Conversely, bodily protective work comprises actions and agencies by which other outside matter is kept out and prevented from being taken inside and transformed into our bodies. Inside the conventionally understood boundary of the human body, such work is performed by the acidity of our stomachs and our immune system. Immediately outside that conventional boundary each person practices organoleptic protective work—filtering out potentially harmful matter such as rotten fruit or rancid meat by how it looks, smells, feels or tastes. As with bodily digestive work, the boundaries within which we can conceptualize bodily protective work are mutable and fluid. The hygiene, sanitation, and contamination prevention practices that laborers across food supply chains perform on a daily basis spans scales of thousands of miles and minutes to years in order to keep matter such as pathogens and poisons—deemed food hazards—from entering eating bodies. Increasingly, we look to entire agrifood supply networks to perform the protective work for us, to keep us from being exposed to, and becoming ill from, dangerous contaminants.

Food safety work categorizes matter that *could be* food into that which is safe (may be eaten) and that which is unsafe (must be destroyed). At the same time, this protective work categorizes environments into wholesome (productive of food) or dangerous (productive of hazards), and moreover categorizes people into good (aiding digestion) and bad (threatening

protection). In forming these categories and kinds, food safety work has the power to transform not only “the social relationships of food provisioning”, as Freidberg argued (2004), but also the material, biophysical relationships—the very metabolism of the land—upon which our efforts to provision ourselves with food depend.

These five conceptual guiderails—governance networks, the apparatus, mastery, standards, and work—illuminate the multiple types of relationships that tie together the decentralized web of food safety governance. Taken together, they decenter the analysis from an a priori commitment to any one explanatory mode and flatten potentially misleading hierarchies of fixed causes and effects. By treating all actors as members of governance networks, my analysis starts from a point that does not presume that authority, capacity, or knowledge are monopolized by any one actor or organization, and thus eschews a strict delineation between the governed and the governor, or the regulator and the regulated. I likewise approach food safety as an apparatus in order to avoid technological, structural, and natural determinisms while still acknowledging the constraints that materiality places on social construction of safety and danger, harm and benefit. I refine the contours of the apparatus by addressing mastery as strategy and control as technique, seeking out a middle path between structure and agency by accepting that ideas and values become built into technologies and technical practices over time—they “do not become autonomous; [but] they acquire momentum” and “direction” (Hughes 1987, 76) that undeniably influence the agency of actors. Within a decentered analysis, however, we must still attend to the primary question of justice: how are burdens and benefits (re)distributed across the web of decentralized relationships, and who wins and who loses as a result? Throughout my critical narrative, therefore, I cling to work—and especially the work required to smooth out the inevitable friction between the visions of uniformity inscribed in standards and the infinite specificity of particular localities and the situated actors who inhabit them—as my “Ariadne’s thread” (Latour 1999) to keep the very real human and ecological stakes of food safety firmly in view.

Roadmap of Chapters

In this dissertation, I argue that people and nature are being *ordered* in the name of food safety, in both the sense of creating order out of “messiness” but also in the sense of being coerced to behave in a certain way. This ordering operates as a food safety *apparatus* motivated by *urgency* over public dangers and acting through the setting, implementation, monitoring and enforcement of *standards*. The apparatus derives power from the moral imperative to ensure *safety* in the face of public danger, but this power is regularly redirected to suit the economic, political, and cultural *domination* of some socio-ecological relationships over others. The costs of this domination manifest in material harms to producers, consumers, and ecosystems, in the opportunities lost through the paths not taken, and in the magnification of systemic risks introduced by technologies and institutions of hubris.

The following chapters tell the story of how the produce industry and government regulators collaborate to seek order through mastery. My purpose in telling this story is not to dampen hope and kindle cynical apathy, but rather to look for hidden points of contingency and choice, which if leveraged might lead things to be otherwise than they are. With this purpose in mind, I conclude by considering the possibility for a different sort of order, or rather a plurality

of orders, that might be possible under a regenerative philosophy of nature and an environmental ethic of partnership.

In the second chapter, I trace the century-long development of technologies, institutions, and discourses by which Americans come to know foodborne human pathogens as an urgent public danger. I begin by examining the deep-seated cultural norm that food should be pure. Beginning with the Progressive movement, I describe the ways in which this norm shaped both emerging public awareness of food safety as a societal problem and also shaped collective response through the enactment of the first national food safety laws. I then look at two distinct epistemologies for evaluating the purity of food, one oriented around the legal concept of adulteration as inscribed in national food safety law and the other oriented around the techno-scientific concept of contamination as revealed through microbiological laboratory investigation. The ongoing struggle between regulatory and public health institutions to reach an accord between these two epistemologies, I argue, has, over time, settled on a pragmatic imperative to detect and track pathogens. Today, this work is performed by an intricate, multi-level techno-institutional network charged with surveillance, detection, and response to foodborne illnesses. It is this techno-institutional network that continuously reproduces a sense of imminent public danger from foodborne illness, justifying and necessitating further exertions of control.

In the third chapter, I turn to examine the exertion of control. I trace the *hazard mastery paradigm*, which I define as the central strategy of the food safety apparatus that frames and shapes collective response to the public danger of foodborne pathogens. I argue that mastery secularizes the moral imperative of germ avoidance by embedding the rituals within formal systems for seamless traceability, comprehensive documentation, and continual improvement. By exerting strong pressure to reveal new hazards, mastery creates momentum in the direction of continuously increasing control across continuously expanding networks. The hazard mastery paradigm is, thus, the strategic mechanism of the food safety apparatus.

The fourth chapter explores the epistemic community of food safety experts working at the intersection of both knowledge and power relations. I analyze the mechanisms and processes by which knowledge production and hierarchies of power reinforce one another through the intermediary operation of *epistemic authority*. I argue that a certain sleight-of-hand—a “god trick”, following Haraway—is required to represent the industrial agriculture status quo and its associated ‘universal’ scientific knowledge as a standard applicable anywhere and everywhere. Although portrayed as ‘universal’, the knowledge upon which authority draws its power originates from the material particularities of specific places, and the situated knowledges of people working in those places.

In the fifth chapter, I argue that a form of governmentality under the guise of “food safety culture” has emerged to ensure that governing at a distance does not unravel completely when the standards upon which it claims to function are interpreted and applied at a specific place. Acculturation, rather than discipline, is the mode for enforcing standards-based governance. I use acculturation intentionally to convey the displacement of extant lifeways with the new values, imperatives, traits, and behavioral patterns associated with food safety culture. It is through such displacement that the food safety apparatus is able to achieve governance “with the grain”, not just to manufacture consent but to nullify the possibility of even imagining dissent. Food safety acculturation is the process and product of normalizing food safety work and producing the sense that it is inevitable.

Extending the argument of Chapter 5, in the sixth chapter I focus on the complications that arise as the formal, abstract knowledge encoded in standardized food safety procedures collides with the local, tacit knowledge and material realities of farming on the ground. At stake is the simplification of farming landscapes and agroecosystems under the totalizing “anonymous power”, as Busch (2000) posits, that hazard control standards exert to organize people and nature. While Chapter 5 examines the ways in which proselytizing food safety culture in the produce industry simplifies *people* by enrolling workers as self-disciplining subjects, reducing their autonomy, destabilizing their tacit knowledge, and further obscuring the nexuses of power and authority in the food safety apparatus, Chapter 6 examines the ways in which standards are made to work—made to produce problem closure over safety and sustainability—in the performance of order out of uncontrolled nature. Universal standards for controlling food safety risks ascribe an aura of legibility to crop fields that belies the distorting frictions among those aspiring universals, the cultural milieu of farmers and their networks, and the lively and unpredictable wildness of animals, plants and microbes in and around farm fields. Constant tension between an autonomous and unruly nature and the ordered logic of mastery threatens the carefully maintained illusion of control.

I conclude by stepping back to examine an underlying contradiction in the philosophy of nature and the environmental ethic that informs the food safety apparatus. I argue that while the apparatus rests on the philosophical legacy of the Enlightenment-era belief in “mechanical order” (Merchant 1980) and operates under an ethic of domination over unruly nature, that domination slips inexorably toward domination over people and over our own internal natures. This leads to contradiction with the governmentality prerequisite to preserve freely acting, autonomous agents. The problem is one of purification (Latour 1993): the apparatus works, on a fundamental level, by forming binaries, dividing the world—and particular people and places—into strict safe/unsafe or healthy/unhealthy categories. Regardless of particular socially-constructed categories of danger and safety, wild and controlled, food in whatever form it takes is one substance which must cross the boundary between environment and body. It brings life-giving nutriment, but also the possibility of disease. This dual nature of food—both necessarily healthful and dangerous—is inescapable. In contrast to the food safety apparatus’ commitment to reductionist, mechanical domination and the endless problems such a stance invites, I suggest a program based rather in a commitment to holistic, regenerative partnership. Rather than idolizing stability and mastery—tipping the balance of continuity and change too far toward the former—partnership accepts periodic disturbances, and tries to work with them. Similarly, a focus on regeneration, rather than production, offers a better balance of priorities, recognizing that *safety* is not the highest good for humanity, but rather the continuity of health and happiness across lives and generations.

2. PRODUCING PUBLIC DANGER

Marion Nestle has observed that, “Food safety is a matter of huge public interest. Hardly a day goes by without a front-page account of some new and increasingly alarming hazard in our food supply” (Nestle 2003). Concerns about the food supply – its sufficiency, quality, wholesomeness and purity—are certainly not unique to the current era. In general, people have always had reason to be anxious about what we eat. Eating blurs the body-environment boundary, and food occupies an ambiguous zone between self and other, health and danger: it brings nutrients that sustain our bodies, but can also bring ‘dirt’ and contamination that threaten our well-being. Consuming food thus requires of us both digestive and protective work (see Chapter 1). In part because humanity as a species has become so good at the former, we can look at just about anything as a potential source of food. But this dramatically expands the universe of possible dangers that we may need to protect ourselves from, forming a dilemma: if we *can* eat almost anything, then how do we know what we *should* eat?

This basic “omnivore’s dilemma” (Pollan 2006)—and the anxiety stemming from it—has been exacerbated in the last century and a half by two factors. First, global industrial transformation of food systems has alienated the process of eating food from the process of growing food. Americans now purchase most of their food through “faceless transactions” (Stearns 2014) after it has traveled hundreds if not thousands of miles through long and complex supply chains, undergoing numerous intermediary processing and packaging steps and changing hands multiple times. Each new node in the chain introduces myriad new points for potential contamination and neglect, most of which are obscured from the anxious eyes of consumers. Second, scientific advances in fields including nutrition, toxicology, and medicine have complicated commonsense understanding of what dangers threaten our health well-being, and how we can protect ourselves from those threats. Together, these two trends mean that “not only is the seller invisible to the buyer, but the most pertinent qualities of the food are invisible too” (Stearns 2014), a state which doubly disempowers lay consumers to perform our own bodily protective work. Instead, we must rely on others to do this work for us, setting up a crisis of mistrust. While “fear of what unseen hands might be doing to our food is natural to omnivores,” summarizes historian Harvey Levenstein, “taste, sight, smell (and the occasional catastrophic experience) were usually adequate for deciding what could and could not be [safely] eaten. The germ theory, however, helped remove these decisions from the realms of sensory perception and placed them in the hands of scientists and laboratories” (Levenstein 2012, 15).

Scientists and laboratories do not act independently or in a vacuum of power relations. Governments have historically underwritten the credibility and legitimacy of food and nutrition experts, providing the authoritative power to legitimate scientific findings and generate widely accepted public knowledge about food and its ‘impurities’. At the same time, food is present in the marketplace, and numerous, often powerful, business interests have a stake in encouraging the public to eat their products; these interests have a hand in shaping and generating public knowledge about the safety and wholesomeness of food as well. Thus the dilemma of food safety, like the overall apparatus, results from a complex entanglement of microbes, growing environments, supply chains, profit margins, experts, state institutions, and the consuming public. How does a coherent urgency to collectively tackle foodborne illness emerge from this imbroglio?¹⁰

In this chapter, I explain how Americans came to know foodborne illness and the pathogens associated with it as a *public danger* over the course of the 20th century. I begin by examining the deep-seated cultural norm that food should be pure. Progressive-era (1890s to 1920s) reformists framed their activism through the lens of purity, and I describe the ways in which this norm shaped both emerging public awareness of food safety as a societal problem and also shaped collective response through the enactment of the first national food safety laws. Two distinct epistemologies developed during this period to differentiate pure from impure foods: the (1) **legal epistemology of adulteration** inscribed in national food safety law and the (2) **techno-scientific epistemology of contamination** that crystalized with the advent of germ theory and its associated field of bacteriology.

The ongoing struggle between regulatory and public health institutions to reach an accord between these two epistemologies, I argue, has, over time, reached a pragmatic settlement through mutual agreement that pathogens should be targeted through a contact-tracing methodology that records, or retroactively reconstructs, pathways of contamination by tracing points of contact between foods and environmental factors. Crucially, that settlement rests on a continuously negotiated compromise that the contamination which matters is that which is out of the ordinary; only abnormal microbial contamination is dangerous to society. Furthermore, the methodology of contact-tracing has combined with the imperative to differentiate normal from abnormal in an intricate, multi-level techno-institutional network that performs distributed protective work through surveillance, detection, and response to foodborne illnesses. Combining regulatory with information-gathering agencies at the Federal, state and local levels with increasingly sophisticated and elaborate laboratory-based technological practices, this network forms a primary locus of power to define and measure an ever-expanding public danger. I conclude with the argument that outbreaks of foodborne illness are not exogenous anomalies, but rather represent “normal accidents” (Perrow 1999) produced by the operation of the food safety apparatus itself.¹¹

Purity and its Epistemologies

The food safety apparatus has formed in conjunction with the development of public expectations of what food should be—e.g. pure, natural, wholesome, clean, fresh—with corresponding expectations of the protective work that producers and handlers, experts, and government regulators should perform on behalf of the consuming public.¹² Key to these expectations is the complementary understanding of what food should *not* be—e.g. impure, putrid, adulterated, contaminated, etc. In the context of food safety, these categories relate to the ways in which practitioners and the consuming public alike conceive and perceive foodborne illness and the culprits (human or not) who cause it.

The Progressive Era in the late 19th and early 20th centuries saw the first major movement in the US to address the safety of food at a national level. In sympathy with the hygienist and sanitation movement’s abhorrence of filth, American progressive activists articulated danger in food through the notion of *impurity*. Their perspective on danger and purity, a multi-layered and often nebulous concept, were infused with a moralistic worldview that linked the material purity of what was taken into the body (food, drink or drug) with the moral rectitude of the (often racialized) individual and the general stability and well-being of society (see, e.g. Goodwin 1999; Levenstein 2012; Tomes 1999; Bobrow-Strain 2012).¹³ The movement in the US directed particular concern toward the dangers of fraud, malfeasance, avarice, and negligence on the part

of processors and manufacturers of food products. In general, if a person suffered illness after eating a food or taking a drug, the cause of illness should be attributed to an impurity of the food (e.g. putrefaction or a counterfeit ingredient), and also to the manufacturer or distributor who had mishandled or tampered with the product so as to render it impure. Instead of originating from a biomedical ontology of foodborne disease, this attitude derived from the general deterioration of consumer trust in the large-scale, centralized food production and distribution systems that materialized following the American Civil War:

Reformers saw the separation of manufacturer from consumer, the advance of technology, and an uncontrolled market system as underlying reasons for the remarkable decline of the quality of their food, drink and drug supply. Before 1870, consumers felt little need for outside protection... Consumers could observe conditions under which their food and medical supplies were produced, handled, and marketed, and a tradesman's social and business future depended on his reputation for cleanliness and honesty. Towns and cities felt capable of controlling business practices by statute if social mores did not. (Goodwin 1999, 48).

The movement sought Federal government intervention to replace the lost interpersonal relations of trust with the protective authority of the state.¹⁴ Following three decades of concerted grassroots activism by women's temperance movements across the country (Goodwin 1999) and several highly publicized scandals—most notably Upton Sinclair's *The Jungle*, the muck-raking, sensationalist exposé on the meat-packing industry's excessive greed and corner-cutting—Congress finally passed the first federal legislation to govern food safety nationwide in 1906, commonly known as The Pure Food and Drug Act (PL 59-384). Not surprisingly, given the temperance movement's moralistic tone and fixation with purity, the act sought to protect the public welfare by prohibiting the manufacture and interstate commerce of misbranded and adulterated foods.¹⁵ Adulteration, which encompassed intentional tampering, was thus the antithesis to the expressed norm of purity during a time of mistrust in the impersonal marketplace. In general, an adulterated food could be “de-natured”, i.e. the vital substance having been removed during processing (as in milling wheat into white flour, see Bobrow-Strain 2012, 110–14), and/or “poisoned”, i.e. laced with a chemical additive (Levenstein 2012, Ch. 5).¹⁶

The fixation with adulteration in particular—in contrast to the nascent, competing threat of germs (Levenstein 2012)—emerged from popular fear that processors and manufacturers were taking advantage of recent advances in applied chemistry and bacteriology to cut corners and hide the resulting inferior quality of their food products from the eyes of consumers (Goodwin 1999, 49). Skeptics at the time were inclined to believe that, rather than saving consumers from natural dangers inherent in food, “food chemists and bacteriologists were [instead] commissioned ‘to make an impossible bridge between nature and the new philosophy of bigness [i.e. centralized industrialization]... to cheat, deliberately and flagrantly’” (ibid). From this sentiment we can infer that purity was primarily understood with reference to an underlying assumption that foods existed in a base natural state. Human agency, therefore, represented a dangerous meddling with that base state, leading to the potential for deviations, or ‘poisonings’, from the ‘natural’, and thus normal, characteristics of food. The problems of a rapidly industrializing food system, in other words, were framed by Progressive activists and reformers as problems of corruption, greed, and negligence, and the new laws were written to counter these problems by prohibiting misbranding and adulteration.

Epidemiology and Germ Theory

While early legal interventions focused on the social and political problem of corruption, two new scientific fields were emerging to define the problem in biomedical terms. Epidemiology revealed disease as a problem for entire populations, and microbiology revealed germs as the agent of that disease. Crucially, these disciplines found common ground in the belief that disease is spread by contamination.

Epidemiology began as a broad “study of associations between environmental factors and disease” (Susser 1985). The traditional approach to this study, epitomized in “High Victorian epidemiology” (c. 1880 to 1914), sought to explain the incidence of disease across populations and places in “a richly literary character, which incorporated a vast range of contextual detail of a human, social, topographical, geological, and even meteorological character” (Hardy 2001). The emergence of bacteriology, and later microbiology, fundamentally altered this tradition by directing public health practitioners toward microorganisms as the essential unit of infectious disease and outbreak. In a way, germ theory and the new discipline of bacteriology it spawned pushed epidemiology into greater alignment with the broader scientific management movement of the same period. Public health during the nineteenth century grew together with increasingly managerial forms of government, and as such embodied “an administrative way of knowing” through surveillance and classification that allowed “for the routine deployment of standard responses” (Sturdy and Cooter 1998). The bacteriologists were able to insert themselves within the network as key spokespersons for the specific causes of disease, which were also the categories of administration sought by the public health institutions: they and their laboratories became obligatory passage points in the system.¹⁷ In order to secure and maintain this position, they entrenched a reductionist epistemology of disease rooted in contact-tracing—a strictly linear approach to solving the problem of contamination.¹⁸ After germ theory, “the focus of epidemiology was reduced to the pursuit of specific agents, singular causes, and the means of preventing their consequences” (Susser 1985): simply isolate and identify the microbe causing the infection, understand how people came into contact with that microbe, and you will know what causes the illness.

Within this broad historical explanation, however, it is critical to locate the precise role of laboratories and microbiological analysis in shaping epidemiological practice. Prior to the ‘discovery’ of germs, a generation of hygienists—including the High Victorian school—had mapped out the terrain of infectious disease, surveyed the many possible vectors of infection, and experimented extensively with different forms of intervention, such as cleaning up and ‘sanitizing’ city environments by purifying water, removing garbage, and so forth. These hygienists, however, lacked a focus on the malicious agent that made people sick and die. As Latour has noted, “Illness, as defined by the hygienists, can be caused by almost anything,” but “If anything can cause illness, nothing can be ignored; it is necessary to be able to act everywhere and on everything at once”—clearly an unworkable plan of action from a pragmatic standpoint (Latour 1988, 20). The “paradox” of the late 19th century, he concludes, was that although a massive social movement spanning North America and Europe had been assembled to tackle infectious diseases—cholera, typhoid, etc.—this mobilization was continuously “quietly undermined by unknown and erratic agents”. Sometimes, the hygienist/sanitarian interventions ‘worked’ and the burden of illness declined, other times disease sprang back seemingly spontaneously despite tremendous effort to contain and prevent it. Such was the case with typhoid in New York City, for example, which refused to be eradicated “no matter how

sophisticated the filtration method nor how thorough the oversight of sewage disposal and urban cleanliness” (Leavitt 1992).

Astronomers today speak of “dark matter” to account for gravitational forces that evade detection, and similarly the hygienists had their own monikers for the hidden “traitor” amongst them, such as “morbid spontaneity” (Latour 1988) or “ptomaine” (Dack 1956). What the laboratory-based bacteriologists brought to the moment and to the movement was a line of sight on the enemy: they made visible the germ, and in so doing introduced a powerful locus around which the tremendous energies of Progressive Era public health reform could coalesce and find anchorage. The rise of microbiology did not so much confine epidemiological work to the laboratory, but rather extended the laboratory, as Latour suggests, to the field and all the “vast range of contextual detail” it encompasses.¹⁹ This is an important distinction, for the food safety apparatus is shaped by this fundamental need to isolate and identify pathogens *throughout* the food supply; public danger is produced by methodical, exhaustive attention to that “vast range of contextual detail.”

Negotiating a Pragmatic Settlement

The disciplines of epidemiology and microbiology together have worked to frame foodborne illness as the result of pathogens contaminating food; germs are dealt with as agents of impurity. Framing illness in this way at once embraces the ontological separation of infectious agents from the food they contaminate and also atomizes foodborne disease by defining it in terms of individual consumption.²⁰ Producing danger in practice becomes a task of “contact-tracing” (Hardy 2001), retroactively establishing a historical record of how the infectious agent came to be present in the food. This “traceback”, as it has come to be called, is now a primary control technique within the food safety apparatus (see Chapter 3).

The moralistic tone of the Progressive era, with its focus on the moral and social shortcomings of people, has softened in contemporary discourse on foodborne illness.²¹ Instead of *food poisoning* and its titillating “association with crime and romance” (Satin 2007, 14), the preferred term is now *foodborne illness*, a shift in vocabulary that marks how today’s discourse distances itself from the Progressive era frame of reference, downplaying human moral failing while emphasizing the agency—and danger—of non-human nature, specifically ‘germs’.²² Take, for example, this summary from Morton Satin’s 2007 book *Death in the Pot: The Impact of Food Poisoning on History*, as told from the perspective of a microbiologist and career food industry expert:

In every historical era, foodborne diseases have altered the course of human events. It was not until the last quarter of the nineteenth century that we began to understand the nature of spoilage and disease. Even after we gained this knowledge, *we were powerless against the forces of nature exerted through her tiniest beings*. Microorganisms, too small to be seen, have constantly evolved in order to survive. In pursuit of survival, they have developed unique and opportunistic mechanisms that often exceed our technical abilities to control them. (Satin 2007, 247–48, emphasis added).

Satin writes from a different frame of reference for food safety, one in which danger emerges from the “forces of nature” and microorganisms in “pursuit of survival”. People do not have moral failings that result in impure foods, but instead failings of knowledge and technology that make them “powerless” to protect us against contamination. For Satin, the same period of the late 19th and early 20th centuries that saw the height of the Progressive movement also saw “a

great deal of food poisoning” not because of corruption, fraud, or willful negligence on the part of food manufacturers and processors, but rather “simply because no one understood the mechanism behind successful preservation” (Satin 2007, 121). Although there is still discursive room to censure industry and government actors for putting profits and power before the health of their customers and citizens, critics today tend to cite industry and government failure to provide a “science-based” united front against the omnipresent danger posed by strictly non-human agents—namely lively and unruly microbes (see, for example, Nestle 2003; Thomas 2014). The food provisioning industries and the government agencies responsible for overseeing the food supply must perform protective food safety work not so much through acts of social and moral purification, but rather by generating new knowledge about the “forces of nature” that can be used to better isolate infectious agents and separate them from food. In other words, danger is now known through technical rationality, framing public danger as a threat best known through scientific investigation into microbial contamination.²³

This new orientation is evident in the way that national law has shifted as well. In the words of one legal analyst, “Distinct from its predecessors, the FSMA focuses on harmful bacteria, parasites and viruses, not the old concerns of adulteration through inks and sawdust” (Sanchez 2011). In contrast to the Pure Food and Drug Act, the FSMA is conceptually organized around the theme of improving scientific knowledge of “food safety problems”, specifically “improving capacity” to “prevent” (Title I) and “detect and respond [to]” (Title II) those problems. For example, Section 104 directs government regulators to “review and evaluate relevant health data and other relevant information, including from toxicological and epidemiological studies and analyses... and relevant recommendations of relevant advisory committees... to determine the most significant foodborne contaminants.” Section 105 mandates that FDA “establish science-based minimum standards for the safe production and harvesting”. One entire section of Title II directs federal regulators to develop standards by which laboratories that analyze food shall be accredited (§202), and another calls on CDC to “enhance foodborne illness surveillance systems to improve the collection, analysis, reporting, and usefulness of data on foodborne illnesses” (§205). Other sections do cover topics of enforcement and disciplinary action, but even these are framed first through the need to generate knowledge about contamination, for example through “enhancing tracking and tracing of food and recordkeeping” (§204) or requiring food facilities to register in a national database so as to aid in surveillance and traceback (§102). Each of these mandates reifies contamination as the primary frame through which to assess the danger of foodborne illness.

The most recent food safety regulations thus reinforce the assumptions that the ‘normal’ state of being is vulnerability with respect to dangers posed by natural forces, that danger can only be known through scientific investigation, and that ignorance and failure to act on knowledge of contamination are the principal modes of human failure.

Accommodating Contamination within Adulteration: An Uneasy Settlement

The apparent settlement just described is not so abrupt or clean-cut as it may appear, however. Government regulators have worked gradually to accommodate the contamination frame within the boundaries of their legal authority, which rests upon legal concepts that were set within the older adulteration frame. The 1938 Federal Food, Drug and Cosmetic Act (FDCA, encoded in 21 USC Ch. 9) replaced the Pure Food and Drug Act. It gave FDA broad authority to regulate the safety of foods other than meat and poultry, and importantly reinforced the adulteration frame of the earlier law by prohibiting “The introduction or delivery for introduction

into interstate commerce of any food... that is adulterated or misbranded”²⁴. Under 21 USC §342(a)(1), food is adulterated “If it bears or contains any poisonous or deleterious substance which may render it injurious to health.” In 1993, USDA’s Food Safety Inspection Service first argued in court that this definition could include foodborne pathogens, and moved to regulate the presence of *E. coli* O157:H7 in ground beef under the “injurious to health” clause (Nestle 2003, 102–7; Thomas 2014, 112–17). While this construal initially stood up in the US District Court, the agency’s later attempt to expand the interpretation to include *Salmonella* failed in court because the judges deemed that pathogen to be “naturally present in raw meat and poultry products” (Thomas 2014, 117), falling back on the purity-as-nature norm to apply the additional clause in 21 USC §342(a)(1) that “in case the substance is not an added substance such food shall not be considered adulterated under this clause if the quantity of such substance in such food does not ordinarily render it injurious to health.” The seemingly arbitrary designation of pathogens as adulterants or not on a case-by-case basis—as evidenced by the contrast between the decision on *E. coli* and that on *Salmonella*—illustrates the ongoing potential for incongruence between the adulteration and contamination epistemologies. At stake in the USDA-related cases is the extent to which pathogenic contamination shall be attributed to human industry and agency rather than to nature, and thus the extent to which producers shall be held accountable for foodborne illness.

In the case of FDA, however, the balance seems to be tipping toward more extensive assumption of human capacity for control. Recently, the FDA has had greater success in arguing that food contaminated with pathogenic bacteria should be considered adulterated, and thus subject to FDA’s regulatory and enforcement authority. Although the FSMA does not explicitly define pathogens (bacteria, viruses, or parasites) as adulterants, the intent of the law seems to lean clearly in that direction: “It stands to reason that because foodborne illnesses are often caused by microbial contamination, the FSMA implicitly grants the FDA the authority to treat microbial pathogens as adulterants” (Thomas 2014, 200). And FDA seems inclined to proceed under the assumption that its statutory authority extends to the regulation of pathogens, and to the regulation of food contaminated by pathogens. The agency’s 2015 Produce Safety Rule defines “undesirable microorganisms” as “those microorganisms that are of public health significance, that subject food to decomposition, that indicate that food is contaminated with filth, or that *otherwise may cause food to be adulterated*” (21 CFR §112.3, 2016). Thomas notes that with this definition, FDA has made a “radical departure” from past precedent by “specifically classifying microbial contaminants as adulterants” (Thomas 2014, 203). However, because the authority is not explicitly granted in the text of the FSMA, it remains to be seen how far the courts are willing to permit FDA’s expansive interpretation of adulteration to justify the agency’s authority to regulate foodborne pathogens.

Recent criminal proceedings indicate that courts may allow FDA significant leeway to equate contamination with adulteration, at least in order to prosecute producers whose food products are implicated in a deadly outbreak. Take, for example, the case of Jensen Farms, a produce company that was owned and operated by bothers Eric and Ryan Jensen. In Fall 2011, an outbreak of *Listeria monocytogenes* hospitalized 143 people across 28 states, leading to 33 deaths from listeriosis (CDC 2012b). Government investigators traced the source of the *Listeria* to contaminated cantaloupe from Jensen Farms’ packing house in Granada, Colorado, where investigators also detected the same strain of *Listeria* that caused the outbreak. FDA and the US Department of Justice arrested the Jensen brothers in October 2013 (Elliot 2013), charging them

with a strict liability violation of Title 21 of the US Code of Federal Regulations, Section 331(a) by “introducing an adulterated food into interstate commerce” (USA v. Jensen et al 2013).

The defendants pled guilty, and the court upheld the findings that (1) *L. monocytogenes* is poisonous or deleterious substance and that its presence on the cantaloupes rendered them injurious to health and furthermore that (2) the cantaloupes were packed “under insanitary conditions whereby it may have become contaminated.” Noting that “The Government needs to prove only that the food was held under conditions that created a reasonable possibility that the food would be rendered injurious to health,” the plea agreement cited the Jensen brothers’ failure to use a sanitizing chlorine spray in the conveyor system they used to wash the cantaloupe: “The chlorine spray, if used, would have reduced the risk of microbial contamination of the fruit.” The plea agreement goes on to cite the full route the now “adulterated” (contaminated with *Listeria monocytogenes*) cantaloupes took as they traveled to retailers and eventually consumers all over the country, relying on traceback records and the laboratory analyses of samples taken from victims, the packing house, and the implicated cantaloupe as evidence. Critically, the case rested on just three points: cantaloupe is food (a trivial point in this case), the cantaloupe were adulterated (*Listeria* had contaminated the fruit due to unsanitary packing conditions in the Jensen Farms facility), and the cantaloupe had circulated across state lines. In particular, it was not necessary for the government prosecutors to prove knowledge of the adulteration or intent to adulterate on the part of Eric and Ryan Jensen (although their ignorance of the crime did mitigate their sentence); the mere presence of *Listeria monocytogenes* on the cantaloupe constituted the crime.²⁵

The stability of the settlement between the techno-scientific concept of contamination and the legal concept of adulteration has come to rest on whether the presence of particular pathogens at particular levels is normal or naturally-occurring. This is an actively contested determination, meaning that the production of public danger is mediated by statutes, regulatory interpretations, and judicial review. In part, the answer depends on whether or not, following common law precedent, they constitute a harmful substance that “the consumer of the food would not ordinarily anticipate and guard against” (Davis, Bower, and Hursh 1987 [2014 update] §80:1, 5). Partly, it also depends on whether or not the producer or handler could have implemented additional preventive measures to protect consumers, as seen in the Jensen Farms case. Critically, the determination also rests on the evolving state of epidemiological and microbiological knowledge of pathogens, routes of contamination, and foodborne illness. While lawsuits brought by industry plaintiffs against regulatory agencies can prevent regulators from adopting a stricter stance with respect to bacterial contamination—as when the courts struck down FSIS’s attempt to regulate *Salmonella*—lawsuits brought by concerned citizen groups can have the opposite effect, “pushing agencies to [more energetically] fulfill their statutory mandates”, *particularly if* the citizen plaintiffs are “able to show that they or their members are at increased risk of contracting foodborne illness as a result of a final agency action” (Winters 2011). Central to all of these contingencies, however, is the question of what type and level of pathogenic presence constitutes normality or ordinariness, and conversely, what type and level constitutes a deviation, and thus an instance of contamination and adulteration.

Detecting Danger: Techno-institutions, surveillance, and DNA fingerprints

Any form of society produces its own selected view of the natural environment, a view which influences its choice of dangers worth attention. (Douglas and Wildavsky 1982).

Douglas and Wildavsky's seminal treatise argued that risk is the product of knowledge about potential dangers and consent to be exposed to those dangers. However, "society" does not spontaneously form "its own selected view" on either matter. Rather, a great deal of work goes into producing that "view" and selecting the "choice of dangers worth attention," and that work is situated among particular people and places. In particular, I argue that the urgent sense of public danger driving regulatory debates over how to regulate food safety and who should perform the protective work depends upon the technologies and institutions that surveil the American population and our food supply. Federal and state public health institutions are intricately woven with clinical laboratories, microbiological techniques, and highly-specialized equipment to form a tightly coupled network that throws its own momentum into shaping the food safety apparatus.²⁶

Before these technologies and institutions were knit into a national network, many foodborne illnesses never rose to prominence as "dangers worth attention" in the public consciousness. As Hardy observes of the 19th-century attitudes,

Unless one or more deaths were involved, or the outbreak was on a considerable local scale, incidents of gastro-enteritis rarely came to the knowledge of the authorities... [T]he doctor was never called unless illness was severe. *Stomach upsets were just too ordinary and trivial to warrant the expense of medical attention.* (Hardy 1999, emphasis added).

Even as public health officials began to turn their attention toward germs, their "anxieties... were not apparently shared by the general public", and it took some time, and increased regular access to medical care, for consumer-citizens to view foodborne illness as an avoidable, and eventually an abnormal and unacceptable, occurrence (Hardy 1999).

I noted earlier that the accommodation of the techno-scientific concept of contamination within the legal epistemology of adulteration depends upon whether "the consumer of the food would not ordinarily anticipate and guard against" the particular contaminant (Davis, Bower, and Hursh 1987 [2014 update] §80:1, 5). The presence or absence of a microbial contaminant is only relevant in a legal-normative sense if the consuming public believes that it should not be there, a sentiment which in turn rests on the level of societal tolerance for gastroenteric illness. In some cases, the public and courts do accept that pathogens are "naturally present" in some products, the most notable example being *Salmonella* in chicken. In this case, the consuming public broadly accepts the onus of responsibility to conduct the bodily protective work against *Salmonella*—it is each individual's responsibility to thoroughly cook all chicken and practice appropriate sanitation in the kitchen to prevent cross-contamination.²⁷ In other cases, such as with the *Listeria* in cantaloupe, the onus of responsibility clearly falls to the growers and handlers because the pathogen is not assumed to be "naturally present". *Listeria* on cantaloupe is rather presumed to be out of the ordinary—consumers do not ordinarily "anticipate and guard against" *Listeria* when eating melons; if they did, they would, for example, cook the fruit. These examples highlight the importance of apparently common-sense understanding of the sources of illness and danger in the food supply. Whether and to what extent "lay" citizen-consumers perceive themselves as powerless to prevent the danger posed by pathogens on a particular food matters enormously to the question of whether the presence of those pathogens will count as adulteration. A key moment in the formation of the food safety apparatus for fresh produce was thus the shift in public tolerance of foodborne illness.

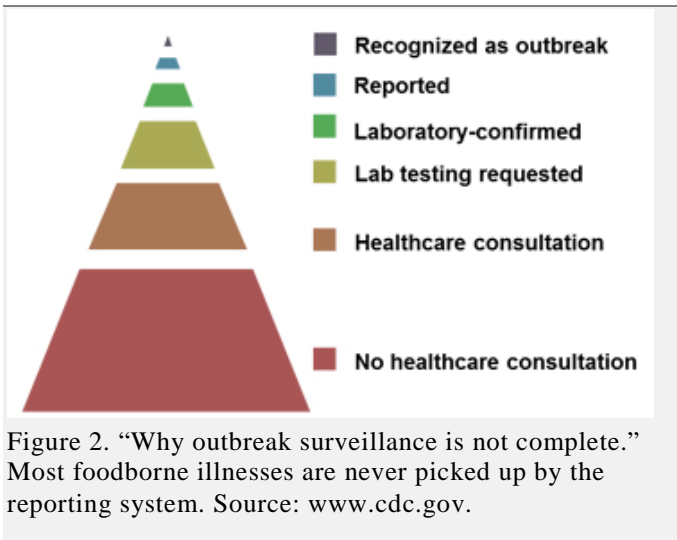
This shift hinged on scientific elaboration of endemic foodborne illness (Hardy 1999). In epidemiological terms, the baseline is the *endemic* or “expected” level of disease (CDC 2012a). An *epidemic* occurs when there is considerably more disease incidence than expected. To know when an outbreak, which is basically synonymous with epidemic, is occurring, therefore, you must first “establish the ‘normal’ rate of disease for that area... [which requires] routine disease surveillance to establish baseline data” (Pendergrast 2010, 6). Any event that stands out in contrast to this baseline—“anomalous blips”—represents an outbreak. In food safety, an outbreak is a special type of epidemic which the CDC defines as “the occurrence of two or more cases of a similar illness resulting from the ingestion of a common food” (Gould et al. 2013). Though the agency does not explicitly say so, this definition assumes that endemic foodborne illness—at least of a severity high enough to be reported (see Figure 1)—should be essentially zero.

In the United States, food safety surveillance is performed by two primary networks, FoodNet and PulseNet. These networks “are the tools that CDC uses for determining the cause and the size of the outbreak (local, statewide/regional or nationwide) by relating the cases or the clusters of foodborne illnesses, which originated from specific areas” (Yeni et al. 2016). Importantly, the knowledge they generate is also used to set national priorities related to food safety and to evaluate progress in reducing the risk of identified foodborne threats. Together, FoodNet and PulseNet form the anchorage points for a techno-institutional network that operates by establishing ‘normal’ baselines of pathogenic contamination and foodborne disease, generating knowledge about the casual factors of contamination and illness, and detecting abnormal deviations from the baseline, such as deadly outbreaks.

FoodNet

The Foodborne Diseases Active Surveillance Network, or FoodNet, was established in 1995 to provide the first ever estimates of how many foodborne illnesses occur in the US. The questions of concern, as Allos et al. (2004) suggest in the first comprehensive review of the program, were “How safe is our food?” and, more to the point, “Can it be made safer?” In particular, “Public health and regulatory officials needed a method to determine whether the changes made by regulatory agencies and the industry were followed by declines in infections” (Henaio et al. 2015). A collaboration between CDC, FDA, and USDA’s Food Safety Inspection Service (FSIS), FoodNet was designed as a sentinel surveillance system, which, in multilateral cooperation with state- and county-level health departments, actively collects information on specific types of foodborne illness from participating states and counties.²⁸ In contrast to passive surveillance systems (e.g. national reportable disease registries) that seek simply to collect as much data on diseases of concern as possible, a sentinel surveillance system seeks to improve the quality of data collected by selecting a subset of reporting sites chosen for the experience and reliability of their staff and the capacity and quality of their laboratory facilities (WHO 2016).

FoodNet receives its information through more than 650 clinical laboratories in the participating jurisdictions that are responsible for confirming the cause of infections. They track just nine pathogens, including bacteria such as *Salmonella*, *Listeria*, and *E. coli* that produce Shiga toxin (STEC)²⁹ as well as parasites like *Cryptosporidium*. However, this number is always subject to change for “many more pathogens could be added to the list... [and] to reduce the burden of illness from foodborne diseases, new problems must be identified and quantified”



(Allos et al. 2004). Indeed, FoodNet is located within the Emerging Infections Program of CDC precisely because foodborne illnesses, framed through the positivist lens of autonomous germs and a perennially imperfect human knowledge of objective reality, are considered a moving target. FoodNet is an *active* surveillance system, after all.

Returning to the central question of whether food can be made safer, it is worth examining how public health officials frame the limitations of FoodNet surveillance and the ways in which they seek to overcome, or at least mitigate, those limitations. The

first method by which public health experts seek to ‘improve’ surveillance is to expand the “catchment area” by increasing the size of the reporting region (Wagner et al. 2001). FoodNet has expanded its own catchment area by adding more counties and states since 1995 (CDC 2015c). The second method is to enhance the reporting signals themselves, improving the transmission of information across the “chain of events that must occur for an episode of illness in the general population to be recognized in the surveillance” (Allos et al. 2004). The chain begins when an individual develops symptoms and seeks medical care, but after that the physician must get a stool sample from the patient (foodborne illnesses are characteristically diarrheal) and send the sample to a laboratory, which must then isolate and identify the pathogen(s) present before sending a report to the appropriate health department or, in the case of participating laboratories, directly to FoodNet personnel. Each link in the chain of communication leaks valuable information, and the FoodNet system operators are constantly seeking to stop up those leaks (Figure 2).

To gauge the baseline incidence of foodborne illness, FoodNet still must rely on the underlying passive surveillance mechanism of the national notifiable disease registry. In the US, clinicians and other health care providers are required to report “notifiable” diseases and conditions to county or state health departments, which in turn notify CDC on a voluntary basis;³⁰ while the list of reportable conditions varies by jurisdiction, most include the major foodborne illnesses including salmonellosis, listeriosis, shigellosis, and STEC (Adams et al. 2015). However, some illnesses slip through: “FoodNet does not track agents for which clinical laboratories do not routinely test (e.g., norovirus),” (Henao et al. 2015). To produce a national picture of the “burden of illness” from any given disease, CDC experts must compile the reports from all jurisdictions and standardize the data so that it is commensurable across different reporting formats and temporal or spatial resolutions. Thus while the requirement to report on foodborne illnesses improves the transfer of information to FoodNet’s reporting sites, which themselves are selected for their reliability in handling the incoming data stream, there are still many potential leaks and sources of uncertainty.

In addition to reporting pitfalls, FoodNet operators are constantly concerned with the methodology for identifying illnesses to be reported. A recurrent preoccupation for the system has been surveying physicians, hospitals, and clinical laboratories in an effort to measure their

performance and persuade them to recognize more potential cases of illness (in the case of physicians) and test a higher proportion of samples for a wider variety of pathogens with greater accuracy (for laboratories) (Voetsch et al. 2004; Boxrud et al. 2010; Hurd et al. 2012; Clogher et al. 2012; Cronquist et al. 2012). In particular, FoodNet officials prioritize the identification, dissemination, and uptake of new diagnostic and laboratory testing procedures, conducting biannual audits of participating laboratories (Jones, Scallan, and Angulo 2007). FoodNet has pioneered this degree and granularity of oversight: “In 1999, to ensure the validity of data summarized across all sites, FoodNet developed and began tracking metrics related to reporting, a process unusual for CDC programs at that time” (Henaio et al. 2015).

To illustrate the exhaustively detailed attention that FoodNet officials give to the diagnostic tests that underlie the system, I highlight one study of laboratory practices for isolating STEC. The study sought “to compare reported practices with published diagnostic recommendations” in order “to ensure that both O157 STEC and non-O157 STEC infections are identified as completely and rapidly as possible” (Hoefer et al. 2010). The authors found that 98% of the surveyed labs used only a culture-based method, which involves growing a colony of the target bacteria that rarely results in detection of non-O157 STEC. The authors strongly urged laboratories to adopt the recommended procedure, which conducts two tests of each sample, pairing the culture-based method with another test such as enzyme immunoassays that specifically search for the Shiga toxin itself. Officials seek to better understand safety not just by increasing the accuracy of laboratory tests, but also by pushing for more fine-grained resolution of those tests to differentiate and identify pathogens. I will return to these themes below in discussing CDC’s transition from the old “gold standard” laboratory technique, pulsed-field gel electrophoresis, to the “transformational” new technique, whole genome sequencing.

To summarize, each of the dimensions envisioned for improving FoodNet—collect more information across a broader scope with a higher degree of accuracy, resolution and standardization—reveals the legacy of scientific management dating from the early days of bacteriology. The goal then as now has been to linearly trace the chain of contamination and its effects, to standardize the categories of disease and their causal agents, and to produce the most comprehensive portrait of the national population and its “burden of illness” as possible. The assumption, of course, is that by examining this portrait, public health authorities can objectively, and from a centralized position, prioritize threats to the national food supply and select optimal national responses.

FoodNet plays a curious dual role in national policy. On the one hand, the network defines public health threats that emerge from the food system—in essence prioritizing where research, regulatory, and management resources should be directed. On the other hand, FoodNet also evaluates whether the regulatory, educational, and management actions taken in response to those threats are effective or successful (Jones, Scallan, and Angulo 2007). Moreover, FoodNet increasingly works to facilitate food safety oversight as well: “A maturation of FoodNet methods for determining and monitoring disease burden has allowed a shift in focus... [to] the attribution of the burden of foodborne disease to specific foods and contexts” (ibid). In other words, FoodNet identifies dangers, pinpoints their source, and decides whether or not the dangers have been neutralized. The surveillance network thus wields tremendous power over how and by whom protective work shall be done, but its vast techno-institutional momentum gives to this power a sense of inevitability and apolitical obviousness that belies its historical contingency. Much of that contingency is black-boxed even deeper within the inner workings of the national techno-institutional surveillance system, within the arcane domain of PulseNet.

PulseNet

PulseNet is a national database system which specializes in collecting and analyzing DNA “fingerprints” (see following section) of pathogens isolated from victims of foodborne illness around the country. PulseNet experts, in collaboration with FoodNet, also bear primary responsibility for standardizing the laboratory procedures for taking these “fingerprints”.³¹ Coordinated and curated by CDC, PulseNet is fed by a network of 83 public health laboratories across the US, to which clinical laboratories send pathogen isolates for more detailed analysis. These data are complemented by adding to the database the “fingerprints” of pathogens isolated from food samples collected by regulatory agencies including FDA and state health or food departments. By comparing data from all of these sites, PulseNet searches for patterns in the specific microbial pathogens that cause foodborne illness: a cluster of pathogens with similar “fingerprints” may indicate a common origin, i.e. a food product that all of the victims consumed, thus pointing to a potential outbreak. If the pattern in victims can be matched up with a “fingerprint” from one of the food samples, then PulseNet is able to identify a prime suspect in the outbreak.

The system is hailed as a means for “identifying the source sooner” in order to “alert the public sooner, and identify gaps in our food safety systems that would not otherwise be recognized” (CDC 2016c). In other words, it is designed specifically to change public perception of the baseline level of foodborne illness: “By greatly increasing the sensitivity of outbreak detection, PulseNet allows us to identify and correct problems with our food production and distribution systems that would not otherwise have come to our attention” (Boxrud et al. 2010). Crucially, while PulseNet can aid traditional field epidemiology in investigating outbreaks, the “routine subtyping of isolates of foodborne pathogenic bacteria received by public health laboratories should lead to identification of outbreaks not readily recognizable by other means” (Swaminathan et al. 2001). PulseNet thus provides a unique capacity to ‘see’ routes of contamination that would otherwise remain invisible to the techno-institutional network for producing public danger, making it a powerful yet opaque techno-institution.

PulseNet operates on the tacit assumption that the public good is best served when individual bodies are prevented from consuming any food that is contaminated with a pathogen—that is, any food on which a pathogen is present. Because CDC defines an outbreak as 2 or more related cases, it is very easy for PulseNet to identify more and more outbreaks, even though these may be small. Also, because food samples are also added to the database and the pattern-searching work, PulseNet’s propensity for detecting patterns increasingly makes it possible to act on *hypothetical* outbreaks—i.e. by issuing a recall in cases where a known pathogen is encountered on a food sample, without there being any reported illness. Such a precautionary response carries profound repercussions for and the people who provide and distribute the implicated food. Yet the highly technical and institutionally dense character of the surveillance system makes the imminent danger that it produces seem inevitable and uncontestable. Put more abstractly, PulseNet purifies the political from the social, the natural danger from the human failing, by normalizing and depoliticizing the contamination frame for protective work.

PulseNet’s claim to legitimate authority to perform this work lies in the institution’s capacity to standardize a definition of contamination and to technologize the process of assigning responsibility for foodborne illness. By maintaining a strict quality assurance program with set standards for equipment calibration and maintenance, analysis procedures, personnel training,

documentation, and so forth, PulseNet seeks to render the site-specific instances of contamination documented by laboratories across the country into a commensurable system of “fingerprints” that can be regularly and automatically—thus, ‘objectively’—scanned for patterns of similarity, which sometimes yield the aggregate phenomena known as an outbreak (see below). By creating the conditions under which outbreaks can be differentiated from the background level of sporadic (endemic) foodborne illness, PulseNet operators are able to make a robust claim about foodborne hazards and risks, i.e. public danger.

Like FoodNet, system managers envision several dimensions of improvement for PulseNet (Boxrud et al. 2010). They cite funding and staffing shortfalls, especially given the rising costs of surveillance activities as the result of ongoing technological development, as a perennial problem. In particular, PulseNet officials lament that laboratory technicians must juggle many competing demands on their time: food safety surveillance is not always the immediate priority. At a deeper level, however, what these officials are actually worried about is the erosion of a carefully curated and professionalized labor force over which they have control. Despite the appearance of depoliticized objectivity that the network strives to maintain, the actual work of fingerprinting pathogens requires skilled judgment; PulseNet’s authority rests on the level of trust given to its laboratory technicians, data analysts, and database managers. A threat to this expert workforce is a threat to PulseNet’s claim to objectively identify and characterize the sources of public danger in the food supply.

Second, PulseNet managers, like their FoodNet counterparts, also worry about the quality of incoming data, especially given that many states do not require private laboratories to send their pathogen isolates or food samples to the area PulseNet laboratory for detailed analysis. The biggest gap in PulseNet’s surveillance, however, results from the paucity of information about exposure, or how the ill patient became infected with the pathogen of concern in the first place. PulseNet is designed to identify clusters of related cases of salmonellosis, listeriosis, shigellosis, and other pathogen-specific foodborne illnesses, but the institution’s place and purpose in the larger techno-institutional network for food safety surveillance depends crucially on its capacity for contact-tracing, or mapping the pathways and nodes of pathogenic contamination. The system simply cannot collect samples from all possible sources of dangerous bacteria, which is why PulseNet must coordinate closely with other institutions—including field epidemiologists—to decide which samples should be collected and from where (or whom). Oddly, and somewhat circularly, the system also looks to its own record to help identify the foods and environments of greatest concern. PulseNet (and FoodNet) rely on a prior history of identified outbreaks, sources of pathogenic contamination, and knowledge of pathogen biology from which to extrapolate conjectures about new patterns of foodborne illness. Yet the historical knowledge is partial and path-dependent; for example, looking only to lessons learned from past experiences with foodborne illnesses cannot give public health officials the power to foresee novel pathogens or forms of outbreaks. Again, significant expert judgment is required to make sense of even the most elaborate and information-rich datasets. The need for epidemiologists to sort through all of this data to judge where the priorities lie was recognized early: “As PulseNet’s capacity expands, the need for epidemiologic assessment of new information expands in parallel” (Swaminathan et al. 2001).

In summation, both PulseNet and FoodNet rely on the standardized, reliable, and comprehensive collection of information about which pathogenic bacteria are contaminating food, people, and the production environment, and where. Each institution has developed its own initiatives to close information ‘leaks’ and improve the reliability and quality of the analyses

performed by its member laboratories. FSMA, in a relatively obscure section, has provided strong reinforcement to this effort to standardize laboratories across the country by directing the US Department of Health and Human Services (HHS)—which oversees both FDA and CDC—to establish a national accreditation program for laboratories that analyze food samples (21 USC Sec. 350k). The law requires this program to “develop model standards that a laboratory shall meet to be accredited by a recognized accreditation body for a specified sampling or analytical testing methodology.” This new laboratory accreditation system further highlights the centrality of how pathogens are isolated, detected, and traced to the overall operation of the food safety apparatus. But what is at stake in this intense focus on laboratory techniques? To better understand this question, I next turn to examining precisely how microbiological laboratories fingerprint pathogens.

DNA Fingerprinting

Public health officials seek to attribute outbreaks to specific food products and the companies that produce them by linking the pathogenic bacteria found in the victims of foodborne illness with the bacteria found in samples of the suspected food and the suspected farm or handling/processing facility. Today, this linkage depends on genetic comparisons, and so PulseNet and FoodNet, and the clinical and public health laboratories that feed information to these institutions, primarily work to collect, isolate, manipulate, and analyze pathogen DNA. CDC describes this work as “analyzing DNA fingerprinting on the bacteria making people sick, and on the bacteria found in food and the environment” (CDC 2016c). The metaphor of DNA “fingerprints” alludes to the forensic facet of this surveillance system, but bacteria do not readily accede to this anthropomorphism. Bacteria reproduce and mutate rapidly – the bacteria that contaminate a leaf of lettuce in the farm field are not “the same” as the bacteria that make a consumer sick after eating it several days or weeks later. I intentionally use scare quotes to draw attention to the ways in which sameness or likeness as applied to bacteria is not always a commonsense or obvious determination; rather, declaring that pathogens isolated from several different sources are “the same” is a claim made by laboratory scientists coordinating across the FoodNet and PulseNet systems. Through their standardized and specialized equipment and techniques they seek to reconstruct the contamination pathway by tracing the whereabouts of the prime suspect.

Isolating and analyzing individual sequences of DNA cannot alone surveil contamination across the “vast range of contextual detail” that characterizes the national food system. In addition, the network must also record, categorize, standardize, and compare DNA sequences to re-contextualize them in time and space. Rather than reconstructing the actions of an individual perpetrator through the traces that perpetrator left behind (e.g. actual fingerprints), laboratories instead try to reconstruct the infectious pathway by comparing “the genetic material of two or more bacterial isolates to determine whether they have shared a recent common ancestor” (Moorman, Pruett, and Weidman 2010). The more genetically similar they are, in theory, the more likely they descend from the same ‘parent’ ancestor, and thus the same place, i.e. the same facility and same producer. This task is neither simple in theory nor in practice, and constitutes an expert judgment call that “requires an understanding of evolutionary biology and population genetics” (Moorman, Pruett, and Weidman 2010). In essence, then, DNA “fingerprinting” involves a translation from genetic to temporal to spatial relationships, which then must be interpreted into determinations of causality and responsibility. The attribution of illness to “source”, therefore, rests on an elaborate chain of associations and translations.

But how do experts judge the relatedness of bacteria isolated from samples taken at different times and places? Microbiologists have refined their methods for categorizing the agents of infectious disease dramatically since the early days of germ theory. While the names of many bacteria often associated with foodborne illness are readily recognizable – *Salmonella*, *Escherichia coli* (*E. coli*), or *Listeria monocytogenes* – microbiologists and epidemiologists are generally interested rather in specific types, or serotypes, of these bacteria. For example, the CDC tracks more than 32 serotypes of *Salmonella*, the most common of which are *Salmonella* Typhimurium and *Salmonella* Enteritidis. *E. coli* serotypes are often categorized by their antigens, the substances that cause an immune response in the body (e.g. a toxin); for example, the notorious *E. coli* O157:H7 refers to the serotype with the 157th O antigen and the 7th H antigen, a combination which has proven remarkably virulent. While *Salmonella* and *E. coli* have hundreds of known strains, *Listeria monocytogenes* has just twelve, and the three most common of these are responsible for 95% of cases of listeriosis in the US (CDC 2016a).

While the food safety surveillance system reports on the baseline national burden of illness by categorizing the causative pathogens according to their serotype, this level of categorization is not refined enough to detect outbreaks or investigate their cause. To trace the chain of contamination requires laboratory methods to “sub-type” pathogens isolated from patient, food, and environmental samples. This process does not so much assign pathogens to pre-defined categories as it compares differences in their genetic sequences, as described above: “The number of differences can tell the scientists how closely related the bacteria are, and how likely it is that they are part of the same outbreak” (Moorman, Pruett, and Weidman 2010).

For most of its existence, PulseNet has used a standardized sub-typing method known as pulsed-field gel electrophoresis (PFGE). To conduct a PFGE analysis, laboratory technicians must first culture the bacterial sample, which generally takes 14 to 18 hours according to CDC procedures; the entire PFGE process takes 24 to 26 hours by CDC standards (CDC 2016d). They then suspend the bacterial cells within “plugs” composed of a special gel, called agarose, and use biochemical to break open the cells to release the bacterial DNA strands, a process called lysing. Whole DNA strands are very long molecules, which are difficult to work with, so technicians cut the strands into smaller pieces using one or several restriction enzymes. These enzymes reliably separate the full strand when they encounter particular sequences of nucleotides, which from a laboratory standpoint means they have a reproducible effect—a critical criterion for PulseNet’s efforts at standardization. Once the DNA has been cut into smaller segments, still within the agarose gel, the plug is placed into one end of a large sheet of agarose gel; to save time and aid in comparison, many plugs are generally run at once in separate channels of the agarose gel sheet. By running an alternating electric current through the gel sheet, the technician can cause the DNA fragments to move through the agarose; because the rate of movement depends on the size of the fragment (smaller fragments move more easily), the DNA pieces slowly separate from one another based on their length. If the DNA is treated with a fluorescent dye, the PFGE process will produce a visible pattern of bands on the agarose gel sheet (Figure 3). By standardizing the restriction enzyme used and the precise strength, angles, and duration of the electric fields applied to the DNA fragments, scientists reassure themselves that they can reproduce the same pattern of bands for any sample of a given type of bacteria. Scientists have produced a standard reference catalogue of thousands of such patterns for all of the major foodborne pathogens. Public health experts can compare—generally using specialized bioinformatics software—the pattern produced by conducting PFGE analysis on an unknown pathogen sub-type to the patterns

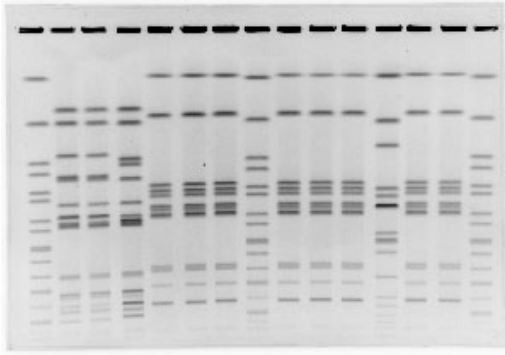


Figure 3. Example of the DNA fragment pattern produced by PFGE from a set of *Salmonella* samples. Source: <http://foodsafety.foodscience.cornell.edu/>.

in this reference library to identify the sample, and can furthermore compare patterns across multiple samples to see if they are “the same”.

While PFGE “revolutionized foodborne disease epidemiology nationwide” in the mid-2000s (Jones, Scallan, and Angulo 2007), CDC and FDA officials recognize many limitations in the process: it is slow, results can vary slightly from technician to technician, the ‘bands’ in the resulting pattern do not directly relate to specific genetic traits, and the level of resolution is not sufficient to “discriminate between ALL unrelated isolates” (CDC 2016d). In other words, PFGE is insufficient to meet the surveillance network’s vision of a comprehensive, universal system of control that can find and stamp

out contamination before it causes harm.

For all of these reasons, PFGE is increasingly eclipsed by a new class of technologies and techniques based on whole genome sequencing (WGS). Like PFGE, WGS begins by culturing bacteria from the relevant sample to form an isolate.³² The bacterial cells are then lysed to release the DNA, which is again cut into short fragments as in PFGE process. From here, however, the process differs. Rather than being plugged into a gel sheet, the fragments are copied millions of times using polymerase chain reaction (PCR). These millions of copies are then fed into a DNA sequencing machine that determines the order of the thousands of nucleotides (A, T, C, and G) that make up each fragment. The millions of fragment sequences are then analyzed by specialized software, which pieces them together in order to reconstruct the bacterial genome, numbering many millions of nucleotides, of the original sample (CDC 2016b).

WGS lures public health officials with its promise to ‘reveal’ pathogenic contamination at the resolution of individual nucleotides, the basic structural units of a DNA strand. “Instead of only having the ability to compare bacterial genomes using 15-30 bands that appear in a PFGE pattern, we now have millions of bases to compare,” as the CDC summary on WGS explains. “That is like comparing all of the words in a book (WGS), instead of just the number of chapters (PFGE), to see if the books are the same or different” (CDC 2016b). This level of information on isolated pathogens is “more detailed and precise” while also “fast and affordable”; this “one test” can replace the work of “two or more scientists to perform four or more separate tests” as part of the old PFGE-based process (ibid). From a regulatory perspective, FDA highlights how WGS “allows us to differentiate between organisms with a precision that other technologies do not allow” (FDA 2016a). FDA equates this precision with speed and efficiency of outbreak response: the “ability to differentiate between even closely related organisms allows outbreaks to be detected with fewer clinical cases and provides the opportunity to stop outbreaks sooner” (ibid). In other words, WGS moves the dial even further toward prevention.

WGS does not, however, simply improve on the existing foodborne illness surveillance system. Rather, the technique also changes the very nature of how ‘outbreaks’ are understood and defined, creating a new visualization of public danger by generating novel potentialities for contamination. For example, FDA points out how its investigators, using WGS, can “link illnesses to a processing facility even before the food product vector has been identified” (FDA 2016a). The power of the technique is to allow investigators to skip over the intermediary links

which they previously had to trace in the chain of contamination from source to consumer; in a way, public health officials to “identify unlikely routes of contamination.” Perhaps most importantly, public health officials believe that access to whole bacterial genomes will allow them to conduct geospatial analysis of foodborne illness:

[T]he most promising and far reaching public health benefit [of WGS] may come from pairing a foodborne pathogen’s genomic information with its geographic location... Knowing the geographic areas that pathogens are typically associated with can be a powerful tool in tracking down the root source of contamination for a food product... *The faster public health officials can identify the source of contamination, the faster the harmful ingredient can be removed from the food supply* and the more illnesses and deaths that can be averted. (FDA 2016a, emphasis added).

The combination of whole genome sequencing with other methods for processing massive amounts of data and integrating different types of data—including geospatial analysis, probabilistic modeling, and meta-analysis—promise to “open a new era of ‘prediction’ rather than reaction to reduce pathogen contamination and outbreaks” (Wang et al. 2016). Notably, each of these techniques and technologies rely on “abundant data” to function as promised (ibid). WGS is a data-intensive procedure, and would not be possible without PCR. PCR allows laboratory technicians to ‘amplify’ a fragment of DNA by reproducing that segment millions of times in a matter of hours using specialized polymerase enzymes. As Paul Rabinow has observed, PCR transformed the field of molecular biology because “it makes abundant what was once scarce—the genetic material required for experimentation,” or, in the case of disease surveillance, for identification and detection (1996). WGS is also heavily capitalized, dependent on expensive sequencing machines, software, and the computer processing power to run it. The transformative potential ascribed to whole genome sequencing is also made possible by the increasing availability of these technologies. The cost of sequencing a bacterial genome has dropped dramatically since the FBI, seeking to defend against bioterrorism attacks following 9/11, paid about \$500,000 for the first such effort to sequence a suspected *Bacillus anthracis* strain in 2001; just 10 years later, it was possible to sequence anthrax for \$500 (Kupferschmidt 2011). Sequencing machines have become commercially available and at a lower and lower threshold of capital investment since 2001, granting the capacity to sequence genetic material quickly and cheaply to nearly any laboratory.

The cheap *abundance* of data shapes the development of the surveillance network. Recall that DNA fingerprints are only epidemiologically helpful if they can be compared to other samples and to known referents. This requires creating enormous genomic databases to store fingerprints along with metadata such as where, when and from whom those fingerprints were taken. Since 2008, FDA has launched a global program to construct and curate such a database, called GenomeTrakr, which as of late 2016 had over 71,000 sequences on file for isolates of *Salmonella*, *E. coli*, *Listeria*, and *Campylobacter*. The system is adding an additional thousand sequences per month, and this rate is expected to increase as more laboratories participate (FDA 2016b).

The example of the rapidly growing GenomeTrakr database perfectly encapsulates the overall trend, and purpose, of the techno-institutional disease surveillance network: to collect *more* data from *more* sources *more* frequently in order to find and stop *more* contamination. The production of public danger is built-in to the food safety apparatus, a structural feature of what Elizabeth Dunn has termed the “sewer state” (Dunn 2007). The institutional networks for

monitoring foodborne illness in the US must constantly seek out pathogenic contamination in the food supply to isolate and identify: “The [sewer] state’s claim is ‘what we can see, we can find, and what we can find, we can remove’” (Dunn 2007). The directionality of technological and institutional development over time in FoodNet, PulseNet, and the broader foodborne disease surveillance network attest to the overriding fixation with seeing and finding more contamination. Thomas Hughes observed that,

The organizers of networks leave nothing outside, or to chance, that would affect the network... [H]istory shows that system builders and managers have striven mightily to *incorporate* the forces of the environment into their systems in order to gain control of the forces. (T. P. Hughes 1986). (emphasis added)

The surveillance network I have described is no exception to this observation. Keeping to the premise that danger and the systems for knowing and controlling it co-produce one another, outbreaks of foodborne illness are as much an effect of elaborate institutional and informational arrangements for surveillance and detection as they are a cause. Science and technology do not operate independently of cultures, politics, markets, or other domains of ‘social’ life, but rather merge into what historian Thomas Hughes calls a “seamless web” (1986). As Hughes says, that “seamless” quality does not simply emerge spontaneously. Network organizers—CDC administrators, FDA officials, laboratory directors, academic experts, and so forth—must work to enroll further parts of the network’s surrounding “environment”. The imperative to generate scientific knowledge about contamination is intertwined with the refinement of the technique of control: namely the development of tools, procedures, and institutions for surveilling food, detecting microbial contamination, and investigating illness. These various elements intertwine ever more inextricably as public health experts and food safety regulators seek to provide more universal, precise, and timely coverage of contamination in and illness from the national food supply. In so doing, they further reify the mastery worldview.

Situation Normal: Contamination Overflow

Lost amidst the rush toward ever greater knowledge of the dangers confronting society through the food we eat is the way that new knowledge is co-produced with new prescriptions for the social order. I began this chapter by examining how national food safety was originally framed through the lens of *purity*, and how this lens informed the development of two separate epistemologies, one based on the techno-scientific concept of contamination and the other based on the legal concept of adulteration. While the modern foodborne illness surveillance network strongly foregrounds the former epistemology, it obscures the connection between knowing *what* cause illness and *who* causes illness. In particular, the sophisticated institutional arrangements to coordinate complex technical analysis of aggregated, standardized, and decontextualized data *en masse* distance the technical work from the exercise of power. Yet tracing and predicting contamination also implicates real people and real production environments, in effect sorting humans and environments along with the food they provide by their ‘purity’. “By dictating, if not manufacturing, the dangers to be controlled, the state obscures the fact that danger and diversity are essential elements of life... Far from eliminating all risk, it keeps us desperate and in perpetual need of protection” (DeLind and Howard 2008). At stake, in other words, is not just the epistemological status of foodborne disease outbreaks—the ways in which knowledge about outbreaks is produced—but also their ontological status (what constitutes an outbreak?) and,

more to the point, the locus of power in terms of who can “reveal” (that is, represent or speak for) public danger.

Writing on “the creation of ‘food poisoning’ as a public health problem” in the United Kingdom, historian Anne Hardy has argued that “The rise of the laboratory permitted the creation of a public health problem by public health professionals and laboratory scientists intrigued by the microbiological complexity and hygienic ramifications of a very common, rarely fatal, and very evanescent complaint” (Hardy 1999). It is easy to lose sight of the historical contingency of our collective assumption that foodborne illness poses an urgent danger to the public weal, especially in an era in which the US regularly experiences multi-state outbreaks. Outbreaks of foodborne illness, especially when deaths occur, draw media attention and raise public concern about food safety, at least temporarily. Such periodic “food scares” accentuate popular conception that the public danger posed by “dietary risks” is discontinuous and fragmented, comprising independent stories of relatively isolated incidents rather than “ongoing, fairly consistent stories” (Caswell 2006).

However, the regular occurrence of food scares does not simply mark a failure of risk management or regulatory competence, nor should they be attributed solely to media sensationalism. As Dunn (2007) argues, “Overflow is not an occasional occurrence, or an indicator that the system has failed. It is a regular, endemic, integral part of a system that restlessly seeks dangers beyond its control, expands to encompass and regularize those dangers and begins the cycle of seeking and expansion again when it discovers dangers that have overflowed the system’s parameters”. In other words, food scares are themselves a normal product of the food safety apparatus—they take on a chaotic and sporadic character precisely when contrasted against the background state of normality and public expectations of what types of illness are ordinary or natural. Crucially, that background state is itself continuously produced, and reproduced, through the constant work of techno-institutional surveillance at the heart of the sewer state.

The deadly agency of microbes, the concepts for understanding that agency, the technical practices for detecting their presence, and the surveillance systems for tracing their impact all evolve together. As I have shown, cultural norms, epistemic criteria, institutional arrangements, and technical solutions together continuously renew our now taken-for-granted collective urgency over the embattled safety of our nation’s food. Crises do not form spontaneously in ‘nature’, and following the symmetry forward, neither are strategic formations an inevitable response. Both crisis and response must be produced. Without a common vocabulary, a normalized set of definitions, a system for reporting illnesses and surveilling populations, and an institutional architecture to manage it all, outbreaks as such would never be observable, and in a certain sense would not ‘exist’ in the societal consciousness.

Conclusion

In introducing her discussion on “the politics of foodborne illness”, public intellectual and health expert Marion Nestle wrote of a bout of food poisoning she suffered with her family in the early 1970s. “What seems most remarkable about that event,” she recalls, “was how *ordinary* it was... We assumed that minor food poisonings were a normal part of daily living” (Nestle 2003, 33). She uses this anecdote to highlight a “profound shift in attitudes” that had solidified by the late 1990s into widespread dissatisfaction with the state of microbial food safety and a sentiment that industry and government were “not doing enough to prevent microbial pathogens in the food

supply”. In this chapter, I have sought to explain this shift as a product of “sewer state” institutions and the increasingly elaborate technologies for finding contamination.

I began with the omnivore’s dilemma, an argument that Americans live in perpetual confusion, battered by a barrage of claims coming from all angles about what is healthy to eat and what will kill us in numerous grisly ways. However, the production of public danger signals that we are not simply omnivorous *individuals*, but an omnivorous *population* and *society*. We are hygienically-minded subjects, ever vigilant for signs of contamination, but we have also been conditioned over the course of a century to be dependent on outside experts to identify and deal with that contamination for us; our identity as eating subjects is based on knowing ourselves to be ignorant and incapable of knowing what is safe or what is dangerous. This dependence on experts has led to the perpetual “overflow” of danger by distancing the first step of food safety work—knowing the problem—from the everyday contexts within which people confront and live with danger. The shift highlighted by Nestle, therefore, can be understood as the co-production of new ‘knowledge’ of the natural order—leading to collective paranoia over our shared vulnerability to pathogens—with new ‘imperatives’ for the social order that subject not just individuals, but the entire fresh produce provisioning network to the anxieties of “germ consciousness”.

I have described in detail the intricacies and development of the techno-institutional network of surveillance in order to trace the direction in which framing of public danger through the concept of contamination has shifted societal expectations for purity from the ways these expectations were understood during the Progressive era, when national food safety laws were first enacted in the United States. Progressive reformers used germ theory to advocate a “germ consciousness” among Americans, which they articulated in moralistic rhetoric concerned primarily with inculcating in consumers a “knowledge of the self” as a vulnerable body in need of protection from dangerous pathogens. Initially, the reductionist epistemology favored by bacteriologists—in which bacteria were “revealed” as the atomic unit of disease, the root source of danger—encouraged as well a contact-tracing approach to foodborne illness detection and response that pursued food safety by policing transactions in the marketplace. National food safety law criminalized the act of adulteration as a crime against individual consumers.

Over the course of the 20th century, however, the increasing interconnectedness and coordination of public health institutions, laboratory standardization, and mass data-collection have transformed the old method of contact-tracing into a predictive technique for preventing public danger, for tracking down and eliminating contamination as close to its “source” as possible.. As a result, “germ consciousness” has expanded to encompass not just individuals, but entire supply chains. Today, the subjectification to hygiene is not limited to eaters, but also to growers, packers, shippers, processors, retailers and anyone else involved in providing fresh produce to consumers. These actors must be mobilized to defend society against contamination and impurity, to accept and perform the bodily protective work throughout the wide network of food provisioning. In the following chapter, I describe how this organizational germ consciousness aligns with a strategy of mastery conveyed through a standard model for food safety work.

3. MASTERING FOOD SAFETY RISK

As contemporary surveillance institutions and technologies work to reveal new instances of contamination and reinforce the urgent sense of danger posed by pathogens in our food, they also focus public policy attention on the question of how society should respond. In this chapter, I argue that this response follows a central strategy of hazard mastery, an ideology articulated, elaborated and promulgated by a new class of expert food safety specialists working to “repair” the many dangerous failings of an industrializing food system. These experts, initially concerned with quality control and product standardization, slowly absorbed safety into their professional mission in the latter half of the 20th century. In so doing, they worked to imbue this new ideology with the faceless and placeless qualities of a universal paradigm, approaching their work with a zeal reminiscent of what historian Nancy Tomes termed “the gospel of germs”, referring to the Progressive era movement to convince people that harmful microorganisms were omnipresent and that “safety from contagion required constant, unrelenting discipline of their bodies and households” (Tomes 1999, 5). Her history concludes in the 1920s with the solidification of “germ consciousness” through the establishment of myriad public sanitation institutions and individually ingrained “rituals of germ avoidance.” As I argue in this chapter, the germ consciousness and ritual avoidance she describes marked only the beginning of a profoundly influential paradigm shift in how contamination would be pursued and combated in the United States: through mastery and control not over just ourselves, but over the entire production environment and wherever germs might be found.

Today’s food safety apparatus is driven by the moral imperative to prevent foodborne illness and death by closing down pathways of contamination—both known and potential—across the produce supply chain. Within the mastery worldview, safety equates to the state of the world in which hazards are reduced to their component sites of contamination which are then rigidly controlled so as to eliminate perturbations to the status quo.³³ In imposing systematic control, food safety technocrats working in both industry and government seek to minimize the uncertainty stemming from pathogenic hazards so as to maintain a ‘normal’ level of commodity production and a ‘normal’ degree of consumer-citizen confidence in the food supply; this normality mirrors the production of a ‘normal’ baseline of foodborne illness against which the national surveillance system contrasts dangerous outbreaks. Their approach to producing a uniform normality, I argue, is a strategy of mastery. Mastery marks an extension of the gospel’s sermon of “constant, unrelenting discipline” from individual subjects—who fear death and morbidity—to entire produce supply chains—which ‘fear’ disturbances to business as usual.

Food safety experts extend that gospel by transforming the “rituals of germ avoidance” into bureaucratic “rituals of verification” (Power 1997). Mastery thus also marks a secularization of the moral imperative of germ avoidance. Technocrats, as I will demonstrate in this chapter, translate that evocative morality into dry calculations of ‘risk’ and embed the rituals of germ avoidance within formal systems for seamless traceability, constant ‘checking-up’, comprehensive documentation, and continual improvement. I will then show how, through risk and bureaucratic rituals, experts depoliticize the imperative to ‘reveal’ new pathways of contamination. By ascribing an aura of natural inevitability to this revelation, they in turn reify the need for endlessly increasing control across endlessly expanding actor networks. In this way, hazard mastery ‘balances’ the overflow of danger produced by the sewer state, preserving the food safety apparatus from collapsing over its own internal contradiction.³⁴

Acting on Danger through Risk

The sense of imminent public danger produced by extensive and intensive surveillance and monitoring of foodborne illnesses and human pathogens raises general concern over the *harms* that consumer-citizens can suffer as a result of eating contaminated food. The language of mastery speaks of controlling hazards—the “biological, physical, or chemical property that may cause a food to be unsafe” according to a standard industry definition (Lewis 2011)—so as to prevent such harms. However, orienting policy and regulation toward the reduction of harms faces a substantial practical problem (Sparrow 2008): how can regulators demonstrate successful control if, by definition, an avoided harm never occurs? To get around this central problem, regulators in general have turned to risk to bridge the gap between expectations of reliable protection and the fundamental indeterminacy of specific outcomes (Power 2004; Hood, Rothstein, and Baldwin 2001).

Renn defines risk as “the possibility that an undesirable state of reality (adverse effects) may occur as a result of natural events or human activities” (Renn 2008, 1). A risk, then, results from the construction of a set of hypothetical futures. Risk-management, by extension, makes use of powerful tools and concepts from probability theory to leverage information about what has happened in the past in order to render future contingencies into variables that can be factored into decision-making in the present: “[Risk] is an important and powerful method of organizing what is known, what is merely surmised, and how sure people are about what they think they know” (Jasanoff 1999). In short, risk is a technique to impose order under conditions of uncertainty.

Risk is thus a normative technique: by rendering contingent futures subject to decision-making power, risk also allocates responsibility and sets expectations for the outcomes of those decisions (Power 2007, 5). Almost by definition, risk identifies the role of human agency behind events which otherwise might be attributed to nature or simple chance. The purpose of calculating risks is to inform decisions so as to better choose among potential outcomes. If the future outcome is not contingent upon a human decision, then there is no reason to calculate probabilities or expected values. Thus every act of calculating a risk also necessarily marks an assumption of responsibility by *someone* over the eventual outcome. Inasmuch as agency is linked to deliberative action (as opposed to reactive or instinctive action), the capacity to conceptualize risks—to think about “what might happen”—is a fundamental hallmark of human agency. By adopting risk as a framework for knowing and acting in the world, we also lower our capacity to accept accidents; in the context of food safety, we see this trend in the constant work of the public health surveillance system to identify more outbreaks, attribute more illnesses to specific pathogens and specific foods, and in general to whittle away at the catch-all background category of “sporadic” gastroenteritis. Importantly, this risk ontology implies a risk ethic: if human actors have power over outcomes, then they also must bear responsibility and can be held accountable for those outcomes. By centering human agency, risk calculations make a world that can, and more importantly *should*, be mastered. In practice, then, the seemingly straightforward goal of preventing harms entails the more fraught process of calculating and managing risk—an activity requiring a fundamental reorganization of institutional rationalities “in the name of risk” (Power 2007).

The food safety apparatus also operates in the name of risk. The techno-institutional surveillance system leverages its vast databases to probabilistically associate particular foods and production sites with foodborne illness, resulting in an ordering, in effect a prioritization, of

foods and sites by their ‘riskiness’. This allows food safety experts to identify the riskiest foods and sites as priority targets against which to exert further control efforts, but it is important to recognize that this seemingly rational and objective calculation is merely a repackaged manifestation of purity that segregates foods and sites into “safe” or “dangerous” designations, and likewise divides the people working at those sites into “good” and “bad” according to a moral economy defined by an idealized standard of control.³⁵

A Standard Model for Universal Control

To situate the abstract notion of a hazard mastery strategy in more concrete terms, I first describe how this strategy manifests as an idealized standard model for food safety. If the following section appears dense, byzantine, and dull, then I have faithfully evoked the bureaucratic tedium that buffers food safety work from political scrutiny.

The standard food safety model represents an abstract system of perfect control which can only ever be asymptotically approached, and is envisioned as the universal norm for food operators across the supply chain. As explained in Chapter 1, to establish control requires a comparison, or check, of the actual state of things against an imagined state of how things should be, in other words a hypothetical *contraratum*. The standard food safety model *is* that normalized imaginary, and forms the point of reference against which actual operations must be checked in order to produce a state of control. The model itself, as inscribed in the documents of the food safety apparatus (see for example FSPCA 2016), comprises multiple component programs conceived as an integrated food safety management system (FSMS) that seeks methodical and comprehensive mastery over a given operation through coordinating a core set of risk-based preventive controls (Figure 4).

Preventive controls may take many forms, focusing on specific production processes, sanitation procedures, or supply-chain management. They are built on a foundation of pre-existing operational policies and programs. The broadest and most generic foundational programs are commonly referred to as prerequisite programs (PRPs), which comprise the daily responsibility to monitor, clean, maintain, and operate the facility safely. Examples include employee health and hygiene, employee training, sanitation, environmental monitoring, equipment maintenance, pest control, product traceability and recall, and supplier approval/control programs. Some PRPs are formulated in company policy as sanitation standard operating procedures (SSOPs), while others are regulated by government agencies, such as Good Manufacturing Practices (GMPs), which in the US are set and enforced by the FDA (21 CFR 110). A basic PRP, SSOP, or GMP may sufficiently control some hazards in a given operation, but other hazards may require the company to establish and monitor more specific preventive controls, such as critical control points, known as CCPs, which have long been considered the gold standard within industry, a history examined in depth in the next section.

The standard food safety model requires the operator to document in the food safety plan or other company policy which preventive controls are used for which hazards, and to provide regular verification that the written policies are followed in practice (e.g. through employee trainings or self-inspection logs). The model requires the operator to validate that all programs effectively control the identified hazards; in this context, validation means the operator must prove, based on “scientific evidence”, that the program is “effective”. For example, if a packing house operator plans to use chlorine to sanitize the water used to wash its produce, the operator would need to demonstrate that maintaining the planned concentration of chlorine in the water actually keeps bacterial counts below a minimum safe threshold, which must also be backed up by a scientific citation. In addition to preventive controls, the operator must monitor the food safety management system to ensure that control systems perform within their predetermined parameters. In the case that a preventive control fails, the operator must take appropriately documented corrective actions, as detailed in the food safety plan or company policy, to restore control and mitigate any resulting risk. Lastly, the model requires the operator to keep complete records of all food safety activities, generally for at least two years. The operator should use these records to internally verify that the programs and policies are carried out, and also to demonstrate to external auditors and inspectors that the plan is actively and appropriately implemented. Records are thus critical to the standard food safety model. As the saying in the food safety industry goes, “It didn’t happen if it’s not written down.”

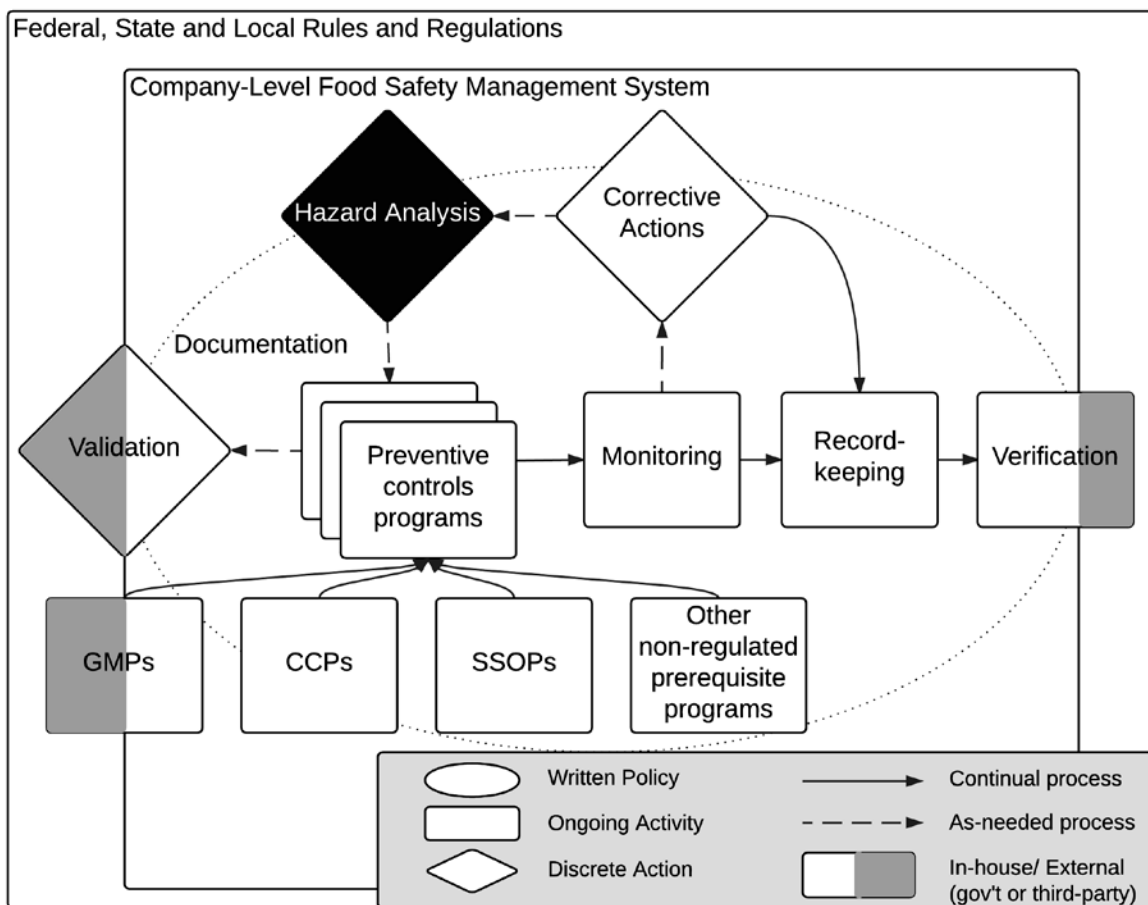


Figure 4. The standard food safety model. Adapted from FSPCA (2016).

The standard food safety model is thus bureaucratic and prescriptive in nature, seeking at once comprehensive and adaptable control over entire systems of production. How has the strategy of hazard mastery taken the shape and form of this particular model? What are its central precepts, agencies and institutions? The following section will trace the history of the model and its influence over the formation and deployment of the food safety apparatus. It then segues to how the model has entered the farm field as a new frontier.

Articulating the Strategy

The Space Program and Modes of Failure

The origins of the hazard mastery paradigm and the standard food safety model trace back to 1959, when NASA contracted The Pillsbury Company to develop and produce astronaut food for the US space program (Bauman 1995; Ross-Nazzari 2007). Knowing that astronauts would be isolated like no other humans in history, NASA set extremely demanding microbiological limits in an effort to avert potentially disastrous foodborne illness on the mission—the agency wanted “to come as close to 100% assurance as possible” (Bauman 1995). The standard approaches to quality control in the food processing industry at the time, however, relied on periodically collecting a sample of the end-product and sending it off to a laboratory for testing. This approach presented Pillsbury with two problems. First, the company could only raise its certainty of a ‘safe’ product by increasing the frequency of sampling, resulting in the costly destruction of an ever-higher proportion of the product. Second, Pillsbury’s only recourse in the case of a positive test for contamination was to destroy the entire batch from which the sample had been collected. Little could be learned about the cause of the contamination and how to prevent it from happening again; in other words, under the end-product testing approach, Pillsbury could only passively react to hazards in its supply chain and manufacturing process. The company had no way to proactively tighten control based on learning.

Pillsbury simply could not deliver food that would meet NASA’s high threshold of certainty. Seeking a paradigm shift, Pillsbury and NASA collaborated on a preventive system that, in the words of Pillsbury’s lead scientist on the project, Howard Bauman, “would require control over the raw materials, the process, the environment, personnel, storage and distribution beginning as early in the system as possible” (Bauman 1995). They turned to an engineering model borrowed from the US Army known as “modes of failure” (Sperber and Stier 2009; Bauman 1974). This approach involved breaking the system down into its component parts, each of which would be examined and assessed for every conceivable way in which a hazard might be introduced. Each identified vulnerability would be addressed separately as a critical control point before reassembling every part back into a unified, and presumably now controlled, closed system.

NASA’s goal to achieve “100% assurance” pushed the project scientists toward a preventive strategy, which would avoid contamination from harmful substances in the first place. To achieve perfect prevention required fine-toothed examination of the production process in its entirety, from raw materials to the final product, to identify any and every potential mode of failure. The problem, the scientists came to believe, was systemic—dangerous contamination could occur anywhere in the supply chain—and therefore the control solution had to be holistic and complete. They posited that minutely detailed records allowing any hazard to be traced back to its source—for example, “the latitude and longitude where the salmon used in salmon loaf were caught was known, as well as the name of the ship” (Bauman 1995)—would allow not only

rapid and efficient response in case a contaminant slipped through the carefully constructed network of control measures, but would also promote an adaptive capacity to learn from mistakes and refine preventive control over time. In other words, they designed the strategy such that every failure constituted a directive to further tighten control.

Establishing the Conditions of Control

This whole-system, preventive approach to food safety did not find a foothold beyond the space program until over a decade later, when a series of major food scares put intense pressure on FDA and the food processing industry. FDA lacked sufficient staff and funding to fulfill its inspection duties and was in desperate need of a new regulatory strategy. Between 1968 and 1970, several influential NGO reports, followed by Government Accountability Office investigation, leveled serious indictments against the FDA for its perceived complicity with the processed food industry.³⁶ The next year, Pillsbury itself came under fire after glass was discovered in some of Pillsbury's baby food products (Ross-Nazzal 2007). Eroding consumer confidence and widespread allegations of regulatory failure created an opportunity window for Pillsbury's scientists to revive the control methods developed for the space program, and pitch them as a new standard model for controlling food borne hazards that could assuage rising public concern.

Seeking a "panacea" (Demortain 2011) for both the processed foods industry and regulators, FDA and the American Public Health Association sponsored a special conference in 1971 "to develop a comprehensive, integrated attack on the problem of microbial contamination of foods" (Kupchik et al. 1971). The final report for the panel on preventing contamination in processed foods, vice-chaired by Bauman, outlined precisely such a program. While the panel acknowledged that "the routes to effective and economical control of microbial contamination of processed foods will vary from one product to another", they nonetheless described generalizable strategies to achieve control over information, space, time, and human behavior, which were conceivably applicable to any food operation.

The panel's report began by asserting that "new techniques that are dependent upon laboratory tests must be developed and added to good manufacturing practice" (p. 57). The panel did not elaborate extensively upon this point, apart from stating that the existing GMPs, while a necessary organizational baseline, "are generally not sufficient" without active and systematic *checking up on* the effectiveness of those practices. By drawing connection between being "checked" and being "controlled" (p. 68), the panel reveals its unspoken assumption—and implicit assertion—that controlling *information* is paramount to controlling microbial contamination: the will to power is inseparable from the will to knowledge. And to check, in the context of the report, is to conduct a laboratory test: "Laboratory tests are an essential part of any program aimed at guarding against bacteriological contamination" (p. 63). The test, then becomes the obligatory passage point *en route* to the requisite information needed to exert control. In other words, the test checks whether the production environment corresponds to the imaginary state of 'purity' represented in the standard food safety model. This connection between information and power to exert control is articulated most clearly in the panel's definition of critical control points:

The critical control point (CCP) is a concept adopted by the panel to describe the location(s) or point(s) in a food processing operation *at which failure to prevent contamination can be detected by laboratory tests* with maximum assurance and efficiency. In theory, if the critical control points have been reliably identified and if the

laboratory tests are negative for contamination, the food processor will have maximum confidence that his product is uncontaminated. On the other hand, a positive test result will alert the processor and help locate the source of contamination... It is important to emphasize in this connection that *nothing is accomplished by making these tests, or any other tests for that matter, unless there is a definite plan of response to unfavorable test results* (p. 68, emphasis added).

Crucially, the definition concludes with an exhortation that the information revealed by the tests be acted upon: “Every test... should therefore provide usable information and the information should be used.” But information itself is subject to the conditions of control, setting up an infinite regression of ‘checking’ which leads to an unavoidable contradiction within the report.³⁷ “[R]apid, reliable, and efficient procedures are relatively scarce,” the report notes, and furthermore, “a high level of expertise is required to develop and apply rapid control types of tests, since false negative results can be disastrous” (p. 63). The panel recommends developing improved, “fail-safe” methodologies that will “facilitate and encourage increased frequency of testing” and which “should be given prompt and widespread dissemination” (p. 64). But at the same time, “To test for every conceivable contaminant in every food is clearly impractical and unnecessary,” especially if informational control can be achieved at a high level of abstraction by prioritizing sites of contamination through the calculation of risks. To this end, the panel recommends that industry partner with government regulators to identify a more efficient/sufficient number of specific “organisms and toxins of concern” (p. 65), a task reliant upon the extensive surveillance and monitoring data collected by the national techno-institutional network described in Chapter 2.

Further complications arise in that usable information is not limited to the presence or absence of contaminants “of concern” in the actual product, but also to information about the surrounding spatial environment. The panel discussed the need for *environmental control* extensively, noting that “Control of the physical environment is clearly basic to the prevention of contamination,” and moreover that “The importance of environmental control is difficult to overemphasize” (p. 72). While in these passages the panel specifically referred to the physical context of a processing plant—the facility’s floors, equipment, tools, ventilation systems, and so forth—elsewhere in the report the panel strongly implied that the relevant “environment” is not necessarily restricted to the confines of the processing plant. The report implicitly framed the boundaries (both spatial and temporal) of the environment to be controlled as inevitably expanding. This implicit inevitability is most evident when the report addressed the case of food products or “sensitive ingredients” without a “kill-step” (such as pasteurization) to destroy any microbial pathogens (e.g. fresh produce). In such cases, the need to prevent “environmental contamination of raw materials” (p. 59) springs into sharp focus. However, the report acknowledged that “many raw agricultural commodities cannot be obtained free of actual or potential contamination” (p. 70), echoing its opening caveat that “Eliminating all outside sources of contamination, especially from raw materials... is not likely to be achieved in the near future” (p. 57). Given the practical limitations of the moment, the panel presented a “recommendation that when the microbial quality of a food depends directly on the microbiological condition of a raw material, the assay of its microbial condition become a critical control point” (p. 71). The panel acknowledged only that environmental control is limited by feasibility, not by desirability.³⁸

Two further aspects of the panel’s report bear mentioning in that they most directly formulate a link between controlling the production environment and controlling people. First,

the panel noted that human beings are not only agents of control, but also sources of hazard inasmuch as we can vector pathogens: “Since human contamination of foods is generally from enteric sources and since pathogens from human sources are apt to be much more virulent than from other sources, these must be considered to represent a severe hazard” (p. 73). Though they gloss over the contradiction inherent in this statement—namely that people must be simultaneously objects *and* agents of control—the ramifications of that contradiction have magnified over time to dramatic consequence in the shape of social and agroecological relations, as will be discussed further in Chapters 5 through 7. Second, the panel asserted that control is not a discrete event, but a continuous state of things: “The accumulated data from all critical control points should be used to *continuously evaluate the total system*” (p. 75, emphasis added). By extension, then, control is not achieved through discrete actions, but rather by adopting a particular state of being characterized by constant vigilance and continual evaluation. This assertion set the stage for the process of food safety acculturation which I discuss in Chapter 5.

These initial conditions of control articulated deep within the text of this report were quickly elaborated and widely disseminated. In 1973 FDA asked Pillsbury to run a training course for the canning industry and its own staff on the company’s preventive, risk-based approach (Pillsbury 1973). The training was titled “Food Safety through the Hazard Analysis and Critical Control Point System,” marking the first time that the model championed by Pillsbury was publicly named as HACCP (Sperber and Stier 2009). The following year, the professional journal *Food Technology* devoted a special issue to HACCP. The first article, authored by Bauman himself, outlines the principles and underlying rationale for the HACCP system, “particularly with regard to microbiological hazards” (Bauman 1974). Over the next few paragraphs, I analyze this article and the special issue in depth to demonstrate how this initial work set the frame of reference for the hazard mastery paradigm.

In his article, Bauman clearly promotes the expansive control that he envisions for HACCP-based food safety systems: “*Until adequate control can be exerted over the entire food processing industry to prevent food ingredients from being vectors of harmful or potentially harmful organisms, constant vigilance must be maintained over ingredients*” (Bauman 1974, emphasis added). Notably, it was not necessary for Bauman to elaborate extensively on the concept of *control* – his audience of food scientists and technologists would have understood implicitly the need to suppress the random, “fickle” variations of chance or nature, a theme echoed in the advertising lingo accompanying Bauman’s article (Figure 5).

Glossing over the ‘why?’ of control, Bauman moved straight to the ‘how?’ of control, which begins with hazard analysis. This amounts to an “inventory” of the entire system, which “must take into account the history of the ingredients” and consider “what could possibly go wrong” at each step of the process. Once each potential hazard has been identified and prioritized, the next step is to “eliminate... those hazards which are totally correctible”. When total elimination is not possible, the operator must “establish a system of control”:

**Even when Nature makes
some of your tomatoes
green and yellow, we can
make all of your sauces
rich and red.**

Tomato harvesting machines are color-blind. They can't pick and choose the ripe tomatoes that give sauces, soups and pastes a rich red color. But Roxanthin® Red 10 lets you take all the nutritious tomatoes you pick, regardless of color, and get a rich natural-looking tomato red color, every time. Besides being an excellent color extender, Roxanthin Red 10 gives exceptional uniformity and superior light and heat stability. This improves shelf life, and even allows your product to sit on steam tables for hours without losing its color.

Roxanthin Red 10 is also water dispersible and chemically stable in the pH ranges normally found in foods. So it can be added quickly and easily, even if your foods are dehydrated. Find out how to make your products look like they mean business, even when your tomatoes don't. Call or write Bud Gormley, Marketing Manager, Food Additives, Roche Chemical Division, Hoffmann-La Roche Inc., Nutley, New Jersey 07110. (201) 235-2448.

ROCHE
The Food Improvers.

Figure 5. Advertisement for a synthetic colorant that appeared in the September 1974 issue of *Food Technology* along with Howard Bauman's introduction to the HACCP concept. Another advertisement later in the same issue proclaims, "Mother Nature is fickle. Profuse with her blessings one day, then turns on a flood, drought, or blight the next. This unpredictability makes natural product cost, supply and quality uncertain. Durkee Synthesized Essential Oils provide an alternative to nature's unpredictability."

If the processing of a food item does not contain a controlled process step which effectively destroys harmful organisms, then a substantial food safety risk may exist. Such steps must truly be under constant control, and the controls must be able to respond to changes in the process. Information must be documented either by human observation and recording or by some kind of automatic instrument. The effective destruction of microorganisms under constant conditions depends on known quantitative and qualitative loads of organisms. Should large increases in loads occur, the process may become ineffective simply because it is not dynamic enough to overcome the change in the load (Bauman 1974).

Prevention, he wrote, depends on inventorying the entire system (i.e. the supply chain and process) to identify and analyze hazards by asking "what could possibly go wrong", eliminating those hazards completely where possible, and establishing critical control points where not. He specifically highlighted the need to understand "The Hazards of the Raw Materials—assessing the likelihood of the product's having become contaminated in the field and during harvesting and storage."

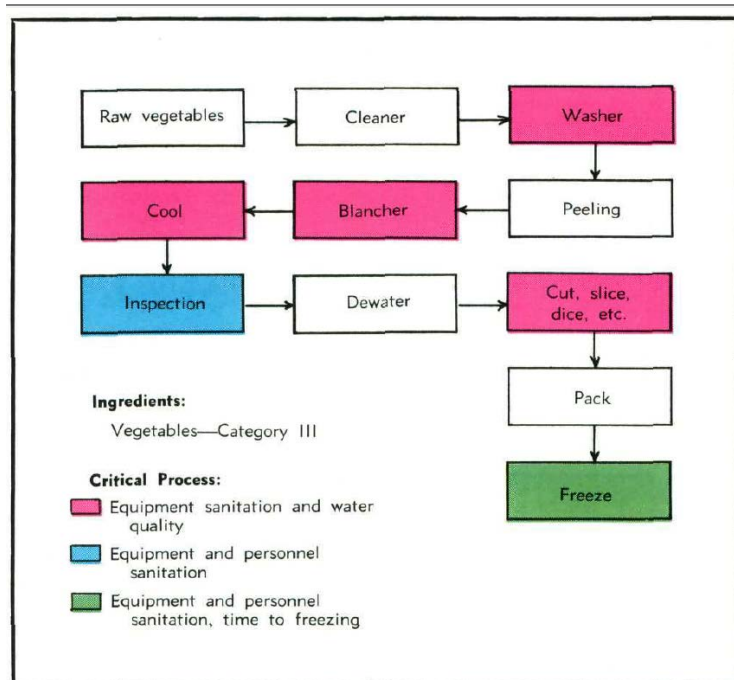


Figure 6. Example flow diagram for a frozen vegetable processing facility, with the stages of production broken down and the CCPs identified (Peterson and Gunnerson 1974).

vegetables (Figure 6). Critically, this article reiterates the importance of people, organized into a clockwork-like system of processes, as agents transforming information about the past into present action:

It must be emphasized that it is not possible to ‘inspect’ either quality or safety ‘into’ frozen foods. Production of high-quality, safe, and wholesome frozen foods is a matter of a determined, knowledgeable, careful, well-organized, and well-implemented process control program designed to anticipate and prevent microbiological and other problems. (Peterson and Gunnerson 1974).

The authors devote their final section to “the feedback characteristics of the system.” Microbiological tests, they remind their audience, “yield results too late” to serve as an adequate reactive protection measure. Rather, “their chief value is in identifying the problem areas and problem situations in the processing” to stimulate “heightened preventive activity” in the future. The feedback loop works by controlling the flow of information over time to establish a “normal” range of indicators and observable product and environmental characteristics. As Bauman writes in his article, “A well-documented history of processing of food lots is essential to establish normal variations which affect food safety, and it is necessary to have some system of traceability of products and ingredients” (Bauman 1974). Again, the system comes full circle to the depoliticized form of control that is synonymous with regulation. The imagined standard food safety model slips easily into the neutral position of simple normality.

With the publication of this issue of *Food Technology*, the scientists behind HACCP defined the conditions of control and the core tenets of the hazard mastery paradigm. First, control requires collecting information from the operating environment, organized by systematic break-down and inventory of the entire production system (i.e. during hazard analysis).

A second article in the same issue explains how FDA had begun to use HACCP to regulate the canning industry. It describes how increased consumer concern over food quality has led to “close scrutiny not only of consumer products, but also of the government agencies who regulate those products” (Kauffman 1974). The author, F. Leo Kauffman, an assistant director for manufacturing practices at FDA, explains how HACCP not only makes inspection more efficient, but also opens an opportunity for the agency to help processing plants identify and correct deficiencies. “HACCP watches the entire production chain,” he concludes.

Finally, a third article examined the use of HACCP in a specific type of facility, processing frozen

However, the boundaries of the operating environment are fuzzy and prone to expand both *spatially* beyond the processing facility and also *temporally* by tracing back the history of raw materials and tracking forward the future routes of finished product. Second, control is contingent upon checking that information against the standard food safety model through laboratory testing of product and environmental samples, but also through checking the processes of checking themselves, potentially *ad infinitum*. Testing “every conceivable contaminant in every food is clearly impractical”, however, not to mention the second- or third-order checks. This means that an arbitrary line must be drawn somewhere and a relation of trust must substitute for a condition of control.

Third, people as agents of control must adopt a state of being that is oriented toward constant vigilance and continual improvement, perpetually anticipating and imagining what might go wrong. However, people themselves are also simultaneously objects of control inasmuch as humans are “severe hazards”, being vectors of both material (pathogens) and informational (errors) contamination. Taken together, then, far from achieving a steady state of normality, mastery is rife with internal contradictions that imbue the paradigm with an inherent dynamism that manifests most clearly in the ever-expanding enrollment of new hazards and new agents of control into the apparatus. This expansion is now evident in the rapid institutionalization of the hazard mastery paradigm across food sectors at every scale from the individual organization to global governance agreements.

Institutionalizing Control

Once Pillsbury’s microbiologists had articulated the mastery strategy as HACCP and gained FDA’s endorsement, they achieved an “exportable formula” (Demortain 2008). And they did export it, gradually colonizing the post-farm-gate food industry over the next two decades (Demortain 2008; Demortain 2011). The professional food science and environmental health literature during the 1970s, 1980s, and early 1990s is marked by numerous articles illustrating the application of HACCP to novel systems, including for example, frozen foods (Peterson and Gunnerson 1974), hospital foodservice (Bobeng and David 1978), commissaries in general (Cichy 1982), shellfish (West 1986), meat and poultry (Adams 1990; Tompkin 1990), retail and restaurants (Bryan 1990), and even home cooking (Beard 1991). HACCP was also advanced as a broadly suitable approach for preventing contamination by specific pathogens of concern, including *Salmonella* (Simonsen et al. 1987) and *Listeria* (Mossel 1989).

For a time, HACCP’s travels were largely limited to voluntary adoption in the private sector. Apart from FDA rules for low-acid canned foods set in 1973 (38 FR 12716), HACCP and the underlying hazard mastery strategy had little presence in enforceable federal regulation, which was limited by statute to *post hoc* enforcement measures that only triggered in the case of adulterated or misbranded foods (see Chapter 2). At the state government level, New York was an early regulatory adopter, in part because it implemented an active foodborne disease surveillance system in 1980, which allowed state agents to systematically identify risk factors for outbreaks (Guzewich 1986). New York State turned to HACCP in 1984 as its primary tool for mitigating these risks, officially requiring HACCP evaluations at “high risk establishments”—i.e. those serving foods known to be a likely cause of foodborne illness, such as hospitals, prisons, caterers, hotels—and incorporating HACCP principles into all regulatory inspections.³⁹ Explaining the rationale behind the adoption, the then chief of the Food Protection Section of the New York State Department of Health argued:

HACCP has the potential to improve the relationship between the food service industry and regulators as we jointly focus on the food and devote less time to items that are sometimes viewed to be picayune. Operators can be expected to respond positively to a process that adapts the regulation to their establishments and lets them know what is most important. HACCP is a mentally stimulating process which is professionally challenging and rewarding for the sanitarian and, therefore, improves self-esteem. Operators are impressed by the knowledge of sanitarians performing HACCP inspections, and this, plus the cooperative approach, results in the sanitarian being held in higher regard by the operators. (Guzewich 1986).

Guzewich's glowing outlook captures the win-win outlook for HACCP that had solidified among food safety experts by the 1980s. With expert champions from the ranks of both industry and government weighing in with a growing list of "success stories" attributable to the model, "the institution of [national] HACCP rules appeared inevitable" (Nestle 2003, 85). All that was required was a catalyst to overcome the last bastions of resistance and spur regulatory action.

That catalyst came in the form of a deadly 1993 outbreak of *E. coli* O157:H7 that was linked to undercooked hamburgers from the Jack-in-the-Box chain of restaurants. At the time, federal food safety activity was at low ebb: USDA's Food Safety Inspection Service had dramatically rolled back its inspection capacity under the Reagan administration's program of deregulation, and FDA likewise suffered from persistent underfunding and understaffing. The Jack-in-the-Box outbreak garnered sufficient media attention to serve as a focusing event for the new Clinton administration, opening up a policy window for USDA and FDA to finally take a more aggressive and proactive stance.

FDA moved first, drawing on the recommendations of a 1991 report from the prestigious Institute of Medicine (IOM 1991) to initiate rule-making in 1994 to mandate HACCP in seafood processing (now encoded at 21 CFR 123); the agency finalized the rule in 1995 (60 FR 65096). While FDA considered requiring HACCP for all food processors under its jurisdiction because it "addresses the root causes" of foodborne danger, the agency's limited resources and political capital constrained its intervention to piecemeal rule-making.⁴⁰ By 2002, FDA only required HACCP for raw sprouts, eggs, and juices in addition to seafood, although it strongly encouraged other industries to voluntarily adopt HACCP (Nestle 2003, 88–90).

USDA followed a no-less-circuitous route, letting the meat industry take the lead in piloting and demonstrating the utility of HACCP before stepping in. In the immediate aftermath of the Jack-in-the-Box crisis, the company's president hired David M. Theno, a consulting food safety expert with an M.S. and Ph.D. in microbiology and animal sciences from the University of Illinois, Urbana-Champaign, as vice president in charge of product safety. To save Jack-in-the-Box from collapsing under the weight of the disaster, Theno pushed the company to adopt an aggressive HACCP program, focusing particularly on supply chain control and regular microbiological testing; under Theno's leadership, Jack-in-the-Box restored and even elevated its reputation to become a "food safety icon" (Bricher 2007). Following this successful demonstration, USDA's Food Safety Inspection Service (FSIS) revised its meat and poultry inspection from an organoleptic (sensory inspection, or "poke-and-sniff") approach to a HACCP-based approach, for the first time requiring all meat and poultry establishments to follow a HACCP system (61 FR 38805). Although industry lobbying substantially weakened the role for federal regulators and loosened the microbial testing standards in the final rule (Thomas 2014, 112–20; Nestle 2003, 90–97), it nonetheless firmly cemented HACCP as the cornerstone of national food safety.

HACCP also traveled globally, in large part because adoption of a common standard model promised to facilitate international trade (Caswell and Hooker 1996). The Codex Alimentarius Commission, an international food standards body organized under WHO and the United Nations Food and Agriculture Organization (FAO), adopted HACCP in its international standards for food hygiene in 1992 (Codex, CAC/GL 21 – 1997). The following year, the European Commission adopted a blanket rule requiring all “food business operators” to adopt HACCP-based food safety plans (Council Directive 93/43/EEC), and in 1994, HACCP was incorporated into the WTO Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement). In summation, “the HACCP model carries with it a strong potential for aligning all actors of food production and food hygiene, turning them into intervening actors of an overall food control system with global coherence and impact” (Demortain 2011, 120). HACCP’s history of expansion across borders and sectors has borne out that potential in shaping a multi-scalar framework of public-private partnership for food safety governance (Figure 7).

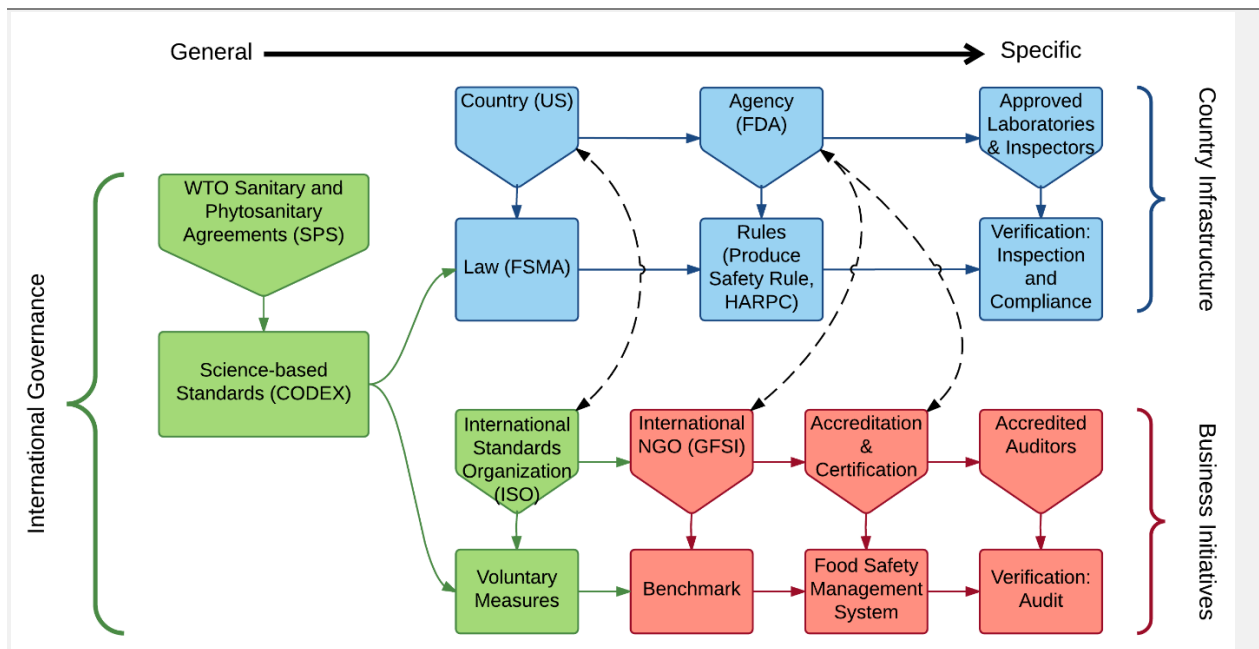


Figure 7. Framework for global food safety governance organized around the hazard mastery paradigm and the conditions of control set by HACCP. CODEX refers to the Codex Alimentarius, an international organization under the UN Food and Agriculture Organization (FAO) that sets science-based international standards. Governments including the US look to CODEX in order to harmonize national law with the global trade community. Industry also looks to CODEX as the authority upon which to base the various components of tripartite standards regimes for food safety (Loconto and Busch 2010). Adapted from (IOM 2012, 300).

The driving force behind this global expansion merits further discussion. From its introduction in the early 1970s, as attested to by the above-quoted ‘win-win’ enthusiasm expressed for the New York state experience, HACCP as a technique has promised industry and government alike “a thoroughly modern and sensible method for keeping pathogens out of the food supply” (Nestle 2003, 67–68). HACCP’s appeal lies partly in its apparent simplicity. Now comprising an ordered list of eleven concise commands to follow in order to develop a food safety plan (Table 1), the HACCP model is designed to be a universal risk-based preventive method. It is also highly prescriptive, demanding constant vigilance and continuous self-

correction. While HACCP offers industry actors, particularly in the processing and packing stages of supply chains, a means to efficiently improve their quality assurance processes, the model also appeals to government regulators, as Guzewich argued in the case of New York’s public health department (1986). HACCP offers agencies such as FDA a generic tool to standardize regulatory oversight for an otherwise highly heterogeneous field of food-related businesses. Rather than specific production processes or facilities, the operations’ standardized HACCP management plan—and the associated records of monitoring and corrective actions—are the target of regulation through inspection and audit. Thus regulators can adopt a universal standards-based system instead of making multiple regulations aimed at many diverse sites and food production sub-sectors. This system effectively devolves the work of managing site-specific conditions to companies who ostensibly know their facilities better than regulators ever could. In principle, HACCP-based food safety management plans can be applied to any kind of food system, but regulators need only to know and understand the abstract HACCP model rather than the particular function of each different facility or production process. The day-to-day monitoring and policing work of food safety devolves onto individual companies and workers on the ground.

Table 1. HACCP Preliminary Tasks (*italics*) and Principles

- a) *Assemble the HACCP team.*
- b) *Describe the food and its distribution.*
- c) *Describe the intended use and consumers of the food.*
- d) *Develop a flow diagram which describes the process.*
- e) *Verify the flow diagram.*
1. Conduct a hazard analysis.
2. Determine the critical control points (CCPs).
3. Establish critical limits.
4. Establish monitoring procedures.
5. Establish corrective actions.
6. Establish verification procedures.
7. Establish record-keeping and documentation procedures.

Source: The National Advisory Committee on Microbiological Criteria for Foods (1997).

The Hazard Control Model Encompasses the Field

A key aspect of the standard food safety model inherited from HACCP is supply-chain control—the requirement to monitor all suppliers providing raw materials in order to control for more ‘things that might go wrong’.⁴¹ This provision was designed to trigger a positive “trickle-down effect throughout the industry” by “empower[ing] producers to enhance food safety throughout the farm-to-fork chain”, a phenomenon observed in the meat and poultry industries: “As American meat-processing plants began adopting HACCP... they put pressure on their suppliers to do the same” (Thomas 2014, 87). In the context of produce, the model incentivizes mid- and end-chain operations—companies that process, wholesale, retail, or serve produce—to verify that all of their vegetables come from farms that are following an appropriate and adequate food safety management system of their own. Thus the model’s core principles of

hazard analysis and preventive control, although conceived for the factory-like conditions of industrial food processing plants, have also determined the characteristics of food safety programs for growing and harvesting in open field environments.

Today, produce farms are regulated under the FDA's Produce Safety Rule, which sets "science-based minimum standards for the safe growing, harvesting, packing, and holding of produce, meaning fruits and vegetables grown for human consumption" (80 FR 74353). The rule applies to all but the smallest farms nationwide, fully covering approximately 35,000 farms and 94% of all US acreage used to grow fresh produce for raw consumption (FDA 2015), requiring them to adopt food safety management systems based on the framework of Good Agricultural Practices (GAPs).

Authored jointly by FDA and the US Department of Agriculture (USDA), the GAPs provided the first universal—though voluntary—guidance for farmers on how to reduce the risk of pathogen contamination during growing and harvesting. This guidance followed directly on the heels of the new USDA and FDA HACCP-based rules, and was strongly shaped by the agencies' new-found interest and HACCP and implicit commitment to the underlying hazard mastery paradigm. The GAPs story began with a joint report by the FDA, USDA, and the US Environmental Protection Agency ordered by President Clinton to map out a comprehensive plan to improve the safety of the nation's produce (EPA, HHS, and USDA 1997). The document heavily referenced HACCP, using the term 55 times in 42 pages and noting its recent application in the new rules for both the seafood and meat and poultry industries. The report's introduction stated the agencies' intention to "encourage the use of HACCP principles throughout the food industry." By seeming coincidence—though in reality a result of newly centralized surveillance institutions created in response to the Jack-in-the-Box crisis—at precisely this time vegetables, fruits and nuts were coming under scrutiny as dangerous vehicles for foodborne pathogens in their own right.

For many years, it was widely believed in the industry and among food safety scientists that only products of animal origin could spread human pathogens: they did not believe that incidental *E. coli*, *Salmonella*, and *Listeria* contamination in the field would pose a threat to consumers, since those bacteria could not survive long enough on plant tissue to be transmitted consumers (Brandl 2006). As one research scientist I interviewed explained the situation in the mid-1990s:

Truly the dogma was human pathogens have no business on plants, no ability to multiply or colonize. It cannot possibly come from the pre-harvest environment. That was very much in tune with what the industry thought as well. It was new to them. They didn't really understand.

The old viewpoint that human pathogens generally did not spread through plants was made untenable when plant-oriented microbiologists scrutinized the "anomalous" cases of outbreaks linked to vegetables and fruits revealed by the new techno-institutional surveillance system (see Chapter 2), and began producing evidence that human pathogens like *Salmonella* or *E. coli* could colonize plant tissues in the field. Although a "secondary habitat" compared to animal hosts (including humans), emerging evidence in the late 1990s and early 2000s indicated that plants can nonetheless provide an environment in which human pathogens can survive and even grow (Brandl 2006; Brandl and Sundin 2013). For example biofilms, microscopic structures that nurture bacterial colonies and protect them from environmental stressors, may form in tiny crevices on plant surfaces, protecting the bacteria from sanitation interventions like washing

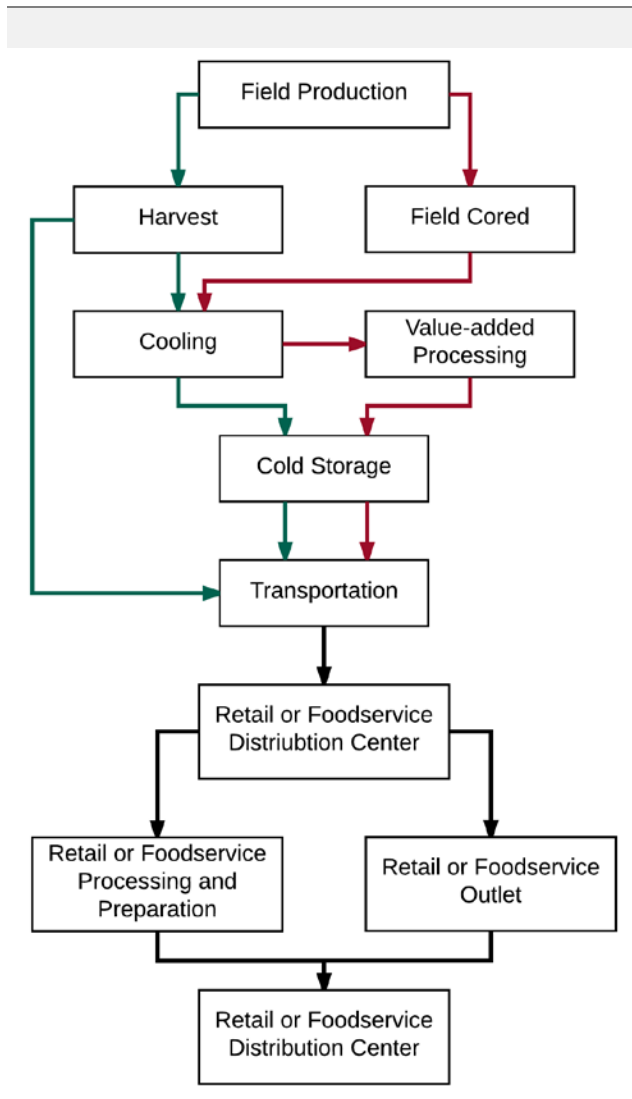


Figure 8. A supply chain comprises all stages of a crop’s lifecycle, from primary production in the farm field through final consumption by a consumer, as in the example above where green denotes raw produce and red denotes fresh-cut produce (adapted from FDA 2006). A supply chain may also refer to the actors responsible for carrying out each stage of production. In the case of leafy greens, for example, this includes growers, harvesters, post-harvest operators (storage, packing), processors (fresh-cut, pre-washed, ready-mix), distributors, and retail or foodservice firms who provide the food to consumers. In the context of the standard food safety model, the supply chain concept is mobilized to identify and define the sites and subjects of control: “As we develop a greater understanding of food safety issues relative to the full spectrum of supply and distribution channels for fruits and vegetables it has become clear that the next generation of food safety guidance needs to encompass the entire supply chain” (FDA 2006).

produce with chlorinated water (Olaimat and Holley 2012; Critzer and Doyle 2010). Combined with rapidly mounting evidence of the mechanisms of human pathogen contamination of and survival on plant tissues, the increasingly regular outbreaks of foodborne diseases linked to fresh produce started to look like a problem originating on farm fields. The feedback loop between the production of public danger and the conditions of control triggered a need to adapt the standard food safety model yet again to encompass a novel environment: the farm field.

With the identification of produce—and the people who grow and handle produce—as a new source of public danger, the recommendations of the joint report on national foods safety, issued in May 1997, prompted the White House to issue a memorandum to FDA in October directing the agency, in collaboration with USDA, to draft the “first-ever specific safety standards for fruits and vegetables” (Clinton 1997). One year later, in October of 1998, FDA published the *Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables*. The document formalized GAPs as non-binding guidance to industry on how to ensure the safety of raw agricultural products (such as fruits and vegetables) “from farm to table” (FDA 1998), conceptualized as a supply chain (Figure 8). Not surprisingly, the document looked to HACCP for inspiration.

The GAPs adopt the same conditions of control as HACCP (Table 2) and follow the hazard mastery paradigm’s formula for food safety: first, identify potential hazards, and second, control them. FDA focused only on “major areas of concern” for microbial hazards: soil and fertilizer amendments, water, livestock, wildlife, and workers. Each section of the GAPs begins with an identification and characterization, in general terms, of the microbial hazard for

each of these areas, and then details general procedures for control. Growers are directed to “use the general recommendations in this guide to tailor food safety practices appropriate to their particular operations,” and are furthermore “urged to take a proactive role in minimizing food safety hazards potentially associated with fresh produce.” The final section is devoted to traceback, mirroring exactly the seventh and final HACCP principle.

The GAPs also adopts HACCP’s proclivity for spatial and temporal expansion. The introduction to the 1998 document states that “operators should encourage the adoption of safe practices by their partners along the farm-to-table chain.” Progressively better control is also framed as a function of better information and technology: “As new information and technological advances expand the understanding of those factors associated with identifying and reducing microbial food safety hazards, the agencies will take steps... to update the recommendations and information contained in this guide.” Lastly, the GAPs reiterate the importance of checking-up on people and maintaining “accountability at all levels of the agricultural environment” through continuous monitoring and traceback records that can “track produce back through the distribution channels to the producer.”

Table 2. Comparison of key definitions of control between HACCP and GAPs guidance.

Concept	HACCP (FDA 1997)	GAPs (FDA 1998)
<i>Control</i>	“(a) To manage the conditions of an operation to maintain compliance with established criteria.” “(b) The state where correct procedures are being followed and criteria are being met.”	“(a) To manage the conditions of an operation in order to be consistent with established criteria.” “(b) To follow correct procedures and meet established criteria.”
<i>Control measure</i>	“Any action or activity that can be used to prevent, eliminate or reduce a significant hazard.”	“Any action or activity that can be used to prevent, reduce, or eliminate a microbiological hazard.”

Although voluntary, the GAPs set an important precedent for adopting the standard food safety model’s conditions of control on farm fields that carried forward into enforceable rules such as those laid down in the California Leafy Greens Marketing Agreement (CA LGMA) and the more recent and far-reaching federal Produce Safety Rule. These rules have tended toward setting quantitative “established criteria” for control which operators must adhere to. So, for example, LGMA prohibits harvesting crops within a minimum of 30 feet of a flooded area and requires that growers wait at least 60 days before planting crops in an area that suffered a flood (CA LGMA 2016, §12). In the case that an animal—such as a pig, coyote, or even a bird—poops in a field, LGMA rules prohibit harvesting crops within a minimum 5-foot radius of the fecal matter; even signs of animal intrusion, such as footprints, require a 3-foot no-harvest buffer (§14). The rule also sets quantitative criteria for microbial quality of irrigation and wash water (§4), which must be checked with regular laboratory testing, and specifies the precise conditions (e.g. temperature, time) by which organic material must be composted before application to the field (§6). In both cases, operators must “Retain documentation of all test results and/or Certificates of Analysis available for inspection for a period of at least 2 years.”

The Produce Safety Rule sets similar, though distinct, quantitative criteria for the microbial quality of water and soil amendments (21 CFR §112.41-60), but does not set quantitative criteria with respect to animal intrusion, merely requiring that operators “must take all measures

reasonably necessary to identify, and not harvest, covered produce that is reasonably likely to be contaminated” (§112.83 and §112.112). Furthermore, the Produce Safety Rule does allow alternative corrective measures provided that the grower or handler is able to scientifically validate (for those farmers who can afford it) the alternative to FDA’s satisfaction.⁴² In both the LGMA and the Produce Safety Rule, the trend has been toward more granular and quantitative segmentation of the agricultural process, consistent with the conditions of control valorized within the mastery worldview and normalized in the standard food safety model. Applying mastery to farms means coercing fields to operate more like the industrial factories in which HACCP originated, amounting to a reductionist and mechanistic compartmentalization of the agroecosystem and farming practice. Herein, it would seem, lie the limits of mastery.

The Ecological Incongruity of Mastery

Unlike processing plants, produce agriculture at the field level is not easily segmented and compartmentalized into a linear flowchart of neatly isolated stages (as in Figure 6). Farm fields are radically open and non-linear systems, a lively and often unruly world where the unpredictable vagaries of weather alter temperature and moisture daily if not hourly, where animals fly and walk through fields, water flows through and across soils, and workers come and go about their jobs and may or may not be suffering an illness themselves, and so on. Farms are

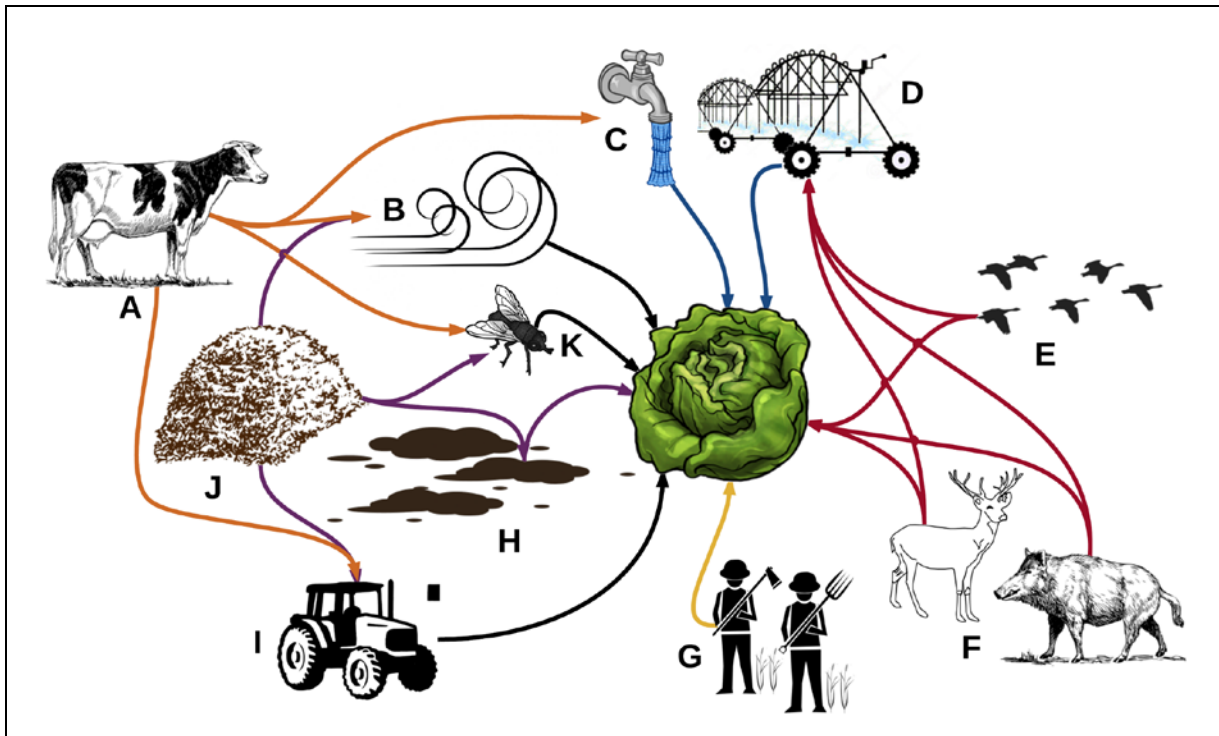


Figure 9. Some examples of the complexity and interrelatedness of potential pathways by which human pathogens can contaminate crops growing in an open field environment (adapted from Harris 1997). In general, the source or reservoir of pathogens such as *E. coli* or *Salmonella* is animal fecal matter, from livestock (A), terrestrial animals (F), birds (E) and humans (G). Pathogens may also contaminate crops through irrigation water (D), wash water (C), or even floods. Pathogens may also persist in soils (H) and soil amendments like compost or manure (J). Insects (K), windborne aerosols (e.g. dust, B), and farm equipment (I) can carry pathogens from livestock pens or manure piles onto crops. In some cases, contaminated seeds can introduce pathogens into the soil, and from there onto the edible portions of the mature crop (Brandl 2006).

full of non-human agents and actants that continuously evade human control. The sheer enormity of biophysical interactions in multiple media—soil, water, air, and plant tissue—makes the goal of identifying and managing a small subset of pathogenic microbial activity seem like tilting at windmills. In an open and living system, imagining what might go wrong is a near-endless exercise in considering remote possibilities, as the potential (however unlikely) routes of contamination are legion (Figure 9). Adhering to the standard food safety model means attempting to impose the same conditions of control upon these agroecosystems, attempting a mechanistic enclosure of these lifeworlds into perfectly calculable engineering diagrams.

Despite this inherent disconnect between the standard food safety model and the lively ecosystems and boundary-defying biophysical cycles that characterize agriculture, food safety experts nonetheless continue to push growers to orient all aspects of farming toward mastery and control. “People think of HACCP as a destination,” one food safety consultant said in an interview. “I look at it as more of a journey, if you will. [Farmers] have done the steps a million times, but not formally, not written it down systematically and taken that science-based approach to identifying the vulnerabilities and addressing them... I think it [the technical character] hinders them from understanding the core function: a system for identifying risk.” What he is describing is the pressure that food safety experts exert on farmers to adopt the conditions of control—mechanistic collection of information, bureaucratic and laboratory based checks, and acceptance of constant vigilance and continuous improvement—as a state of existential being.

Under the totalizing aegis of mastery, which relentlessly seeks out new potential hazards and sites of hazard, the envisioned grid of control now extends to all aspects of the farm, even into the production of yet-further upstream inputs for growing vegetables, fruits and nuts. Take, for example, the case of compost tea, a nutrient-laden and microbiologically active liquid soil amendment made from steeping finished compost in water, often with other additives such as molasses or kelp to promote beneficial microbe growth. While compost tea has a place in the toolkit of Integrated Pest Management (IPM) systems as “a good natural delivery tool for a quick boost of nutrients” (Swain 2013), it also has raised food safety concerns that pathogens might grow along with the beneficial microbes. Following the hazard mastery paradigm, the response has been, once again, to focus attention on the source and history of raw materials, to expand the grid of control over space, time, information, and behavior. As explained in a recent blog post on the subject from the Farm Food Safety Conservation Network:

Considering the safety of compost tea, a consensus seems to be emerging that the safety of the tea is all about the quality of the ingredients being used, as well as how those ingredients are used... So, it is critical to start with compost that has been validated to be free of pathogens... If even one small portion of the batch of compost is unfinished and contaminated with a human pathogen like Salmonella or E.coli, the brewing process will ensure ALL microbes will grow in the brew, including those of the pathogenic variety! (Guth 2016).

The onus to ensure the safety of fresh produce extend well beyond the field itself through the detailed application of the full hazard mastery paradigm to agricultural inputs such as compost and compost tea. The above article continues:

Bottom line, if you want to brew an agricultural tea and you are growing a product eaten fresh, it is a really good idea to use the very best stabilized compost, potable (pathogen free) water, standardized procedures and ingredients, sanitized equipment, and then *take regular samples of the final tea for Listeria, Salmonella, and E. coli* to reduce the risk

that the final product being applied risk to the people consuming your produce. If your ingredients or processes change, update your brewing procedures and retest the final product. As with everything food safety and organic compliance related, keep records on hand to show inspectors you are working to reduce the risk of your tea and to track your processes. (Guth 2016, emphasis added).

Once again, the principles of continual checking (validation), standardized procedure, raw material purity, intensive record-keeping and verification, and perpetual adaptation are plainly evident even at this remote site to which a potential pathway of contamination has been traced.

The unspoken irony in this progression of control “upstream” into the capillary reaches of the agrifood system is that while food safety experts pursue mastery by increasingly atomizing the sources of hazard and their associated risks, they simultaneously blind themselves to the possibility of systemic risks and “food-system borne disease” (McMahon 2013). For practitioners of the hazard mastery strategy, total system risk is simply the sum of all uncontrolled points of potential contamination; there is no ontological space within this worldview to imagine the possibility for emergent or holistic risks. Likewise, such risks are invisible to the contamination-tracing epistemology. “Handling systemic risks requires a holistic approach,” writes Renn, and an epistemology that “goes beyond the usual agent-consequence analysis” (2008, 5).

Yet as McMahon argues, “Food-system generated risks... do not show up on any food-safety test. They cannot be protected from by any HACCP food-safety protocols, are not visible through pathogen tests or microscopes.” While she refers primarily to a broader notion of disease that encompasses food insecurity, malnutrition, poverty, and various forms of social injustice, the point equally implies to pathogens. To put the 2006 spinach outbreak in a more holistic context, for example, it is necessary to acknowledge that *E. coli* O157:H7 first emerged within the heavily controlled setting of densely-packed industrial cattle feedlots (Nestle 2003, 40–48); it is very likely that it was in such an extreme environment that the pathogen acquired the deadly trait to produce shiga toxin. In addition to the ways that industrial design homogenizes animal husbandry and encourages the evolution of more virulent and antibiotic-resistant strains of various pathogens that can infect humans, large-scale centralized industrial packing, processing and distribution systems increase the likelihood of cross-contamination and greatly magnify the potential extent of foodborne illness outbreak (Stuart and Worosz 2012; DeLind and Howard 2008).

The insidious consequence of mastery’s blind spot toward systemic risks generated by the industrialized uniformity of large-scale agriculture and food manufacturing is to draw attention away from the role that the most powerful and influential agribusinesses play in creating the *conditions for* foodborne illness to become a widespread and pressing public danger. As food safety experts and public health officials atomize risks by following the contamination-tracing epistemology, they also individualize the responsibility for food safety work and the blame when something goes wrong. The onus of responsibility thus tends to trickle downward to the most vulnerable and least powerful agrifood actors—the people who work on the ground to grow, harvest, pack and ship produce. I analyze the consequences of this blame avoidance strategy in detail in Chapter 5.

Conclusion

The power to demand goodness in food—as defined by cultural norms of what makes food safe, natural, moral, and appetizing—has introduced new forms of domination and vulnerability into postcolonial food commodity networks. (Freidberg 2004, 5).

In this chapter, I have examined the historical development of this hazard mastery strategy, traced its precepts, and outline the framework through which it seeks an ever-expanding control over agrifood systems. The hazard mastery paradigm operates to reveal new routes by which pathogens can contaminate, or render impure, the networks for food provisioning, focusing the panoptic ‘eye’ of the apparatus further and further upstream in the supply chain. This produces an incremental shift toward the standard food safety model by rendering new forms of control imaginable, even at the field level. The power to which Freidberg refers in the above quote derives from the formation of a hazard mastery paradigm that defines safety strictly according to a reductionist and totalizing vision of control encapsulated in the standard food safety model. The food safety apparatus does not just manifest through reconfigured or retrenched power relations, but also through the reconfiguration of entire worldviews in order to normalize the continual work of imagining and pre-empting new sources of danger in the food supply.

It is difficult to overstate the ontological, epistemological, and normative novelty of the mastery worldview as applied to food safety. While the moral imperative driving the “gospel of germs” in the early 20th century bears much in common with the hazard mastery paradigm of the 21st century, the similarities largely end there. Prior to the rise of HACCP and the standard food safety model, we (consumers, producers, citizens, regulators, in short, society) allowed that the world is periodically dangerous and that food poisoning periodically happens. The strategies to deal with those dangers were largely *ad hoc*, isolated and independent, dealing with acute crises as they appeared. In place of this “patchwork” approach, the food safety apparatus advances an imaginary of system-wide, exhaustive control that promises to counter contamination proactively by stopping it at the source.

The mastery worldview departs most clearly from the germ avoidance era of the last century in its implicit and strong belief in the existence of a “source” that can be bounded and cut off. The ideal of mastery can only be approached through a domination of people and nature, although, “the underlying tension inherent in applying food-safety principles developed for the controlled industrial context of factories to the dynamic ecological matrix of farm fields remains unresolved” (Karp and Baur et al. 2015). In Chapters 5 and 6, I examine in detail the consequences of this unresolved tension between the conditions of control sought through the hazard mastery paradigm and the untidy materiality of produce provisioning networks and the unruly liveliness of farm fields. It is in this situated context that the absurdity—and folly—of performing food safety work to the specifications of the standard food safety model are most readily apparent, and most poignant. Before coming to the consequences of the hazard mastery paradigm, however, I turn to an inspection of the agents of this strategy, the epistemic community of food safety experts and the authority they wield through the apparatus to override local specificity and unruliness in the name of an all-encompassing vision of safety via control. The “god-trick” by which they rule is the subject of the following chapter.

4. THE ARCHITECTS OF MASTERY

The ultimate value of the national food law [Pure Food and Drug Act] depends upon the wisdom of the Bureau of Chemistry, which body must arbitrarily become *food-gods*, determining what is good and what is bad. We may safely assume that present problems will be worked out in the interest of the consumer. (Ayers 1907). (emphasis added)

We can now see how “urgency” is produced and a strategy formed in response to foodborne illness. However, while the standard model of control sets a generic blueprint for action, there are two key components of this model which cannot be specified by a farmer or post-farm operator: hazard analysis and validation of control steps.⁴³ Both steps require outside experts to supply the “scientific and technical evidence” required to show that the ‘right’ (i.e. possible) routes of contamination have been identified and that effective measures have been adopted to prevent, reduce, or eliminate contamination. These experts wield tremendous power to set the food safety agenda and shape the implementation of mastery on the ground, but who are they and how do they speak authoritatively about contamination and control? Through what network channels and institutional arrangements do they generate “robust” food safety knowledge, and why do farmers and other practitioners listen to them at all?

In this chapter, I use observations gathered through interviews, event ethnography, and textual analysis of research statements to explore the work performed by an epistemic community of food safety experts, whom I refer to as “the architects of mastery”. I refer to them as an epistemic community because they are bound together by a common policy purpose (hazard analysis and control process validation), common ways of knowing and causal beliefs rooted in shared scientific disciplines, and lastly a common assumption (really, a normative commitment to mastery) that top-down, centralized decision-making will lead to optimal protection against foodborne pathogens (Haas 1992). To illustrate the ways in which this group of would-be “food-gods” actively works toward mastery, I examine the case of one novel institution for food safety knowledge production, the Center for Produce Safety (CPS). Based in Davis, California, a national bastion of mainstream agricultural science research, this center coordinates a key nexus of powerful ‘captains of industry’, government regulators, and scientists who together work to build an epistemic authority that extends a particular vision of produce safety that helps glue together the larger food safety apparatus.

The Center’s authority comprises the power to set and normalize representational relationships between genomic analyses, laboratory experiments, controlled field trials, and agricultural landscapes. The architects of mastery frame these activities as ‘normal’ science, in the sense that CPS funds research to fill in well-defined information gaps related to the sources of reservoirs of pathogens, how they move through agricultural environments and contaminate crops, the best ways to detect and monitor pathogens, how to distinguish benign from dangerous strains, how pathogens survive on harvested produce, how to best sanitize wash water and soil amendments to kill pathogens, how to prevent cross-contamination from equipment to produce, and so forth. Nonetheless, as I will show, the research funded by CPS subtly adjusts the natural, social and technological orders for provisioning fresh produce in the United States. I argue that the epistemic community convened through the Center functions to pull off a “god-trick” (Haraway 1988) that naturalizes (and thereby depoliticizes) foodborne pathogen risks and normalizes (and thereby standardizes) certain contexts and modes of production.⁴⁴ The danger, I

conclude, is that epistemic authority lets the Center determine not just *what* is good and bad, but also *who* is good and bad. Specifically, the architects of mastery work to co-produce a homogenizing contemporary order that excludes farms, farmers, and food provisioning arrangements that do not fit the envisioned conditions of industrial and mechanistic control.

Building the Center

The Center for Produce Safety formed following the deadly 2006 outbreak of *E. coli* O157:H7 in spinach. That outbreak recalled interviewee A___ “really shocked the leafy greens industry, and really brought it to its knees... The FDA came out publicly and said, ‘Don’t eat any spinach of any kind.’ The leafy greens industry, not just spinach but lettuce and romaine and all that stuff, just collapsed in a day.”⁴⁵ “So,” he continued, “the leafy green industry in the Central Coast of California got together and decided we can’t have this going on, we need to do something.” State lawmakers and the FDA were threatening mandatory government intervention. “We were in the storm... of the spinach crisis,” another interviewee, B___, told me. “I along with another individual were responsible for rallying other buyers together to send a message to our industry partners, grower-shippers, that we needed a couple of things. One, was specific, measurable, and verifiable food safety standards. And the second was a *common* standard.”

The standard that California’s growers and shippers “needed” took form as the California Leafy Greens Marketing Agreement (LGMA), a certifiable food safety protocol for leafy greens (see Chapter 1). Though participation in the agreement is voluntary, the California Department of Food and Agriculture enforces compliance once growers sign on, and within a matter of months, 99% by volume of all California leafy greens were being grown to LGMA standards. The question of what behavior, precisely, the LGMA standards would require proved elusive, however. A technical committee composed of “luminaries of various kinds”, as A___ put it, convened to determine a set of best practices. The group asked itself, “What should best practices be, since we’re apparently not following them?” But, speaking as one of the “luminaries” present for the deliberations, A___ confessed that “we had no stinking idea” how to answer some of the practical questions. How far should a field be from a livestock operation? What are safe thresholds for pathogens in irrigation water, and how should they be measured? Can any animal transmit an infectious dose of pathogens onto a field? Initial standards were little more than guesses, and there was a sense that the LGMA technical committee was just, according to A___, “going on faith-based science.”

Faced with such a massive shortfall of knowledge and the overwhelming sense that food safety experts were simply groping in the dark on how to set technical parameters for safe production, the movers and shakers “decided that the other arm that was needed was some kind of mechanism for us to generate the information, the data on which to base these kinds of decisions...” (A___). So industry leaders from the Produce Marketing Association and the Western Growers Association coordinated with regulators at the California Department of Food and Agriculture (CFDA) and scientists at the University of California, Davis to establish the Center for Produce Safety in 2007.⁴⁶ While the Center is housed at Davis, near the Central Valley hinterlands, and was a response to a Californian agricultural crisis, its purview has grown to encompass the entire nation. The Produce Marketing Association and Taylor Farms, a large Salinas-based produce company that competes with Dole and Fresh Express,⁴⁷ both contributed \$2 million in seed funding for the center, along with \$500,000 from CDFA. Since the first funding cycle in 2008, CPS has allocated \$20.4 million to 71 research scientists from across the

nation for 121 research proposals that support its mission “to continually enhance food safety” for produce supply chains. In the remainder of this section, I will situate the Center within the broader food safety governance network by examining where it gets the money to fund research, who sets the Center’s research priorities and selects the projects it will fund, who conducts the research and what kind of research it is, and lastly who CPS targets as the audience for its scientific products.

The Funding

Today, the money CPS uses to fund produce safety research comes from both industry and government. Each year, the Center seeks funding through the USDA Specialty Crop Block Grant Program, which disperses funds to state departments of agriculture in order to “enhance the competitiveness of specialty crops” in the US. Generally, these funds are distributed to CPS projects by CDFA, the Center’s long-standing partner and by far the largest state recipient of this USDA funding, but other state agriculture departments including those of Florida, Washington, and Oregon have also contributed. CPS awards between \$2 and \$3 million for projects each year (Table 3), most of which is provided by USDA specialty crop block grants: in 2014, CDFA funded 8 of the 14 CPS projects for a total of \$2,083,914 (73% of total CPS awards for 2014); in 2015, CDFA funded 8 of the 11 CPS projects for a total of \$1,517,816 (84%); and in 2016, CDFA and Florida’s agricultural department funded 7 of the 10 CPS projects for a total of \$1,589,728 (79%).

For reference, USDA funds fifty to sixty food safety projects nationwide per year through specialty crop block grants (Table 4). Assuming that USDA allocates between \$4 and \$10 million per year to food safety projects, the Center accounts for approximately twenty to forty percent of USDA’s specialty crop block grant food safety funding nationwide. CPS, in other words, is now a significant national clearinghouse for food safety science and expertise.

Table 3. CPS Research Awards, 2008-2016

Year	Total Project Funding	Number of Projects	Average Project Award
2016	\$ 2,205,719	10	\$ 220,571
2015	\$ 1,810,082	11	\$ 164,552
2014	\$ 2,855,265	14	\$ 203,947
2013	\$ 2,987,250	17	\$ 175,720
2012	\$ 1,804,261	10	\$ 180,426
2011	\$ 2,213,553	16	\$ 138,347
2010	\$ 2,838,946	18	\$ 157,719
2009	\$ 3,088,147	21	\$ 147,054
2008	\$ 559,411	4	\$ 139,852

Source: Center for Produce Safety, http://www.centerforproducesafety.org/grant_opportunities_awards.php

Table 4. USDA Specialty Crop Block Grant Funds for Food Safety, 2008-2016

Year	Total USDA Specialty Crop Block Grant Funds	Total Projects Funded	Estimated Food Safety Funding*		Food Safety Projects	
			(Lower)	(Upper)	Count	Percentage
2016	\$ 62,632,900	693	Not available		Not available	
2015	\$ 63,251,275	755	\$ 4,200,000	\$ 8,400,000	50	(7%)
2014	\$ 66,398,531	839	\$ 4,900,000	\$ 10,416,000	62	(7%)
2013	\$ 51,555,867	695	\$ 4,000,000	\$ 9,072,000	54	(8%)
2012	\$ 54,332,963	752	\$ 4,600,000	\$ 10,584,000	63	(8%)
2011	\$ 54,332,963	765	\$ 4,600,000	\$ 10,920,000	65	(8%)
2010	\$ 60,943,000	859	\$ 3,000,000	\$ 7,056,000	42	(5%)
2009	\$ 48,672,000	790	\$ 3,800,000	\$ 10,416,000	62	(8%)
2008	\$ 9,500,060	252	\$ 1,000,000	\$ 4,536,000	27	(11%)

*USDA breaks down the total number of projects funded each year by type, including food safety, but does not provide the level of funding by project type. The lower estimate assumes that food safety projects are funded at the same level as the average of all program projects; the upper estimate assumes that food safety projects are funded at the average CPS level of \$168,000 per project. Source: USDA Agricultural Marketing Service, Specialty Crop Block Grant Program, <https://www.ams.usda.gov/services/grants/scbgp>.

The Center supplements these block grant funds with industry contributions. In 2015, it launched a 5-year campaign to raise \$20 million, reaching the halfway point in spring 2016 with substantial contributions from 62 donors spanning the supply chain, including from trade associations such as the Western Growers Association (\$1 million) and the Washington State Tree Fruit Association (\$750,000), major wholesalers such as Dole and Fresh Express (\$500,000 - \$999,000), the foodservice giant Sysco (\$250,000 - \$499,999), retailers such as Target (\$100,000 - \$249,999) and Wegmans (\$150,000, through the Wegman Family Charitable Foundation), and numerous growers, packers and shippers at various contribution levels. Many of these same companies and associations also have representatives in the Center’s leadership and guidance groups, giving these industry groups additional power to shape the CPS mission and priorities.

The Advisors

CPS is guided by both a board of directors and a technical committee. The members of these committees determine the annual research priorities for the Center, and the technical committee “provides the necessary scrutiny and tight controls needed” to decide which projects and applicants should receive funding. Following the motto that “industry-wide problems require industry-wide brainpower”, CPS bills itself as a “a collaborative partnership that leverages the combined expertise of industry, government and the scientific and academic communities.” The composition of the advisory board and technical committee, however, are heavily weighted toward representatives of agribusiness.⁴⁸

Only 5 of the 29 members of the board of directors hail from a non-industry organization, one academic microbiologist from the University of Florida and four representatives from government agencies, including CDC, FDA, the California Department of Public Health, and the Florida Department of Agriculture and Consumer Affairs (Figure 10). The other 20 members work for grower-shippers (7), retail and foodservice companies (5), marketing and distribution companies (4), and trade associations (3). There is one independent consultant. The Technical

Committee comprises 35 members, with a markedly different makeup (Figure 10); noticeably, the technical committee is dominated by experts working for chemical, equipment, and seed suppliers such as BASF, Dupont, Birko, and Monsanto (collectively grouped as chemical companies in Figure 10). Trade associations and grower-shippers round out the top half of the technical committee’s membership, with small groups of government officials, academic researchers, independent consultants, and marketing representatives filling in the remainder of seats. Only one non-profit NGO, The Nature Conservancy, is represented on the committee. Note that five individuals—two trade association representatives, one grower-shipper, one consultant, and one academic—are members of both groups.

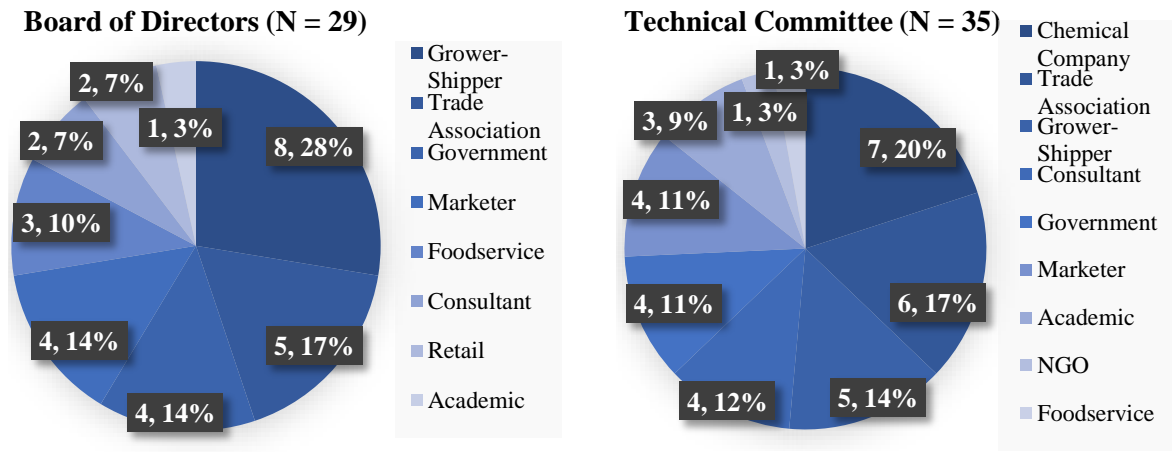


Figure 10. CPS Advisory Board and Technical Committee Members, 2016.

Through its board of directors and technical committee alone, the Center has significant connections to major lobbying organizations—including the Produce Marketing Association, Western Growers Association, and Florida Fruit and Vegetable Association—with both regional and national presence. In addition, CPS has direct connections to government regulatory and research agencies at the state and federal levels. Two CPS members serve on committees for the California LGMA, and two grower-shippers and one marketer have representatives at both the Center and LGMA. At the federal level, the Director of FDA’s Office of Partnerships serves on the CPS board of directors, and a senior scientist at FDA’s Center for Food Safety and Applied Nutrition, the sub-unit responsible for rule-making and implementation under the Food Safety Modernization Act, serves on the Center’s technical committee. As will be seen in the following section, CPS leverages these organizational connections to lengthen its reach over both industry action and government standards.

The Priorities

Each year, the Center’s advisory board and technical committee seek “input and insight from the stakeholders” to “identify high-priority research needs.” Once the broad needs are established, the “Technical Committee provides the necessary scrutiny and tight controls needed to ensure funded research projects are *practical, measurable and translatable*” (CPS website, 2016, emphasis added). In his announcement of the 2017 research objectives, the chair of the CPS technical committee (who works for a major grower-shipper) wrote, “As in previous years we are soliciting proposals to address near-term research needs including *Listeria* prevalence and

persistence, FSMA Produce Rule-related metrics, co-management practices, and commodity-specific needs as well as longer-term fundamental research and novel solutions.”

This list is emblematic of the Center’s long-standing approach of funding both “longer-term fundamental” (i.e. “basic”) research and “applied, practical, and knowledge gap–filling projects.” In general, as will be discussed in greater depth later, CPS “fundamental” research seeks to characterize pathogens and routes of contamination in order to provide evidence in support hazard analysis, risk assessment, and guide development of future control technologies. For example, a project from the 2014 funding cycle proposed to “provide fundamental knowledge on the genetic basis of plant defenses against human pathogens to guide the development of genetically resistant varieties of fresh produce.” CPS “applied” research may propose ‘rapid’ risk assessment, usually as a yes/no determination regarding the ‘safety’ of specific practices; for example, one project from the 2015 funding cycle proposed to characterize “Microbial food safety risks of reusing tail water for leafy green production”. More frequently, “applied” projects are those that evaluate a particular control technology or process, such as an early project from the 2009 funding cycle that sought to optimize the design of lettuce harvesting knives to minimize pathogen cross-contamination during the harvest.

CPS funds projects that align with the hazard mastery worldview. Following the GAPs guidelines (see Chapter 3), both the LGMA standards and the Produce Safety Rule are designed to control five major routes by which pathogens might contaminate produce: soil amendments, agricultural water (i.e. for irrigation or washing), wild and domestic animals, workers, and farm equipment. CPS has organized its annual request for proposals to align with this framework of control, which as I have demonstrated draws heavily on the HACCP tradition. The approach to ‘solving’ microbial contamination is through better technology—new chemical, physical, or biological interventions into the underlying mechanics of the production system and even the food itself. Success must be *measured* in terms of precision, efficiency, and effectiveness of control. While the technical committee chair included, among the list of CPS research needs, “co-management practices”—referring to efforts to minimize food safety risks concurrently with environmental conservation—sustainability in practice is of secondary interest, at best, to the Center’s epistemic community (see Chapter 6).⁴⁹ There is only one environmental representative in the entirety of the Center’s advisors, and as I discuss in the following section, CPS does not fund ecologists, conservation biologists, or sustainable agriculture researchers and practitioners. CPS prioritizes quick-turnaround, applied projects that lead to technical “solutions” to the universal problem of contamination.

Officially, CPS “sets its highest priorities in supporting research towards ready-to-use, data-based solutions or information which catalyze and support science-based actions and decisions to prevent or minimize produce safety vulnerabilities across the supply and marketing chain.” However, in the Center’s own words, “CPS does more than fund research.”

It’s critical that we disseminate the results of that research and ensure that new knowledge is put to use across the supply chain... CPS provides knowledge of industry processes, applications, varieties and conditions to academia and the research community to better target and direct research that will have immediate application in the produce industry. Our educational efforts extend to regulatory agencies as we partner with the U.S. Food and Drug Administration, the U.S. Department of Agriculture, the Centers for Disease Control and others to shape food safety guidelines. (CPS 2016).

In setting its research agenda, the Center's leadership and technical advisors actively seek to fill "knowledge gaps" in industry practice as well as in regulation. The priority is not simply to better understand contamination or even to better control pathogens; it is rather to intervene in and guide the overall governance network through building epistemic authority to set the conditions and trajectory of food safety knowledge production.

The Scientists

Approximately 75% of the seventy-one scientists who lead CPS-funded research projects are based at public, land-grant universities.⁵⁰ The largest contingent, not surprisingly, is based at the University of California, Davis – the same location as the Center. However, researchers from land-grant universities and colleges in twenty other states have also received CPS funding, providing another indication of the Center's national scope; CPS has even funded researchers from Canada, Spain, and Israel. In addition to university researchers, eleven scientists based at government science agencies such as USDA agricultural research stations or the cooperative extension service have been funded by CPS. Notably, only three private-sector scientists have received money from the Center. As it builds its epistemic authority, CPS has a strong incentive to seek the highest level of credibility and perceived objectivity for its researchers. E___, the first chair of the CPS technical committee, emphasized that one of the Center's main priorities is to avoid any appearance of bias in the research generated through its funding:

[For] the research that we publish, the research that we fund, the stipulation is that, [whether] good, bad or indifferent, if you don't like the result, it's too bad, it's still going to be published. If it says something is an inherently dangerous practice and you do that practice, it's still going to be published because we don't want to get into a situation where there's any kind of censorship of data.

This stipulation likely explains the Center's apparent preference for funding researchers based at public land-grant universities, since these institutions convey an aura of respectability and trustworthiness both to the general public and to farmers.

By discipline, most of the scientists work in the fields of microbiology (39%), food science (35%), engineering (9%), or animal science (8%). Only seven scientists, just 9% of all those funded by CPS, belong to a different discipline. Note that I coded the scientific discipline by referring to the online profile of the lead or principle investigator for each project at their primary institution (e.g. faculty bio). For the sake of simplicity, I consolidated sub-fields into the major disciplines of microbiology, food science (including food technology), engineering (e.g. environmental engineering, biosystems engineering, agricultural engineering), plant science (e.g. horticulture, plant pathology), and animal science (including veterinary medicine). Taken all together, the research scientists funded by CPS are institutionally and disciplinarily homogeneous. They are situated primarily in the strongly controlled settings of microbiology laboratories and agricultural experiment stations, and together form an epistemic culture (Knorr-Cetina 1999) that favors technological 'fixes' to food safety problems.

Plant science, for example, facilitated the "discovery" that human pathogens could colonize crop plants through persistence in protected surface niches and biofilms and through internalization (e.g. through the roots or stomata) (Critzler and Doyle 2010; Brandl and Sundin 2013). More recently, this field has contributed the idea of genetically altering crop plants—through conventional breeding or direct genetic engineering—to reduce the survivability and growth of pathogens on or within the plant tissues (Manulis-Sasson and Sela (Saldinger) 2015), a

research area that, as mentioned above, CPS also funds. This focus on reductionist epistemology and high-technology interventions is also reflected in the large number of chemical, seed and equipment company representatives on the board of advisors and the technical committee, and that predisposition shapes the CPS research portfolio and message to align with a particular worldview and knowledge politics, a point I will return to later in discussing the “god-trick”.

The Research: Just filling in the ‘GAPs’

Now that we have seen where the Center gets its money, who decides sets its agenda, how they prioritize research, and what kinds of researchers they fund, it is time to turn to the funded research itself. What “knowledge gaps” do awarded research projects address? How do they generate knowledge to fill those gaps? What are the goals and targets of the research? And in what context—crop type, location, form of inquiry—does CPS-funded research take place?

Methodology

To better answer these questions, I collected the project titles, years, abstracts, funding amounts, and principal investigators for each of the 121 projects that CPS selected for funding between 2008 and 2016, which total over \$20 million in funded research. I coded each project based on the following themes: crop type, geographic location, pathogen of interest, target of control/source of contamination, type of study, and research goal (see Appendix A for detailed results). Projects funded in the 2013 RFP or before had full digital reports available on the CPS website, and where necessary I referred to these reports to supplement the proposals for which important information was missing in the title or abstract (note that the format, content, and level of detail varied dramatically among project abstracts). Some projects did not specify a location, crop, or pathogen of interest – these I coded as “unspecified”. Similarly, not all themes contained mutually exclusive codes and some projects matched multiple codes for any given theme (e.g. the project examined multiple crops or pathogens of interest).

I categorized projects by *crop type*: leafy greens, other vegetables and melons (cantaloupe in particular), berries, tree fruit, and nuts. Many projects—especially those based primarily in laboratories—did not specify a *geographic location*, but where possible I identified the state(s) or geographic region(s) (e.g. Eastern US) in which the study took place. The *pathogens of interest* I coded with generic terms for the major bacterial pathogens—*E. coli*, *Salmonella*, *Listeria*—and for ‘other bacteria’, ‘viruses’, and ‘parasites’ as whole groups; note that many projects differentiated between different types of bacteria, for example between generic *E. coli* and STEC or O157:H7, but for simplicity I lumped them together. The *target of control or source of contamination* referred to the specific biophysical aspect of produce agriculture the project sought to examine: these included the produce itself, soil, soil amendments, agricultural water, wash water, facilities and equipment, wildlife, livestock and genomes (e.g. in characterizing and differentiating among pathogens).

Type of study referred to the setting and nature of the research. Projects which involved: primarily laboratory analysis (e.g. genomic mapping) I coded as ‘laboratory analysis’; an experimental simulation of “real” conditions in the field or a facility under controlled laboratory conditions I coded as ‘laboratory simulations’; controlled trials in a “real-world” setting such as a research farm or plots within an active farm or facility I categorized as ‘field trials’; and collecting samples from the environment (e.g. water, soil) or otherwise measuring environmental conditions I categorized as ‘environmental observation’. Lastly, the theme of *research goal* represents the purpose of the research within the context of the mastery paradigm:

‘characterization’ denotes research aimed at describing routes of contamination, epidemiology and biology of pathogens (e.g. survival rates, virulence factors), and prevalence of pathogens. ‘Detection’ denotes projects that sought to improve efforts to test for and monitor pathogens in the environment, on produce, in water, in facilities, or on equipment; ‘prediction’ denotes projects seeking to model potential contamination based on risk factors so as to predict where pathogens might be and at what levels. Finally, ‘control’ denotes projects seeking to evaluate procedures for controlling contamination, such as sanitizing wash water or employing falcons to deter pest birds from entering fields.

Characterization research corresponds to hazard analysis—measuring background prevalence, identifying and tracing pathways of contamination, describing the biological and ecological characteristics of pathogens and their relationship to their environment (soil, water, wildlife, humans, produce, facilities and equipment, and so forth). These activities inform estimations and calculations of the risk associated with pathogens, vectors, and routes of contamination, and the evidence produced by these research projects tells the produce industry (and potentially regulators as well) where to focus their monitoring and control efforts. Detection and monitoring research along with control research provide the technical and scientific evidence by which operators can validate the measures they take to prevent, minimize, or mitigate contamination. These studies generally involve evaluation of sanitizing agents or testing procedures, but in some cases evaluate farm or facility practices such as wearing gloves, pasteurizing nuts, using falcons to deter pest birds, or maintaining buffer zones between produce fields and livestock operations or riparian zones.

Findings

At the surface level, CPS projects examine production practices such as growing, irrigating, harvesting, washing, and storing produce. But as much as the processes for shepherding lettuce, tomatoes, cantaloupes, pistachios and other produce through the supply chain might appear as the subjects of research, a clear group of antagonists emerges within the project descriptions. Pathogens, usually *E. coli* or *Salmonella* strains, are the primary culprits, but other actants in the production environment—cattle, manure, soil, compost, irrigation water, flood water, sheep, white-tailed deer, wildlife, flies, climate, tools, workers, amphibians, riparian zones, dust, even the surface of the plants themselves—aid and abet the crime of contamination (Figure 11). These antagonists are the focus of a suite of monitoring and control practices which the research projects aim to develop, evaluate, and optimize. Researchers describe their projects as monitoring, screening, detecting, testing, preventing, sanitizing, treating, validating, and eliminating. These are activities of repair and mastery (Henke 2008), and they embody the fixation with control that is characteristic of the food safety apparatus.

Every study funded by CPS except one seeks to better characterize hazards and assess risks (59, 49%), detect pathogens and monitor contamination (25, 21%), or control contamination by killing pathogens or preventing their spread (36, 30%). In other words, the direct goal of these projects is to generate the “scientific and technical evidence” required for hazard analysis and validation of control measures. The Center has spent over \$9.5 million on hazard analysis, about \$162,000 per project, and over \$10.5 million on validating control measures, about \$175,000 per project. The outside expertise that farmers must rely upon to specify the parameters of the standard food safety model is thus very expensive, a point I return to at the end of Chapter 5.

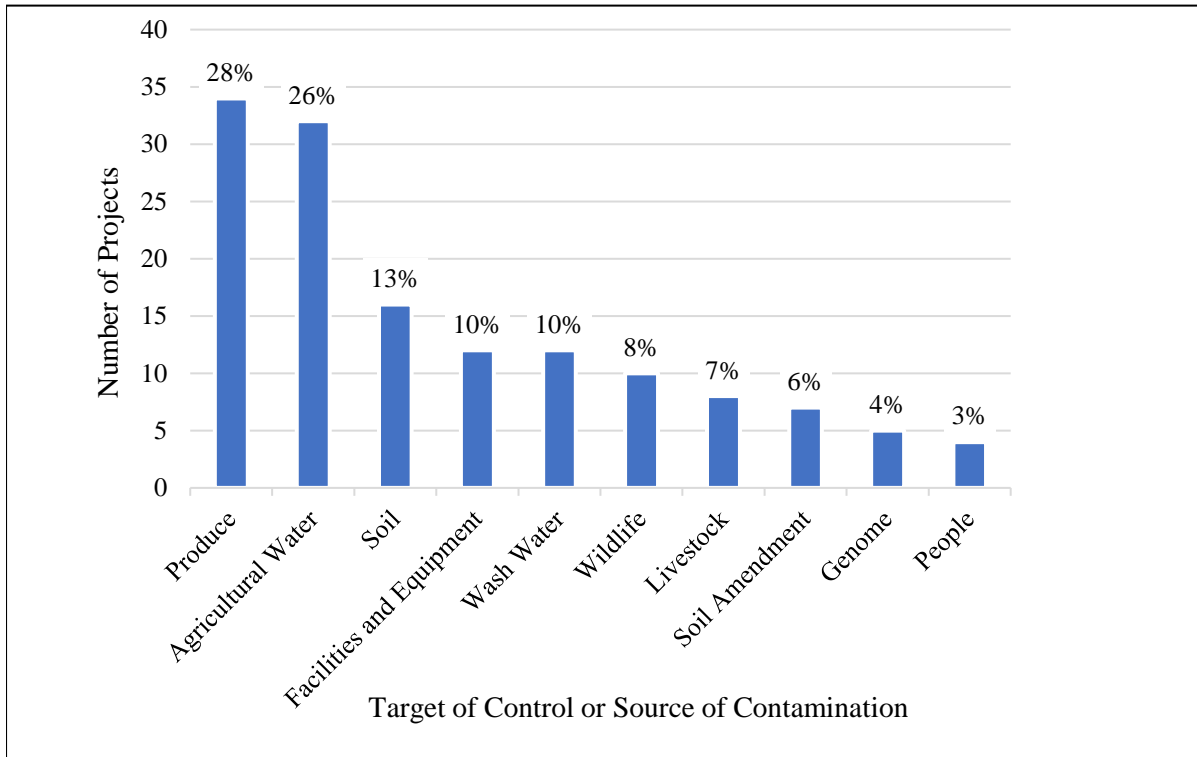


Figure 11. Number of projects by target of control of source of contamination examined. Percent labels indicate the proportion of all projects (N = 121) that examined each target; note that percent values do not add to one hundred because some projects had multiple targets.

While projects did not always fit neatly into my categories of laboratory analysis, controlled simulation, field trial, and environmental observation (and some projects combined several of these categories), it is nonetheless useful to consider the relative importance and cost that CPS seems to attribute to these different types of research. Few projects involved basic laboratory analysis (18, 15%), and these typically examined genomes (e.g. to better differentiate virulent from avirulent strains of bacteria) or analyzed pathogen-chemical reactions (e.g. to determine at what concentration a given water sanitizing chemical would kill *Salmonella*); however, these projects cost \$198,000 on average. Laboratory simulations, on the other hand, cost an average of \$142,000 each, and were the most commonly funded type of project (47, 39%). The Center also funded numerous environmental observation studies (39, 32%)—for example, collecting water samples from irrigation canals, sampling soils, taking swabs from packing houses, or surveying wildlife—which focused mostly on characterizing hazards, with a handful of projects also seeking to test pathogen detection technologies; these studies cost about \$171,000 each. Interestingly, field trials were relatively expensive, on average \$185,000, and less frequently funded (28, 23%); this may be related to the special “balancing act” of field trials discussed below.

To consider the extent to which the knowledge produced by CPS pulls the “god-trick”, I examined the frequency with which researchers sought to characterize hazards and risks *in situ*, as opposed to in a “placeless” laboratory or experimental farm. Environmental observations were almost always specific to a region (e.g. irrigation water in California and Arizona) or crop (e.g. mangoes), though they frequently were not specific for both location *and* crop. However, many

projects, especially laboratory simulations, did not specify the location of the study (63, 52%), the crop of interest (45, 37%), or even in some cases the pathogens under investigation (25, 21%). In most cases, the researchers implicitly assumed that the findings from a laboratory analysis, a simulation, a model or a controlled field trial would provide generalizable evidence about the state of the world beyond their situated experiments. For example, a project funded in the 2010 cycle sought to “evaluate microbiological testing methods that are currently recommended by the [EPA] and the United States Composting Council (USCC) for accuracy in detecting pathogens across a wide variety of ‘point of sale’ composts. The results from this study *will determine the most practical and sensitive microbiological testing methods to ensure the safety of compost for use in the produce industry*” (emphasis added). Note that the study promises to “determine” the optimal methods in a way that will apply to, implicitly, *all* compost and *all* produce growers.

By way of contrast, some projects conversely and intentionally situated their practical impact. Another project also funded in 2010 to investigate soil amendments—in this case, crop residues tilled back into the soil—stated: “Because the research will be conducted in the Salinas Valley, our results should reflect real world dynamics of the production environment in coastal California.” A 2011 project assessing the survival of pathogens on cilantro plants in “field” conditions in California—aimed at assessing the riskiness of harvesting from the same plants multiple times, allowing for regrowth—made a more direct comparison: “While the interactions between *Salmonella* and cilantro in laboratory studies have clearly shown that pathogen growth is likely at non-refrigerated temperatures... our understanding of risk potential in more ‘real-world’ production conditions is largely absent.”

These contrasting project descriptions reveal an interesting tension in the CPS research portfolio between different approaches to balancing “place, control, and consent” (Henke 2008, 114). Henke argues that farmers walk an ever-shifting line between adaptation to the environment as ‘given’ and intervention to transform that environment into a ‘made’ place more congenial to their vision of farming. On one hand, laboratory research “is intended to cut through the messiness and contingencies of place” by constructing an aura of placelessness. This will enhance the resulting knowledge’s perceived scientific rigor, especially among scientists and policy-makers. On the other hand, field trials embrace a measure of that messy contingency in order to better connect with, and thus influence, growers in a particular place (ibid). Growers are more likely to accept research as legitimate if they see it as relevant to their conditions.

CPS thus has a strong interest in appealing to growers and convincing them that the research funded by the Center is grounded in the “realities” of growing, harvesting, and distributing produce. For example, in announcing the 2017 call for proposals, the technical committee chair wrote, “The outreach and interaction through discussions and on-farm visits with researchers who truly want to understand the realities of our processes and products will result in even better proposal alignment with our industry’s needs.” The trouble, of course, is that the Center is interested in controlling just one variable—food safety risk—whereas “growers want to control anything that limits production” (Henke 2008, 115). Furthermore, the Center’s actual purpose is to change behavior by regulating how growers and field laborers work in the fields, a topic I discuss in depth in Chapter 5. In each of these ways, the architects of mastery must convince growers to consent to the epistemic authority of food safety experts. The subject of whether or not the evidence produced by CPS-funded research is *applicable* or “translatable” to particular farms and farmers is an underlying and persistent tension in CPS’s work. In the

following section, I will examine this friction in depth through close analysis of one specific research project.

Research (and boundary-work) in action

The research funded by CPS must fit a carefully bounded mold which is closely monitored and shaped by its executive board and technical committee. However, the meticulous boundary work to separate desired research on technical fixes that can “repair” the status quo from unwelcome “revolutionary” questions—which might expose vulnerabilities in the underlying structure of agrifood provisioning—faces a critical challenge in the form of CPS’s commitment to provide transparent, “ready-to-use” solutions.⁵¹ The findings have to speak to different types of audiences and each has a different perception of what kind of finding is actionable. The board members are well aware of the multiple audience perspectives, as C___ told me:

If I was a regulator, to me what would be actionable would be, how do I evaluate a process or a product to judge whether the process or the product is actually safe for human consumption? So I’m looking at it through a slightly different lens than a producer would. A producer is looking for, what is the tool that I can use, what is the step I can take, what is the practice I can implement to reduce the likelihood for contamination or eliminate it outright?

The Center’s annual symposium, at which funded researchers showcase and share (for those who can afford the entrance fee⁵²) their findings, provides a venue in which to align these different perspectives. This event is a key point of translation between scientists and the broader governance network of growers, packer-shippers, wholesalers, distributors, retailers and regulators. It serves as a stage for “acting out” the research, not only to “disseminate” but also to legitimate the evidence produced by researchers and to enroll new actors into the epistemic culture built by the architects of mastery.

The format of the symposium gives each expert 12 minutes to present. The presentations are bookended by commentary from a mixed panel of interlocutors (both practitioners and scientists), which also fields questions from the audience. During the two-day 2014 Symposium, held in June at a conference center in southern California, I witnessed several occasions in which the value and legitimacy of research findings were judged against how well those findings could represent what were taken to be real working and operating conditions on the ground.

The very first panel of the Symposium—covering contamination potential and treatment options for irrigation water—included Dr. Samir Assar, the Director of the Division of Produce Safety in the FDA’s Center for Food Safety and Applied Nutrition, who has, according to his online FDA profile, “led the development of FDA’s policy, regulation, and guidance on produce safety.” At one point the moderator asked Assar for his opinion on the applicability of the findings to FDA’s efforts to establish national science-based standards for safely growing fresh produce. He chose to speak of representation:

It’s important that the risk assessment, that the characterization [of a farm], is indeed *reflective of or representative of the conditions and practices associated with the operation or a group of operations*. And that’s kind of the key approach to the FSMA produce safety rule... So tools that are available—quantitative risk assessment tools—can certainly help you get there, and again the more accurate the information, the more information, the more robust that you can make these tools and make them reflective of

the operations, then the better the picture will be in terms of characterizing your farm. (emphasis added).

Assar's comments this first day of the symposium set the stage for a set of questions implicit for the remainder of the presentations. Does what a researcher simulates in a laboratory represent what a practitioner does in a commercial setting? Does what a researcher finds in one place represent what might be found in another place? Does a sample represent the whole? Can the production environment be broken down into discrete parts for reassembly in the lab?

At stake in each point of representation is not only the identification of an antagonist—is it the water itself, or the method of application?—but the identification of a point of responsibility—is it a matter of monitoring pathogens in the water source, or at the point of application? The sorts of representations that “stick” when translating a researching finding into a “solution” also defines the points of responsibility, influencing the political question of who shall be held accountable (who to blame) if something goes wrong. To demonstrate the process by which the CPS epistemic community envisions natural and technological order through research that simultaneously co-produces visions for a ‘better’ social order for food safety governance, I turn next to a micro-analysis of one particular research project funded at the symposium.

Micro-case: The role of wildlife in moving pathogens around the landscape

The micro-politics of representation that play out during the symposium can be subtle. In 2014, the symposium concluded with a final panel covering “Hot Topics in Food Safety,” one of which addressed how wildlife move fecal bacteria across agricultural landscapes. The presenter on the topic has been funded by CPS across several project cycles to develop a GIS-based tool that can predict routes by which bacterial pathogens can enter produce fields from surrounding landscapes such as riparian zones⁵³ and woodlands, where wildlife are prevalent. By comparing fine-grained maps of bacterial genetic dispersal across the landscape with a suite of spatial models of different animal movement patterns (e.g. for birds, rodents, and large mammals like deer), the researchers proposed to winnow out the poor predictors and leave only the best maps of pathogen risk. The project proposal promised that, “Ultimately, a web-based tool can be developed to apply the best model to new lands and help the produce industry evaluate crop planting decisions, pre-harvest surveillance practices and harvest practices to prevent product contamination.”⁵⁴

At the start of his presentation, the researcher navigated the “external validity”, as he put it, of this study very carefully. In a long caveat, he explained,

What I'm going to mention early on here is we did this work in upstate New York. The geography represents a very different area than some other produce growing areas around the US. So we talked yesterday about how reproducible is science, and what I want to emphasize is what I see as internal and external validity. Internal validity would mean in this case, through the data that we create, can we reproduce it in the same environments in which we created it. External validity would be, can we extrapolate from those data that we created in New York to, for example, the Salinas Valley [California, the “salad bowl of America”]. Obviously these are very different landscapes, so it's very, very unlikely that we have external validity, *but* the systems we develop can be applied to these other landscapes.

The last line is crucial. The presenter here asserts that the important knowledge to produce is not a knowledge of material *outcomes*—which are specific, tied to context and place, limited in capacity to represent and thus not applicable universally—but a knowledge of *processes*, which through their abstraction can represent any place and thus apply anywhere and everywhere. This researcher advances the same argument in the abstract for his follow-up project, also funded by CPS, which unambiguously states,

This GIS tool can be applied to any location because it utilizes a farm’s unique combination of landscape characteristics (e.g., proximity to domestic animal operations), soil properties (e.g., soil moisture), and climate (e.g., precipitation) in its prediction process.⁵⁵

This distinction operates as a border checkpoint to differentiate between a parochial knowledge of limited application and an abstract knowledge of near-universal application. The constituents of CPS, especially its regulatory members, desire the universal knowledge promised by this GIS-based model because *this* sort of knowledge can robustly claim to represent all production environments and in so doing legitimate standards for production. Recall that holding all producers accountable to the same standards is the paradigmatic and dominant goal expressed in food safety discourse.

But the border is not impermeable. Slippage between site-specific outcomes and abstract processes is constant and necessary. So, for example, when discussing the findings from upstate New York, the presenter stated, “If you look at all models, 27 out of the 28 models that showed a good fit all have riparian zones as an important factor in dispersal, they all included riparian zones in the models. So that means there’s a lot of very good evidence that in *these* landscapes riparian zones are important for transmission.” I have emphasized the word “these” in the second statement because this little word, so easily overlooked, is all that stands between limiting the finding “riparian zones increase pathogen risk” to a specific group of fields in upstate New York and applying it in a standard presumed to be representative of the entire country.

And, indeed, the slippage between particular and universal knowledge happens just a few minutes later, as the limiting factor of “in these landscapes” begins to fade from view, dropping in and out of the presenter’s concluding summary of “key findings”:

We see that more dispersal was detected in the riparian corridors than outside in those landscapes. So confirming that riparian corridors are very, very important for dispersal. We find more dispersal in the areas that have more forested landscapes. The actual dispersal is correlated with terrestrial dispersal models, in this case specifically deer. We don’t find much correlation with avian dispersal models... So I think this might be one of the very interesting outcomes from this, that maybe transmission through birds—at least in some landscapes—is not as important as we sometimes thought.

The caveats remain in some cases, not in others. And the discussant panel—consisting of representatives from large grower, packer, processor and marketer companies as well as a government official from Health Canada—picked up on this ambiguity. The moderator homed in on the bird finding immediately, mentioning that farmers always “throw their hands up in frustration” because they can’t keep birds out of fields.⁵⁶ “Could you share with us a little more about your thoughts,” he asked, “and perhaps why birds might not be as significant as we think they are?”

The presenter followed with a nuanced explanation of the difference between long-term dispersal patterns and acute events—like 50 geese landing in a lettuce patch—and why the models do not exonerate birds as vectors of pathogen contamination. But another panelist piped up about forest areas. “To me, I think a lot of it is common sense,” said the Arizona-based grower.⁵⁷ “If you plant a field next to a heavily forested area, that has a great habitat for deer or other wildlife, then you run the risk of a higher chance for some sort of contamination.” Again, the presenter tried to reign in the extrapolation. “It is pretty obvious the more forested area, the more movement,” he acknowledged, “but it's not quite that simple.” The point, he cautioned, was not to produce blanket statements about woodlands or birds or deer, but “to put some science behind it rather than just working on common sense, which I think will ultimately help with government agencies and auditors.”

Sensing the tension in the back-and-forth, the moderator deftly deployed humor to cover the situation. “So panel, M___’s already kind of cleared up the fact that we can’t just, you know, ignore birds... [cue dramatic pause]... but he might have given us license to just clear cut forests!” Laughter duly rolled forth from the audience as the moderator completed his punchline, “I might be oversimplifying.”

The panel ended on a somber note when the government representative from Health Canada weighed in with a reminder to balance food safety with “being good stewards of the land”:

I think you have to be very careful about disturbing ecosystems, because we all know as biologists what happens when you make one small change in something that can create problems that you didn’t even foresee. And I guess one minor example, not directly related, but we see for example in the poultry industry where they’ve tried eradicating [several types of] *Salmonella*, and basically a lot of people feel that’s the entry point for *Salmonella enteritidis*. So when you’re disturbing these ecosystems and making changes, you have to be very careful.

At this point, we might conclude that the representations which stick with different audiences vary and remain healthily contested. But the Center steps in one more time to produce a single narrative of the findings and what—and whom—those findings represent. Following the symposium each year, CPS publishes a document of *Key Learnings*, summarizing and distilling for those not present (and even those who were) the main points to take away from that year's research.

For the key learnings from 2014, under the heading “Are Animals a Big Contributor to Produce Contamination?” (note the leading question), the report states,

Dr. M___ [the presenter discussed above]... reported that deer are much more important than birds with regard to their ability to contaminate produce fields and that pathogen dispersal occurred when riparian corridors were present to allow terrestrial animals to move freely between wild lands and produce fields... This research again points out that risks posed by the presence of various animals is not equal and that terrestrial animals, especially those which are commensal with human activities may pose the greatest risk by being common carriers of human pathogens.⁵⁸

Notably, all references to caveats such as “in these landscapes” have been dropped, and no reference to “being stewards of the land” or the potential for adverse consequences, environmental or otherwise, are mentioned in relation to controlling wildlife. In the context of a Center that serves as perhaps *the* primary interface between (large-scale) growers, retailers,

scientists, and regulators, these findings carry tremendous influence over how food safety is *practiced* in the field. Even if these precise conclusions do not find their way into the de jure standards for growing and harvesting produce, the simple fact that they are presented and negotiated within this unique milieu means that CPS “key learnings” have a unique legitimacy. These learnings thus have the strong potential to create a de facto standard for interpreting and implementing the “flexible” portions of those rules. Implementation decisions that are in theory left to the discretion of individual operators, including determining which hazards matter and how best to control them, are in practice highly constrained by the type of evidence that food safety experts, not least among whom are represented through CPS, decide is ‘scientific’. I return to this point below through discussion of the promise and paradox of flexibility, and address the consequences of this paradox for farmers and farm workers in Chapter 5.

The Architects Pull the God-trick

The micro-case just presented is indicative of the work performed by CPS, and I suspect also the work performed by other expert bodies engaged in co-producing the vision of natural and social orders underlying science-based standards for food safety governance. By standardizing those locally situated facts, technologies and expertises so that they become the baseline norm against which all other possible facts, technologies and expertises are evaluated, food safety science pulls a version of Haraway’s “god-trick” (1988). Although purporting to represent a risk assessment view from nowhere, scientific models of risk and control very definitely represent a view from somewhere, and that somewhere has particular characteristics and real consequences when treated as universally representative. The channels of power by which burdens and benefits are distributed form an understated substrate of technical debates, circumventing open public dialogue around safety and its consequences. The underlying naiveté of the assertion that food safety governance should simply follow and facilitate the implementation of the best available science (and technology) is dangerous. When experts take over the debate, most other people are screened out of the conversation (Woodhouse and Cozzens 1995, 541). Whose science and whose technology will be represented in setting standards has tangible and substantial political and economic stakes.

The domination of safety research by a particular epistemic community rooted in food science, microbiology, and engineering has important implications for institutional arrangements in produce safety. One repercussion is to simply de-politicize food safety. In the parallel case of safety reforms introduced to the meat and poultry industries in the late 1990s, Wengle observes:

USDA/FSIS’s responsiveness to political concerns is also constrained by an overwhelming reliance on food science, the discipline that undergirds food safety regulations. Food science centers on the study of the chemical and physical properties of food and while it may excel in this field, it is (at least currently) not well equipped to assess the validity of political concerns that pose questions that have not been examined and arbitrated by food science. Hewing closely to food science then, the USDA/FSIS did not assess and evaluate political demands that were, hence, easily de-legitimized as “unscientific.” (Wengle 2015)

The strong epistemic culture cultivated and spread through CPS produces the problem closure noticeable in Thomas’ (2014, xiv) realist position: produce is made safe when standards are based on the “best available science” and when all food producers are held to “the same food safety standards”. Other concerns that fall outside the paradigm’s simple grid—the unmarked

tradeoffs incurred through single-minded focus on safety (Karp and Baur et al. 2015), the morality of sacrificing ecosystem functions or biodiversity on the altar of sanitized fields (Stuart 2008; Stuart 2009), the injustice of putting “mom and pops” out of business, the potential systemic risks brought into being by pursuing absolute hygiene⁵⁹ to the exclusion of other dimensions of health and well-being (McMahon 2013), and so on—must struggle against the weight of this inertia to even be recognized as valid concerns.

The Universal Pathogen and the Universal Subject

A group of Spanish researchers is conducting studies into sustainable approaches for using chlorine dioxide to disinfect surface irrigation water for produce fields. But they say their results should be useful to growers worldwide, regardless of where they farm. “We want this to be applicable for all growing conditions, all climatic conditions and all water sources for any growing area,” said Ana Allende [the lead researcher].
—CPS 2015 Monthly Produce Research Report, January 2016

A dominant thread within food safety discourse assumes that pathogens are independent of the social, economic, or geographic context of production. A typical articulation of this argument was expressed by D___, a food safety scientist with decades of experience working in the fresh produce industry (and with close ties to CPS): “Pathogens don’t know what size operation they’re on, and the smallest operations are those that are least ready to understand how to do produce growing safely.” The point, of course, is not just that pathogens are independent and universal, but that because they are universal, the threat applies to everyone, and the risk (and responsibility/burden of managing that risk) encompasses all producers equally.

This excerpt from an interview with one CPS board member illustrates the connection between constructing a universal pathogen and constructing a universal subject of food safety governance:

Really, there’s a lot we do know about human pathogens, you know microorganisms, how they get around, what the problems are, what they’re on. The problem I see in the produce industry is not that we don’t know enough, *it’s that the people that are practicing it don’t know enough*. The level of sophistication and scientific knowledge, or even interest in science or belief in science, can be rather low among a lot of farmers... There’s also a widespread thing in the produce industry... which I hear all the time, which is, “Well yeah, I know people get sick from produce, but it isn’t mine! I’ve been farming for 40 years and I’ve never made anybody sick, so why should I have to even do these things?” You know, that’s a real problem, because CDC estimate a whole lot of people are getting sick from produce, and somebody’s making them sick. And to say, “Well, I know people are getting sick but it’s not me that’s doing it”... There’s an attitude problem in the industry, where nobody thinks that it’s their problem. Most of them think “This is somebody else’s problem, why should I have to deal with it?” (A___, emphasis added).

Here we see the fluidity of creating representations about nature—pathogens, microbial ecology, agricultural landscapes, etc.—and representations about people. The role of CPS is precisely to navigate those interwoven representations, to manage the formation of identities that render actors governable subjects and the formation of natural order that renders farm fields and packing houses controllable objects. This is not to say that there is not resistance toward that effort to enroll all actors into a common food safety culture by universalizing the risk posed by microbial pathogens. Indeed, due to pressure from family farm lobbyists, the 2010 US Food

Safety Modernization Act was amended at the eleventh hour with a clause exempting many small farmers from complying with the full requirements of the law. One facet of the associated discourse around this exemption is that small-scale operations belong to a different class of operation, and the risks associated with large-scale growers and supply chains are not representative of all contexts (DeLind and Howard 2008). And again, the acts of resistance to universal standards for produce safety are interwoven with resistance to the ways not just in which risk assessment represents farms, but also in the ways in which experts on technical committees represent, or rather fail to represent, the full diversity among US farmers. Reflecting on this relationship, an organic produce wholesaler, who works closely with hundreds of small-scale farmers across California and further afield, explained the situation this way:

One thing that I was thinking about is that some of the resistance around food safety comes from a general distrust of policy makers, and just a belief that they know what agriculture or farming is like. And for someone to be saying that I should be following this, that and the other policy when they've never been to my farm and they don't know what I do – [that] is really where a lot of resistance comes from.

Up for contestation are expert claims to know about farms and farming. Resistance to such knowledge claims—that a laboratory represents a field, a lab tech represents a farmer, or absence of a pathogen represents the public good—demonstrates the tangibility of epistemic authority as wielded through CPS and related knowledge production institutions.

The Promise and Paradox of Flexibility

One strategy to circumvent or deflate resistance is to discursively legitimize a universal, abstract *process* as a means to justify standardized regulation over a regulated community that is acknowledged to be heterogeneous. As discussed in the micro-case I related earlier, food scientists present processes as flexible and adaptive in a way that thresholds, metrics, critical control points and standards are not. One process should be able to fit all farms, in other words, without forcing them to fundamentally change their mode of production (and existence).⁶⁰

And the produce industry is actively embracing the idea of universal processes. A 2008 editorial written by a representative of the Produce Marketing association and a key CPS leader for the *The Packer*—a weekly periodical for the fresh fruit and vegetable industries—stated, “What truly makes your food safe is the process, is the risk assessment” (*The Packer*, April 14, 2008). Product testing does not disappear—indeed, in my fieldwork I have encountered extensive sampling and testing regimes for pathogens in and around produce—but the industry is now advancing process, rather than outcome, as the appropriate regulatory target. Thus food safety in the produce world amounts to, as one long-time industry insider explained it to me, a series of steps:

That you understand the most likely risks of contamination, that you monitor those risks, you have corrective actions in place – well, you have alert parameters first of all, that tells you when you've gotten into a less safe region of that risk than you're used to, than is normal – you have corrective actions to bring you back under control, you have evaluative procedures to determine whether or not the risk has actually created a public health concern, you have records that demonstrate that you have done all that you can do, and that's pretty much it... That's food safety in the produce world, at the growing level. (D___).

Ostensibly, the regulatory arrangements that have emerged in the US to ensure food safety fit into a flexible or experimentalist form of governance, as pointed out by Wengle (2015). This can be seen, for example, in the preamble to FDA's Produce Safety Rule, which requires all but the smallest-scale US farms and packing houses to comply with "science based minimum standards" for the safe growing and handling of fresh produce:

FDA intends to adopt a regulatory approach that considers the risk posed by both the commodity and relevant agronomic practices, and provides the most appropriate balance between public health protection and flexibility. We recognize the need to incorporate appropriate flexibility within regulations to reflect the diversity of commodities and associated processes, practices, and conditions covered within the scope of this rule... In addition ... [this rule] would establish a framework for alternatives to certain requirements of the rule. We realize that numerous differences exist among practices based on risk or agro-ecological conditions and therefore alternatives to certain requirements would be permitted when adequate and documented scientific data or information support such alternatives. (78 FR 3504, January 16, 2013).

Flexibility would seem to be built into the risk-management paradigm encoded in the GAPs. The preface to the 1998 document states that "Operators should use the general recommendations in this guide to tailor food safety practices appropriate to their particular operations" (FDA 1998). Indeed, the capacity to tailor risk management to the particular production setting has been a hallmark trait in the widespread shift away from outcome-based and toward process-based (or management-based) regulatory techniques (Coglianese and Lazer 2003; Gilad 2010). The regulation and governance literature discusses extensively the relation of such regulatory mechanisms to a broader trend toward decentralized, flexible, and participatory governance (Levi-Faur 2011). The basic argument is that centralized public administrators are best suited to meta-regulatory roles, setting the broad parameters within which private sector producers are left to their own discretion in deciding how best to self-regulate their particular operations.

Flexibility sounds good in theory, but the gulf between being able to, *on paper*, produce new research to justify alternative management approaches and actually producing that research *on the ground* becomes the crux of the problem of realizing flexible governance. As D___ explained it to me:

Doing in-field food safety research is very difficult. You can't work with the pathogens themselves, you have to work with surrogates. You can't work with surrogates because there are none. So they're using attenuated pathogens, which requires a whole other level of control. And then you actually have to do it in the environment in which the produce grows, because climate, moisture, temperature, humidity, soil microbiology, all of that interacts in ways we don't understand yet. So the only way we can take them into account is to actually do them on site. And that is difficult. It's expensive, and there's really not enough money out there to do expensive research like there was to do research in the laboratory.

In other industries, the barriers to producing scientific knowledge necessary to realize the "flexibility" of risk-based food safety systems has homogenized the market by pushing out small producers and artisanal products. To return to Susanne Wengle's work (2015), she found that "scientification" of food safety regulation under the HACCP system profoundly changed the politics of inclusion and exclusion among meat processors. Many small-scale, artisanal processors went out of business and the availability of the specialty products they provided

declined. However, she argued that it was not that the large processors and agribusiness firms simply out-competed small-scale or artisanal processors in an open market, but rather that scientification solidified a slanted field of competition by universalizing (another god-trick) a type knowledge produced in industrial scale settings; just like with farmers who rely on locally available informally-treated compost, the metis of artisanal meat processors was structurally denied and delegitimized. They and their products were left to compete in an ostensibly “flexible” and “experimentalist” regulatory regime, but with only the technologies, protocols, and metrics designed to suit a context fundamentally different from their own, that of big industrial processors. “The experimentalist [i.e. purportedly flexible and context-adaptive] character of science-based regulatory systems can be undermined,” Wengle concludes, “if – and to the extent that – the science underlying it excludes a particular stakeholder, either by raising the burden of regulatory compliance or by de-legitimizing their concerns in the politics surrounding regulations.”

The discursive move to advance processual flexibility as an antidote for standardization is clever, but there is a tension between (1) the ideal of fully characterizing the risk associated with every different context in which vegetables, fruits, and nuts are grown, handled and distributed, and (2) the cost in time, money and resources of producing the knowledge of those risks. Clearly, a compromise will be needed, which means that some knowledge of risk located in a particular place and time (e.g. over a few months in upstate New York) will have to stand in for unknown risks at other places and times. Crucially, this is a process of representation, and the co-production idiom cautions us that ordering nature in this way also signals an ordering of society and technology, and thus an exercise of power.

Naturalizing Pathogen Risks, Narrowing Democratic Imagination

Wielding epistemic authority to transform particular views from somewhere into universal models of best practice works to naturalize the risk posed by foodborne microbial pathogens. This in turn works to depoliticize food safety, as evidenced by repeated claims that “everyone is on the same page”, sharing a common “goal” or “mission”, or part of a single “culture of food safety”. Where does that leave those who might be on a different page, or pursuing a different mission? If foodborne pathogens are a wholly natural (i.e. non-human) hazard, then there will be an optimal, best way to deal with them that is a matter of technical calculation rather than political negotiation. In other words, the problem of pathogens conveyed on produce is discursively closed for active normative debate. The overall strategy is set, the appropriate management and regulatory techniques for addressing food safety are known, and all that is left to do is fill in the remaining “gaps” identified by assessing where the produce supply chain fails to meet the conditions of control. The very idea that there might be negotiation, compromise, or trade-offs in produce safety is negated, rendered irrelevant, by the framing of a common problem that affects everyone equally. Questions of cost, fairness, and equity are never raised because the inevitability of the food safety apparatus as produced through the “god-trick” makes them irrelevant.

Without such questions, other ways of producing safety—or producing a more comprehensive conception of the good, like health or well-being—fail to be imagined, at least within the epistemic culture propagated through the Center for Produce Safety. The case of CPS illustrates another example in which “centralized methodologies of risk analysis tend to reduce the diversity of standpoints and perspectives that might make policymaking more robustly

democratic” (Jasanoff 2012, 14). While an *E. coli* outbreak might symbolize a failure of the democratic state, hewing too closely to technocratic, universal “solutions” symbolizes a failure of the democratic imagination.

I conclude with an insight expressed to me by a key figure in CPS and in produce safety reforms more generally:

Don’t dump stuff on growers and say if you can’t do this, we’re not going to buy from you. Or eventually they won’t be there to buy from. I’ve seen this in the poultry industry – and again, I’ve been around for a long, long time – and I watched this happen with seafood, I watched this happen with juice, I watched this happen with meat and poultry, where the demand because of outbreaks, got so out of control that the smaller operations simply went out of business or sold off to larger operations. So now if you take a look at meat and poultry as an example, there may be a dozen meat and poultry operations in the country, and that’s it. Where there used to be hundreds. (D___).

Only producers who embrace the universal risk-assessment process and enroll themselves in the disciplining culture of food safety—who know their farms and packing houses through quantitative models, PCR tests, pH and chlorine readings, traceback forms and databases—can produce safe food in the world thus described and brought into being. In the following chapter, I trace the contours of this food safety culture and explore the implications as it seemingly inexorably engulfs growers and farm workers.

5. FOOD SAFETY ACCULTURATION

We have now looked at how food safety standards originated within the apparatus and the epistemic community of food safety experts that decide the technical details of those standards. Over the next two chapters, I pivot to discuss the work of putting these standards into practice, with particular focus on the people and places by whom and upon whom this work is performed. I consider the character and consequences of this work, and what it means for both human and natural sustainability, resilience, and well-being.

I begin in this chapter by arguing that *implementing* standards functions as a process that is symmetric to the process of *setting* standards: both require a ‘trick’. In chapter four, I argued that food safety experts perform a sleight-of-hand—what I called a god-trick—to make situated knowledge appear universal. Through this trick, experts are able to ascribe a global reach to standards, justified because those standards are based on ‘just the facts’ as though those ‘facts’ apply everywhere equally the same. However, this does not explain how these abstract standards achieve power to change the material configurations and practices at the diverse local sites where food is produced. The key challenge, then, from the perspective of mastery, is how to effectively shape the behavior of farmers and workers who are otherwise much more knowledgeable about the conditions of growing food than are the ‘expert’ standard-setters.

To overcome this problem, another sleight-of-hand must occur to make ‘universal’ knowledge and its associated standards applicable to individual and decidedly highly heterogeneous farms and farmers. To articulate smoothly with pre-determined universal standards, these locally situated actors must perform a standardized safety script *as though it were their own*. In so doing, they must allow their agency as voluntary actors to be subsumed within the dominant structure of the food safety regulatory apparatus, all the while preserving the illusion that they act fully under their own power. Referring to the Greek myth of the titan who stole fire—a symbol of vital, creative power—from the gods and gave it to humans, I call this illusion the “Prometheus-trick”. Just as food safety experts rely upon the illusion of a god-like knowledge to justify their presumption of global authority over standards, they also rely upon the illusion that this power is democratically shared among all actors across the food chain, and that all have access to the creative forces that shape agrifood provisioning.

Experts turn to this Prometheus-trick in an attempt to resolve a fundamental incompatibility between decentralized governance networks and the hazard mastery paradigm. To avoid the rigidity, expense, and authoritarian approach of centralized, top-down regulation, decentralized strategies of “governing at a distance” (Rose and Miller 1992) suggest that (1) meta-regulation, e.g. standards, must be flexible enough to effectively apply to diverse unique operations (e.g. farms), and (2) that the people best situated to make use of that flexibility are the practitioners themselves, e.g. the farmers and laborers who spend every day working to grow, harvest and distribute fresh produce.⁶¹ Food safety experts used these same rationales to promote HACCP (see Chapter 3), claiming that this form of meta-governance is neutral with respect to the specific context of regulated firms, each of which retains discretionary flexibility to reduce risks in the ways which best suit their operation. This same logic can be seen in action in the preamble to FDA’s 2015 Produce Safety Rule (78 FR 3504, January 16, 2013):

FDA intends to adopt a regulatory approach that... provides the most appropriate balance between public health protection and flexibility. We recognize the need to incorporate

appropriate flexibility within regulations to reflect the diversity of commodities and associated processes, practices, and conditions covered within the scope of this rule...

By adopting a meta-regulatory role based on setting broad standards, FDA makes the meta-governance claim that it will most optimally encourage effective and efficient reduction of food safety risks by granting growers freedom to innovate and experiment, within bounds, with practical interventions that best control hazards on their particular farms.

In practice, this supposed flexibility and the liberty it preserves is deceptive because all actors are judged according to their adherence with the hazard mastery paradigm. Both the architects of public danger and the purveyors of mastery frame protective work as purification, the control of contamination through strict separation of pathogens and their sources from all contact with food and its production environment. Given that the entire apparatus rests on the continual maintenance of this condition of control, the moment of performance, in which local actors reconfigure their subjectivities to fit universal aspirations, poses a threat to the apparatus' central technique of scientific governance through standards. How is the necessarily decentralized and discretionary work of translating universal model to grounded practice *itself* to be controlled and kept in line? What is to keep the standard – and the public comfort with and confidence in the food supply which it sustains– from unraveling completely when it is interpreted and applied flexibly or experimentally in different ways at different places?

I first argue that a form of governmentality under the guise of “food safety culture” has emerged to fill this role and perform the Prometheus-trick. Acculturation, albeit in the shadow of discipline, is the primary mode for enforcing standards-based governance. I use acculturation—originally meaning “the adoption and assimilation of an alien culture”⁶²— to convey the displacement of extant lifeways with the new values, imperatives, traits, and behavioral patterns associated with food safety culture. It is through such displacement that experts seek to govern “with the grain”, not just to manufacture consent but to nullify the possibility of even imagining dissent. Food safety acculturation is the process and product of normalizing food safety work and creating the sense that it is inevitable, as though farmers and workers themselves control the form, content and direction of that work. The fundamental question raised for critical analysis, though, is at what cost?

I conclude by arguing that, as food safety experts proselytize the US agrifood workforce to a universal food safety culture, they exert a homogenizing force in our agrifood system, reducing demographic, cultural, and epistemic diversity through systematic exclusion of anyone who is “other”. Put differently, food safety constitutes a new moral economy (Busch 2000) that sorts producers into ‘good’ and ‘bad’ based on the ‘riskiness’ of their operation, as judged by their compliance with and internalization of the universal culture. Furthermore, food safety acculturation foists a further burden of responsibility—and possible transfer of blame and liability—on agrifood workers while simultaneously (and paradoxically) delegitimizing their tacit knowledge through forced deferment to distant experts, thereby eroding the autonomy and discretionary power through which they might fulfill the added responsibility.

But what, precisely, are the mechanisms of acculturation? How are actors across the supply network enrolled into the food safety apparatus, and how do food safety professionals displace their existing conduct with behavior, values and attitudes that run “with the grain” of the hazard mastery paradigm? Lastly, what opportunities exist to resist or reclaim food safety work from the dominant paradigm? To answer these questions, I examine the phenomenon of food safety training and behavioral change. Drawing on close observation of growing and handling

fresh produce, employee training, and the discourses of food safety culture within the industry and as it intersects with popular media, I parse those activities that comprise food safety work from the core activities of food provisioning.

Interlude: The Moment of Harvest

I pull into a dirt lot at the nondescript intersection of two likewise nondescript, arrow-straight roads that cut through the uniform fields of growing greens. At 5:30 in the evening, the sun hangs just over the horizon. Night comes early in February, the prime growing season for the desert regions of Imperial Valley and Yuma, along the US-Mexico border. That's a good thing for the harvest crews, who start work when the temperature drops off at the end of the day. The valuable yet fragile leaves of crops like lettuce, romaine, and spinach must be kept cool, ideally between 32° and 35° F, both to prevent spoilage and to deter pathogens. The colder the ambient temperature at the point of harvest, the less likely the product is to degrade—or hitchhiking pathogens to proliferate—during the few hours it takes to transport the greens from field to packing house.

Manuel, the food safety manager for the harvest, parks his silver pickup truck next to me. I get out to shake his hand, and glance at the nearly full lot. An impromptu staging area, Manuel tells me, where the foremen (*mayordomos*) and tractor or harvester drivers, the “skilled” workers of the harvest operation, meet. Usually with many years of experience both on the line and running a crew, the foremen and drivers are employed year round by the harvester, Manuel's employer, and based out of the Salinas Valley hundreds of miles to the north. They have migrated south for the winter season, and will head back in March, when the season shifts again.

The crews, seasonally employed and mixed gender, show up directly at the field. In the distance I can see them already at work, their progress marked by the divide between a rich



Figure 12. The abstract symbols of policy and concrete practice on the ground merge in the signage affixed to every surface of this wash station. Following the guidelines, everything must be labeled in writing, even the paper towel dispenser.

carpet of deep green in front of them and a yellowish expanse of exposed stalks behind. Harvest crews can work for up to 10 hours a night, six days a week during peak season. Tonight should be quick, though, as Manuel expects to wrap up by midnight. Baby greens are harvested with a fairly small crew—five to ten workers—depending on whether the customer has ordered the greens packed in large bins, which can be loaded by machine, or in relatively small totes, which have to be packed by hand. For comparison, crews for

harvesting whole product, such as head lettuce or romaine hearts, can be much larger, on the order of twenty to fifty workers, since those crops must be harvested entirely by hand.

Manuel and I are both ready, and we walk toward the field. Before I can enter, though, I have to observe the requirements of the visitor standard operating procedure (SOP). Following Manuel's lead, I wash my hands vigorously with soap and water; it is supposed to take 20 seconds, or the time it takes to sing *Happy Birthday* (a mnemonic used by food safety trainers to teach approved hygiene practices to crews). Everything about the wash station is labeled in Spanish and English, and a prominent sign reminds me to *lávese las manos frecuentemente* (wash hands frequently, Figure 12). With freshly scrubbed hands, I don a hairnet and reflective vest, and remove my watch to my pocket – no wristbands, necklaces, earrings or other personal accoutrements that may inadvertently fall into the harvested product are allowed in the field.



Figure 13. The harvest machine mowing baby spinach leaves.

The hygiene ritual observed, we enter the field. The harvest crew is moving away from us, and we follow along the already harvested beds, now a “safe” place to walk. Our boots crunch through the densely packed stalks that remain. For the baby greens, in this case spinach, the tender leaves are mowed up with a large harvesting machine, which draws the cut leaves onto a conveyor belt (Figure 13).

The leaves are carried up and to the back of the machine, where several gloved and hair-netted workers stand on a special platform. Arranged as a factory line, their work begins on the trailer being pulled along parallel to the harvesting machine. Workers on the trailer prepare empty bins and place them on a conveyor belt, which passes the bins to the three workers (mostly women) who gather the leaves as they flow up and pack them loosely in the totes. The packed totes are then conveyed back to the trailer where 3-4 workers (all men) cover, stack and secure them (Figure 14).



Figure 14. Factory line for packing baby greens on the move.

An anti-rodent soundbox has been affixed to the front of the harvester, near the blade and the headlights. It emits a high-pitched, throbbing chirp which rodents supposedly find intolerable, causing them to run away. I can see why they would. Manuel says he tested the chirping box at a friend's house, where the noise seemed to resolve a long-standing mouse infestation. In addition to the soundbox, two workers walk between the beds ahead of the machine, tasked to look for any signs of animal activity or other problem, such as a bit of litter. If they see anything, a hand signal to the driver tells him to lift the mowing blade over the contaminated area, effectively skipping that section of the bed. All of these anti-animal measures are, Manuel tells me, rarely necessary, for it is very rare to see animals in the field during the actual growing season. In his experience, all the people moving in and out of the fields keep them off. It is much more common to see animals in the off-season, when the fields are largely let alone.

As we trail behind the crew, periodically pausing for me to take a snapshot with my camera, I ask Manuel how the spinach greens were sampled for laboratory testing prior to the harvest. He stops and takes out his smart phone. Within a minute he has pulled up all the records for this particular bed, including when and where (with GPS coordinates) the samples were taken and the certificates of "no-detect" from the lab, which certify that the standard PCR test found no traces of *Salmonella*, EHEC (Enterohaemorrhagic *E. coli*), or *E. coli* O157:H7 on the leaves tested. Turnaround time on these tests is everything, and a difference of even 12 hours can be significant enough to switch to a more efficient laboratory; the current lab used by Manuel's company can return results in 24 hours. Even with testing every bed, Manuel tells me they have not had a positive pathogen detection test all season... so far, he adds. The ease with which he can back up that statement with documentation—even in the middle of the night, in the middle of a field—speaks to the importance of keeping and maintaining records. With our feet firmly

planted on the raw stalks of freshly harvested spinach, the world of text is but a screen swipe away, ready to weigh in (or weigh down) on the work actually performed on the ground.

After trailing the crew for several passes, Manuel deems that the harvest is well enough in hand to borrow the foreman, Luis, to speak with me for a few minutes. With ten years as a harvesting foreman under his belt, and many years before that working on the lines, he is in a position to speak to how the work has changed through the rise of food safety culture. It is *más tenso* (more tense) now than in the past, he tells me. Today there is more pressure on the foremen, but he has learned to handle it, and he appears cool and calm standing amidst spinach. The audits don't worry him too much, Luis says matter-of-factly. All you have to do is follow the rules and get your workers to follow the rules, too. He tells the workers *why* they have to practice the many precautions laid out in the SOPs—washing their hands, removing their jewelry, wearing hairnets, and so on—explaining that it matters to everyone who will eat the crop, including the workers themselves and their families. Packer-shippers will often gift a palette of washed and packaged greens to the harvest crew, which makes safety personal for the workers. Luis feels such confidence in his crew that an audit can even be a chance to “show off” their exemplary organization and hygiene; adhering to the symbolic abstractions of food safety becomes a source of pride, rather than anxiety.

But Fernando, the foremen for the other harvest crew working on the next field over, clearly experiences anxiety. To be a good harvest foreman, he tells me, first and foremost you have to constantly check both the quality of the product and the diligence of your crew. A joke among the foremen says that “it’s a high-paid baby-sitting job”, but in reality the job is a carefully orchestrated balancing act. You have to have a good relationship with the workers, he says, and you can’t be a hard-ass all the time. You have to be friendly and understanding, too, or you’ll lose the loyalty of the crew. For example, if any employee forgets something like their hairnet or gloves, it is counter-productive to yell at them or start an argument on the spot—just give them what they need to do their job, and pull the worker aside to talk about it later. Keeping

the peace is half the foreman’s job.⁶³ The other half of the job is constant vigilance, being ready at all times to meet whatever problem may arise with the proper (that is, the way it is spelled out in policy) corrective action. The pressure, Fernando concludes, is a lot, but it is also interesting work, because it’s thinking work: he has to think about every aspect of the harvest and keep all the requirements straight. And then he has to write it down.

		Domingo	Lunes	Martes	Miércoles	Jueves	Viernes	Sábado
Pre-Cosecha								
Inspección de Pre-Cosecha		4:30 PM	4:30 PM	4:30 PM	4:30 PM			
Enjuague de Maquina		4:35 PM	4:40 PM	4:45 PM	4:50 PM			
Inicio - Bara de spray: Cloro / Nivel de pH/Cloro reactivo		4:45 PM	4:50 PM	4:55 PM	5:00 PM			
Desinfectante, jabón de manos, agua, toallas de papel, papel higiénico, baños		4:45 PM	4:50 PM	4:55 PM	5:00 PM			
Inicio - Cubetas - agua clorada / niveles de pH/Cloro reactivo		4:55 PM	5:00 PM	5:05 PM	5:10 PM			
Maques para pasto y barba, guantes, mandales, mangas		5:00 PM	5:05 PM	5:10 PM	5:15 PM			
BREAK - Cubetas - agua clorada / niveles de pH/Cloro reactivo		5:00 PM	5:05 PM	5:10 PM	5:15 PM			
Medio día de trabajo								
Bara de spray: Cloro / Nivel de pH/Cloro reactivo		10:00 AM	10:00 AM	10:00 AM				
Desinfectante, jabón de manos, agua, toallas de papel, papel higiénico, baños		10:00 AM	10:00 AM	10:00 AM				
LUNCHE - Cubetas - agua clorada / niveles de pH/Cloro reactivo								
Fin de día								
Lavar y Desinfectar Maquina								
Maquina # 777		6:00 AM	6:00 AM	7:00 AM	8:00 AM			
Maquina #								
Traillas limpias y cargadas		5:00 PM	5:00 PM	5:00 PM	5:00 PM			
Reofers Limpios		6:30 PM	6:30 PM	6:30 PM	6:30 PM			
Inspección de Yarda		4:30 PM	4:30 PM	4:30 PM	4:30 PM			
Inspección visual del equipo		4:00 PM	4:30 PM	4:00 PM	4:00 PM			

Figure 15. Weekly harvest cleaning sanitization record kept by the harvest crew foreman.

To demonstrate, he takes me back to the edge of the field, where he has parked his truck. Opening a side compartment, he takes out a clipboard where he records the steps he takes to fulfill the harvest SOP each night (Figure 15). The form has been translated to Spanish, as Fernando, like many foremen in California, is not fluent in English.

For hygiene, the workers who directly handle the product (as in Figure 3) must wash their hands with soap and water and then dip their hands in a bucket of chlorinated water (duly labeled *agua con cloro*) before putting on their gloves. Fernando is responsible for regularly testing this water to make sure the chlorine concentration and pH stay at the proper levels to deter pathogens. Putting the clipboard back in the truck, he takes a box of test strips from his vest pocket and dips one in the water container. Sure enough, the chlorine test clearly shows ~100 ppm, a common target for chlorination, and the pH test shows a solid 7, within the acceptable range of 6.5-7.5 (Figure 16).



Figure 16. A gloved Fernando demonstrates how he tests the pH of the wash water used by the harvest crew.

Culture as Panacea

The above story demonstrates how an overriding imperative to master microbes has penetrated, at the “capillary” level as Foucault or Latour would say, the patterns of social behavior in the farm field. Through signs, clothing, machinery, mnemonics, managerial relationships, paperwork, work practices, and the physical shape of the vegetable beds and fields themselves, individuals working in the fields find themselves guided almost imperceptibly into the grooves of the food safety apparatus. Gradually, a generic food safety ethic is taking hold among agrifood workers in such a way that it becomes engrained in their behavior, attitudes,

language, and worldview. This insinuation, however, has been neither secret nor unintentional—rather, it is the product of a deliberate, carefully orchestrated plan to spread food safety culture.

In November 2014, the influential consumer advocacy group STOP Foodborne Illness interviewed Wal-mart’s vice president of safety and health, Frank Yiannas, about “getting to the path of food safety as a social norm.”⁶⁴ Yiannas has also authored a book on the subject (Yiannas 2009), and in the interview he reiterated the “mission” behind the book, to focus on what he calls “the soft stuff”, or human behavior and organizational culture:

In the field of food safety today, there is much documented about specific microbes, time/temperature processes, post-process contamination, and HACCP – things often called the hard sciences. There is not much published or discussed related to human behavior and culture – often referred to as the “soft stuff.” However, if you look at foodborne disease trends over the past few decades, it’s clear to me that the soft stuff is still the hard stuff. We won’t make dramatic improvements in reducing the global burden of foodborne disease, especially in certain parts of the food system and world, until we get much better at influencing and changing human behavior (the soft stuff).⁶⁵

Dissecting precisely what Yiannas means when he states, with emphasis, that “food safety equals behavior” requires greater attention. In part, it is the transition from an active train-test-inspect disciplinary system over the agrifood workforce to a sense of being inside a Foucauldian panopticon: workers should follow protocol at all times as though someone were watching them, scrutinizing them. Take, for example, an anecdote from Drew McDonald—VP for quality, food safety and regulatory affairs with Church Brothers Produce, a major grower-shipper-processor based in the Salinas Valley—relayed in a 2015 blog post from the California LGMA. In this story, McDonald struggles to respond to a skeptical retail purchaser who, after touring the Church Brothers operation, said, “I just don’t believe what I saw today is representative of what happens every day.” McDonald’s solution is to take the purchaser to the top of a nearby hill, overlooking the fields:

He handed the buyer the binoculars and said, “Go ahead, take a very close look at what these crews are doing. They can’t see us, but they’re still taking the same precautions they took while you and I were down there close to them.”

The buyer – still reluctant to give in – inquired, “Which one of those is your crew?”

Drew pointed to one of the harvest companies and said, “I think it’s that one there. But here’s the point – take a look at all of them. They’re all following the same practices.

Because that is how we do things in the California leafy greens industry now. *All of us.*”

Only then did the buyer get it. (emphasis added).

But this story reveals a panopticon flipped on its head, in a way, for it is also a performative, rather than disciplinary, act intended to convince the buyers (and by proxy the state and the consuming public) of the smooth functioning of this panoptic system. Rather than the god-trick of the central eye that sees all (Haraway 1988), actors within the apparatus are subject to a Prometheus-trick, pretending that the standardized safety script is their own, rather than the rigid and rote product of the hazard mastery paradigm. A key element of the push for a food safety culture is that it is a *single* food safety culture that can span many farms, packing houses, and processing plants— the idea of standardization applies to behavior and company organization in the same way it does to the “hard science” aspects of the production environment, process and infrastructure. Hence the power of McDonald’s performance is two-fold, demonstrating both what his workers do when they are being watched and also that

distinguishing between workers is unnecessary because everyone, “all of us,” behaves the same way, following the same SOPs and protocols.

In the process of standardizing food safety culture, training workers—and training trainers to train workers—has become an industry in its own right. One private third-party certification firm—known primarily for its laboratory and auditing services—now works on the “soft stuff” as well: “NSF International combined leading research on human behavior and psychology with the organization's expertise in food safety to design an intelligent behavior-based food safety assessment model that helps companies build a culture of food safety.” People, the company continues, are the remaining “rogue element” in an otherwise “right”, “sound” and “sanitary” production environment:

People are dynamic. We don't simply do what we are told, and we can't be programmed like a computer to perform perfectly at all times. Our research and experience to date, and that of the food companies we work with, confirms our belief that sustainable safe practices within the food sector are best achieved when we go with the grain of human behavior. Only by effecting change in food handler behaviors will we be successful in embedding food safety within organizational culture, bring about meaningful improvement. (Fone 2012).

Workers are increasingly recognized as the “first line of defense against foodborne illness.” This can work, paradoxically, both to discipline and empower agrifood laborers.

Workers who are trained to recognize and address the most common sources of pathogen contamination are the first line of defense against foodborne illness. When they understand the intent of preventive protocols and have channels to signal problems with implementation, those workers can help verify compliance with food safety measures between periodic audits.

Farmworkers are extremely skilled, and their experience and knowledge can be refined to reduce risk at the point of harvest. Tapping into farmworkers' expertise is a vital yet under-recognized component of any effective strategy to prevent foodborne illness. The relatively simple measures they can implement, combined with ongoing surveillance and appropriate investment in training, equipment and sanitary facilities, would go a long way toward reducing the incidence of pathogen contamination in produce. (Fone 2012)

Again, we see the outlines of a discipline/empowerment paradox that must be evaded by means of the Prometheus-trick. By highlighting the skills, experience and knowledge of farmworkers (assuming they have already been acculturated), this company's food safety narrative reinforces the apparatus by displacing its overarching agency—and imperative to control—onto the illusion that workers and individual actors possess their own agency. But it is a subordinate agency, leaving a critical observer to wonder whether this rhetorical tactic is a double-edged sword for the apparatus: does this acknowledgement leave an opening for alternative skills, experience and knowledge to contravene the strict hazard control paradigm?

To be sure, the specter of fear and anxiety brought about by the threat of lawsuits and prosecution provides a strong back-up deterrent to any form of resistance. When US Marshalls arrested the Jensen brothers in connection with a 2011 outbreak of *Listeria monocytogenes* linked to cantaloupes (see Chapter 2), FDA officials stated that pressing the charges “sends the message that absolute care must be taken to ensure that deadly pathogens do not enter our food supply chain”(Elliot 2013). The brothers eventually faced five years of probation, six months of home detention, and \$150,000 in fines and faced lawsuits from 66 of the 147 victims of the



Figure 17. Infographic, “What is a culture of food safety?” California LGMA (2015).

outbreak (Ortiz 2014; *Food Safety News* 2015). Their case, along with the prosecution of top executives at the Peanut Corporation of America in connection with a deadly outbreak of *Salmonella* linked to peanuts in 2008-9 (Goetz 2013), has ushered in a new phase of federal food safety oversight that has dramatically raised the stakes, and the anxiety levels, across the produce industry. At the British Retail Consortium’s 2016 annual Food Safety Americas Conference—a forum for some of the biggest multinational agribusinesses to compare notes on food safety—the first plenary speaker warned the audience that “complacency kills.” Citing the Jensen Farms and Peanut Corporation cases, he went on to describe the “new human illness standard” that FDA has adopted in waging its “war on pathogens.” The newly coined standard “suggests that whenever a food product becomes associated with an outbreak of foodborne illnesses, it will trigger a federal criminal investigation of the company” (Flynn 2016). Even if owners, managers, or workers are not aware that their products are contaminated with pathogens or are not intentionally shirking their food safety responsibilities, they can still be found criminally negligent if that product harms one of their customers. The question facing each and every person in the industry, the speaker drove home, is “What’s the risk that I could find myself going to jail because of a food safety decision that I made?”

The rising fear and anxiety cultivated within the apparatus perversely encourage actors to cling more tightly to the hazard control paradigm to protect themselves. That stress can lead to tension among owners, managers, and workers. Danielle, a food safety manager for a diversified, organic farm that sells most of its product through a CSA, spoke of her continual efforts to oversee her company’s employees without slipping into what she called a “cop mentality.” But the stakes are high. “I think there’s now more accountability across the board,” she said, referring to the Peanut Corporation and Jensen Farms cases, “It’s not just the ownership, the CEOs, exec level,” she continued, “I mean, it went down all the way to the plant manager... So that it’s kind of that game: I could be on the chopping block,

you know, or it could just be the owners. And so it's very difficult to know that the owners may make a different decision than you would like to make, so how do you protect yourself? What do you do?"

When I pressed Danielle on what she actually does to protect herself, she laughed, "Cross your fingers that there's enough insurance!" "No, I'm kidding," she continued. "[I] try and document as much as possible. As stupid as it sounds have as many emails or whatnot as opposed to verbal conversations over the phone, so at least that I have some backing that, hey, we'd like to move in this direction, I do not recommend... whatever. So hopefully that will work. Have insurance yourself, you know, do whatever you can do personally."

Henry, the food safety manager for a prominent organic family farm in California's central coast, told a similar story. The thing is, he told me, when farmers get into some trouble, it's the paperwork that saves them, but they're obviously focused almost solely on growing and production, not filling out and keeping up with the paperwork and forms. Food provisioning work is increasingly complex and requires multiple layers of expertise, but the biggest problem is how to coordinate among them. "I'm starting to think," said Henry, "that this whole farming thing is about people management".

It is critical that each operation—whether growing, packing, shipping, processing—have the right people in the right place at the right time in order to provide a convincing performance for auditors and inspectors. In Henry's words, safety-focused managers increasingly act "more like police", following employees around to observe compliance (or failure to comply) directly. Farm employees, therefore, also feel the stress of food safety culture under discipline as mid-level managers and foremen push their fears of liability and accountability further down the chain of command. It is important to recall that field workers often live a precarious existence—most are immigrants, some illegally, with little social capital or access to work outside of agriculture. They have historically been considered "low-skill" labor, and as a result have often been poorly paid for difficult work, which moreover tends to be seasonal, requiring migration. Agricultural workers are acutely aware of their vulnerable position, and so are particularly sensitive to the "cop mentality" or "policing" by their managers—it is not surprising if they feel compelled to comply with what their bosses tell them to do.

The stress is compounded by the growing reliance on unannounced audits. A California LGMA auditor, for example, can show up any morning, at 7 am, and ask to go out to see the operation. So Henry and the workers he oversees are always self-disciplining to ensure that any auditors and inspectors who visit the farm see not only that the appropriate policies, the right documentation, complete records, and so forth are in place, but also that the operation possesses a sound business structure with a clear hierarchy of responsibility. It is to preserve the expectation of responsibility, and accountability, that the apparatus must maintain the illusion that individual operators have autonomy. Only actors who are perceived to possess agency can truly be said to comply, because there still exists the possibility of non-compliance. Once again, this is another instance of the underlying paradox of the apparatus—standardized hazard control versus context-specific autonomy to react differently to different circumstances—that gives rise to the Prometheus-trick.

But how is this trick sustained? To examine this question, I turn next to analyze cases of food safety training in different contexts, demonstrating how different modes of acculturation are employed among different types of actors operating in very different circumstances to

manufacture consent to the same overarching paradigm. All paths lead to the apparatus, as will be seen, but perhaps some paths are less fixed than others.

Training the Prometheus-trick

Below I relate observations taken during three different types of food safety training. Train-the-trainer sessions focus on preparing the managerial staff at large growing operations to enroll the workers they oversee into food safety culture. Trainings for small farmers, conversely, target farm decision-makers, who, because of the scale of the operation, generally also must manage the farm and any workers they may employ. Lastly, trainings for the organic grower target farm operators regardless of scale, but specifically those farming and handling produce under the constraining framework of the National Organic Standard. Each case varies dramatically from the others, partly due to the different audiences and partly due to the individual differences among trainers. What is important to note from these descriptions are the strategies and devices through which trainers alternately coerce and cajole the trainees to see the world through the lens of danger and control, a topic I will return to at the end.

Train-the-Trainer

In July 2013, I attended a “Train the Trainer”⁶⁶ workshop hosted by the California LGMA group in Salinas to roll out new training materials (Figure 18). In part, the workshop formed one link in a chain of translation between food safety standards and their implementation on the ground. “We know from experience that people don’t like to hear the rule,” explained the workshop facilitator, “they want to hear what they have to do.” Through these glossy, full-color flipbooks, LGMA sought to give trainers a starting point for turning the rules on personal hygiene and sanitation into specific proper behaviors that employees would know to follow (see **Box 1**). In so doing, the agency also sought to add another layer of consistency in the formation of a pan-industry food safety culture for leafy greens agriculture.

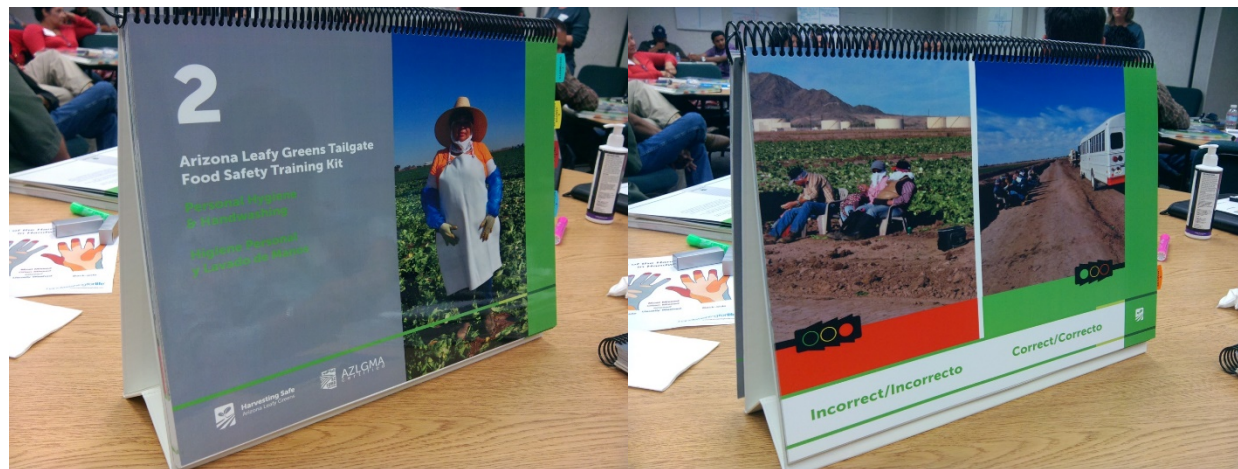


Figure 18. LGMA tailgate food safety training kit flipbook. The Arizona LGMA developed three large-format, full-color flipbooks for easy transport to the field for use in a pre-harvest training. The flipbooks provide simple visual examples demonstrating both correct and incorrect behaviors—the right panel shows incorrect and correct locations for a harvest crew to eat their lunch. Information is presented in both English and Spanish.

The training took place at a typical hotel conference room, with the ~25 participants—growers, handlers, and marketers of mostly middle-management status—spread across half a dozen circular tables. Following the generic mold of participatory meetings everywhere, the training began with a breakout session. Wielding multi-colored markers, the facilitators tasked the attendees with filling in large sheets of paper with responses to a number of questions about the employee trainings in their own operations: Where do the trainings take place at your company? What is the typical size of a group trained at your company? What materials do trainers use for training on food safety? Who trains the trainers, oversees and monitors them? What materials does harvest worker receive (if any) for food safety? What is your biggest food safety training challenge? What would help make food safety training at your company better?

Most participants reported holding trainings twice a month, generally comprising a 10 to 15 minute presentation “at the tailgate” of the harvest manager’s pickup truck right before they began the work of the harvest. Typically, in a harvest operation as I described above, the crew for any given day will first convene as a group at the parking lot staging area, in other words, outside and with the clock already ticking. Interestingly enough, and likely representing the heterogeneity of operations even within the leafy greens industry, the size of trained groups generally ranged from 10 to 40, although one attendee reported conducting trainings of up to 100 workers at a time.

The topic of challenges elicited the greatest volume of responses. Many attendees expressed frustration over trying to fit food safety trainings into the already tight production schedule. Anything over 10 minutes, they argued, causes a delay in that schedule, which “goes all the way to the top” and risks reprimand from the “big boss” (i.e. the farm owner). Furthermore, the proper behaviors conveyed through the training materials do not always account for practical limitations in the field. When the temperatures reach 90 or 95 degrees, protested one of the attendees, the personal hygiene garments—aprons, arm sleeves, hair nets and so forth—can be too hot for workers. This places operators in a difficult position. Some, in order to stick to the harvest schedule, will allow field workers to disregard these items if it gets too hot. However, this contravenes official recommendations to halt work—throwing off the schedule and possibly sacrificing some of the crop—if the ambient temperature is too hot for protective clothing. The trainers evaded the uncomfortable question of whether food safety takes precedent over farm worker welfare, rearticulating that official policy should protect *both*, meaning that the production schedule should take lowest priority.

At least six attendees complained that their new employees lack basic knowledge of acceptable hygiene and sanitation behavior. Especially in the southern growing regions of Imperial and Yuma, near the US-Mexico border, harvest crews turn over rapidly; a training every two weeks might miss a large number of workers. Furthermore, there are language barriers. Many of the middle managers at Central Coast farms—especially foremen, operations, and harvest managers—are bilingual, Spanish and English, to varying degrees. Many fieldworkers, meanwhile, hail from indigenous Zapotec or Mixtec communities in Mexico, and speak Spanish as a second language, if at all. Harvest crew trainings frequently are conducted in Spanish, but since food safety materials are as a rule drafted first in English, there is a two-fold translational challenge both in translating into Spanish and then from Spanish into an indigenous language and local dialects. The attendees at the train-the-trainer workshop expressed concern that often the translators at a tailgate training may themselves not be entirely knowledgeable on proper food safety practices, and might regularly lose important aspects of the message in translation.

Despite the difficulties in translating a large volume of information into clear messages for employees about “what they have to do”, the workshop attendees seemed most interested in the gap between training and achieving actual behavioral change among the crews. In part, this problem was attributed to “old-school” supervisors and workers who refuse to listen, the “people that have been in the industry years and years don't think they need to change.” There was also a sentiment that the work crews lack discipline; supervisors do not receive sufficient training and often do not truly “buy-in” to the need for redoubled food safety vigilance. The workshop leaders and participants agreed on one point: if supervisors do not lead by example, monitor their crews, and enforce policies, then the deviant behavior among workers will not change.

The workshop facilitators underscored the need to “verify”⁶⁷ that the workers understand and internalize the information, and presented two strategies: (1) Ask review questions to confirm that the workers absorbed the knowledge; and (2) Observe them at work to confirm that behavior improves and follows the best practices. The attendees reported creative approaches given the tight constraints of a tailgate training. Many relied on textual handouts or printed PowerPoint slides that they would physically give to field workers; some even reported inserting a flier into the paycheck envelopes, following the philosophy that “they have to hear the message many, many times” and “you gotta start teaching food safety at home,” including seeing the flier on a kitchen table or countertop after the pay envelope has been opened. Still others emphasized the importance of visuals and pantomimed demonstrations of proper practices. Supervisors and trainers must themselves act as models of hygiene and sanitary behavior, demonstrating proper compliance at all times; if they should slip up, the mistake should be used as a teachable moment. One attendee, a harvest supervisor, told the group how, even though he kept his head completely shaved, he still always wore a hairnet to demonstrate good practices to his crews.

While many of the trainers focused on challenges related to conveying the information contained in their training primers and reinforcing behavioral follow-through in the field, several expressed the challenge of instilling food safety culture in workers: How to explain to the workers *why they should care* about and follow the fairly banal and at times pedantic food safety GAPS and SOPs? One participant, echoing the sentiments expressed by Fernando in the Moment of Harvest anecdote above, noted the importance of treating the workers “always with respect”, implying that food safety trainers have to enroll field workers without condescending toward them. This is clearly a difficult balance, however. To help make the import of the information real and relevant, many trainers actively quiz workers—using cold-calling techniques—following the presentation; so as to not strike a purely punitive note, trainers also offer incentives of various types, such as a small amount of cash or a drink/snack, for correct answers. The trick, as one attendee put it, is to connect the food safety practices to the money that workers could earn or lose, for example by suffering a pay cut for violation of a company food safety policy.

The LGMA advisor present at the workshop brought up the story of a tour for victims of foodborne illness—organized through the consumer advocacy group STOP Foodborne Illness—which LGMA helped organize earlier that year. The tour, which LGMA recorded and broadcast widely, offered a chance for LGMA members to hear personal stories from people who fell ill or suffered personal tragedy as a result of foodborne pathogens on their fresh produce. These stories, the advisor pointed out, seem to have a big emotional impact — personal testimony is good for “reaching them individually”. Such stories make food safety an “individual responsibility”, “hook them emotionally”, and “burn that into their brains”. This messaging not only targets field workers, though, but can be used, suggested the LGMA advisor, to get owner commitment from the top, which could lead to more time for training in the production schedule.

Box 1. LGMA Handwashing Demo

Washing hands is one of the perpetual challenges of supervisors and trainers, and the LGMA facilitators offered a hands-on demo on the importance and difficulties of proper handwashing. For the activity, everyone in the room rubbed their hands with a special lotion containing UV-reflective glitter that glows under a black light. We then all went to the bathrooms to wash our hands and remove all of the lotion, pretending to be on a short 5 minute work break to mimic being in a field (although most participants took this as a joke, making wise-cracks about speed).

When we returned from our handwashing efforts, the facilitator turned off the lights and projected our hands, illuminated by just a black light, onto screen. Each of us submitted our hands for inspection, and the screen revealed if we had done well or poorly at handwashing. The more lotion remained after washing, the more surface area of our hands would light up on the screen, mimicking microbes or other contamination that we had failed to remove.

Most people's hands glowed around the fingertips, nails, at the webbing between the thumb and forefinger, and around calloused areas; a fair number of us, myself included, glowed all over. The demonstration led us to perform for ourselves the difficulty of one of the most banal germ avoidance rituals, handwashing, and in so doing sought to displace our "false" comfort and heighten our sense of urgency over the "real" magnitude of the food safety problem.

Following the demo, we discussed the proper handwashing technique. First, rinse. For training purposes, facilitators recommended explaining to workers that the water is necessary to activate the soap, or "make it work." Next, apply soap and lather, again explaining that the lather loosens the dirt. Once the dirt is released, scrub to get the dirt out of all the hard to reach places and cracks. Rinse again to wash away all the loosened dirt and any contaminants that might be clinging on. Finally, dry thoroughly so that wet hands don't attract more dirt. Also, cracked hands might be more vulnerable to contamination.

Training Small Farmers

For small farmers, in contrast, trainings take on a very different tenor. In 2013, I attended a workshop with about 20 other participants designed to help small farmers develop a food safety plan. Hosted by the NGO Community Alliance with Family Farmers (CAFF) at the Permaculture Skills Center in Sebastapol, CA (north of San Francisco) the atmosphere could scarcely have contrasted more with the LGMA event. We gathered in an open-air pavilion, located adjacent to active farm fields. The atmosphere was very jovial and informal, full of greetings and jests among the attendees who seemed to mostly know one another. The informality was reinforced when we later moved into the sun to sit on hay bales.

The session began with the CAFF organizer, Kayla, asking everyone to introduce themselves and state an outstanding question that they had about food safety or FSMA. Most of those present operated on a few acres cultivating orchard or specialty crops for direct-to-consumer markets such as CSAs, and their questions reflected concerns related to costs of third-party audits, exemptions to FSMA-based regulations (which were still in draft stage at this point), and whether specific practices—re-using a box or hosting "you-pick" events where customers harvest their own produce—posed a food safety problem. One attendee from a local food wholesaler and distributor based out of Sonoma reflected that "every farm is its own ecosystem", including with respect to food safety, and urged the farmers present to consider a food safety plan as a communication tool to help buyers understand the unique conditions of each farmers' land and operation.⁶⁸

A food safety plan, Kayla told the assembled farmers, should not be a standard or standardizing instrument. "A food safety plan is not supposed to cookie-cutter everyone," as she later told me. Rather, it just means writing down procedures for monitoring the fields, equipment, employees, and packing houses and what corrective actions will be taken in case of a

(potential) hazard. Even when a customer does not strictly require one, she added, a food safety plan is a sign of professionalism and good for customer relations. As she told me, it puts farmers “on a professional level,” opening up additional market access because “a professional buyer needs a professional farmer.” But beyond customer relations, a solid plan also serves as a road map for the farm operation, a record of all farm activities and risks which can be useful beyond just preventing contamination.

So what should be in a plan? Kayla began by reviewing the GAPs basics—managing contamination from water, soil, tools/equipment surfaces, human workers (hygiene) and animals. She discussed handwashing (“hygiene is the biggest of them all”), flooding, wildlife, water sampling and laboratory testing, and compost (“keep the soil off the harvestable crop”). “The auditor is a set of eyes,” as she explained to me. “It’s not them [making demands], it’s the customer who’s asking for assurance [through the auditor].” And buyers or customers are most interested in the growing area, as she reminded the attendees, so every food safety plan should include a thorough pre-harvest assessment. These are easy to conduct, she said, just walk around the property and look for any signs of intrusion. Note if you see foot prints, fecal matter, signs of nibbling, any foreign material or other signs of hazard, and write it down along with the steps you take to remove the hazard and any crops it might have contaminated from the field. To make this extra effort palatable for her audience and calm their nascent anxieties, she appealed to a frame of reference familiar to family farmers by comparing food safety work to being a good steward of the land—farmers need to also be good stewards of their customers’ health and well-being. “Just say what you do,” she repeated frequently, “and do what you say.” Auditors read everything, and compare written records to what they observe of the farm, she emphasized, implying that internal consistency and demonstration of thoughtful consideration of the food safety implications of each practice are the most important criteria for successfully navigating an audit.

The entire presentation and Kayla’s approach to training small farmers in food safety was designed with the aim of reassuring them that food safety would not, really, require farmers to do much more than they already were in the normal operation of their farms. She also carefully cultivated the appearance that farmers themselves can take ownership of food safety on their farms; through her repeated advice to “just say what you do”, she built them up as valued experts in their own right. In short, she presented food safety on their terms and appealed to their self-pride. Such an approach makes strategic sense for a trainer, since small farmers frequently approach food safety information sessions with the attitude that the monetary costs, labor time, paperwork, and precautions are neither appropriate nor necessary for their scale of operation. Small farmers are often also acutely sensitive to any attempts by agribusiness or big government to ‘push them around’ and marginalize their activities and worldviews, so it was very important for Kayla to reinforce their sense of autonomy and independence in performing food safety work.

Skepticism toward rules and standards that are written by and for the “big guys” featured as a central topic of conversation in another focus group I attended in November 2013, this one convened among small-scale Latino farmers associated with the Agriculture and Land-Based Training Association, most of whom were training to transition from working in the fields as a hired hand to starting up their own farms. This workshop was conducted entirely in Spanish, the primary language of the attending farmers, and I have translated their words into English here.

“We know what we have to do”, one of the attendees at that workshop asserted. But with all the additional documentation requirements, she wanted to know, “Who is going to do this

work? Because our time is very valuable.” From their perspective, food safety trainings fail to make sense not because of disagreement with or ignorance of the underlying hygienic and sanitation concerns, but because the trainings reflect rules written to resolve problems associated with large-scale growers and handlers and not, as another small-scale Latino farmer put it, “*reglas que de verdad necesitamos*” (“rules that we actually need”). Approaching small farmers and farmers of color as though they have a “knowledge deficit” when it comes to food safety is common, but misguided (J. S. Parker et al. 2012; J. Parker et al. 2016). Small farmers seem to understand food safety quite well. They know that pathogens can contaminate produce through unwashed hands, wildlife, unclean water and all the other myriad sources. But they also understand what food safety means for them as small operators.

“Food safety is, number one, a worry,” one small-scale Latino grower told me. “Worry not only for me as a farmer, but also for the recipient who is going to eat the food.” The small-scale farmers I spoke with readily personalized food safety with a level of thoughtful introspection that the large-scale operators represented in the Train-the-Trainer workshop aspire to instill in their field workers. “We know that if a product arrives at the market already contaminated and manages to make somebody sick, that we will pay,” said another Latino farmer. She continued, “So we are afraid that this could happen.” And they reflect on their own interests as consumers, as well as farmers. “If I go to the store and I buy lettuce—organic or conventional—to me it doesn’t matter if it came from a small producer or a large one,” reflected another farmer. “What matters is that the person washed their hands... [So] there is no doubt that we, as farmers, are going to do everything possible.”

What does concern them about food safety training is whether the rules and expectations put their operations at an unfair disadvantage relative to large-scale agribusiness interests. Their strawberries, for example, compete in some of the same super-markets as major brands. So while the standard food safety training portrays risks and proper preventive behaviors in a one-size-fits-all package, small farmers do not always buy into that narrative: they want to know “where does the risk really come from?”

At one point, to drive the message home, the workshop organizer and food safety coordinator for the farmer collective posed a loaded question: “Who do you think has a higher risk if, let’s say, a bird poops on a lettuce leaf: you all who are harvesting by hand, or the large operators who are harvesting by machine? Who has a better chance of seeing the poop on the lettuce?” The reply immediately chorused back, “We do!” One of the attendees quipped, “*Nosotros lo vamos a ver y ellos lo van a tener*” (“we will see it, and they will be stuck with it”). “Exactly,” the organizer said. “The rules that are being proposed come from the large-scale companies, which [rules] afterward rose to the level of government.” Here she pivoted to discussing food safety rules and requirements, a topic that she has worked on with these farmers in previous sessions, as well, since the organization maintains its own umbrella food safety certification that applies to and covers all the farmers in its training program. To maintain certification—and access to the supermarkets at which they sell their most lucrative crop, strawberries, under a common label—the individual farmers need to be able to pass the annual audits. Under her tutelage, the farmers now accept, as one put it, that “rules are fine, [since] we no longer have to be creative in finding solutions.” Again, the strategy taken by the trainer is to recognize the unique positionality of small farmers, acknowledge the inherent bias of formal food safety rules, but nonetheless drive home the imperatives of food safety culture—to be constantly vigilant, record everything, and strive to continuously improve.

Food Safety for the Organic Producer

In October 2015, I attended the first food safety training organized by California's leading organic certifier, CCOF (California Certified Organic Farmers). Present at the two-day course were organic growers (strawberries, orchard fruits), packers, other handlers, and at least one food safety professional with a tomato processing company. The attendees entered training with skepticism, if not downright hostility: as one of the attendee said, when asked why he signed up, "We were told we have to do this, so we're here". The trainers—a husband and wife team—spent the first hour seeking to overcome this resistance. They began with a video of Pharrell's hit song, *Happy*, because, as the lead trainer put it, "If you're more positive, you can solve problems faster and more creatively. Most people when they think about food safety, having an auditor come, they shut down." Implied was that everyone should be happy to do food safety, encouraging attendees to will away any negative attitude they might feel toward the prospect.

Next came an appeal to the audience on the basis of shared experience and empathy. The husband started off as a small organic farmer before transitioning to organic auditing with CCOF and later food safety auditing through the prominent certifier, PrimusLabs. He continued, "I come from both points of view... [and] never found anything in the food safety rules that would exclude organic. Regardless of what anybody says, the organic systems can be just as safe as the conventional systems". He turned to his wife, who appealed to their pragmatism: "Why should we be happy to do food safety?" She listed four compelling arguments in the form of reminders of the different mechanisms of oversight by which farmers may be disciplined in the case of an actual foodborne illness linked to their farm. First, to protect customers because no grower or handler wants to make their customers sick. Second, because the buyer is always right, and the companies buying produce require certification. Third, to protect growers from lawsuits so that no one loses their family farm or business. And lastly, to follow the law and avoid fines or other sanctions for non-compliance with FSMA regulations.

She stressed each point in turn, beginning by stressing the *urgency* and the pressing public danger of foodborne illness. As an MD with a background in microbiology and public health, she played the role of expert in telling the story. The modern distribution system, she explained, has increased the length of time and the number of handlings between farm and fork, upping the possibility for pathogen transfer and growth. Furthermore, the use of antibiotics in livestock has resulted in more dangerous pathogens. At the same time, society has changed: more people are alive today, but they are not necessarily healthier and many are immunocompromised and thus more vulnerable to foodborne pathogens. Furthermore, there is no kill step for produce—washing in the packing house or processing facility may clean vegetables and fruits, but it does not sterilize them: "The activities we do in the packing house are not a kill step. They reduce the level, but they don't eliminate the problem." And lastly, referring to the techno-institutional surveillance system, there is now "better science", allowing the CDC to track foodborne outbreaks through "genetic fingerprints" faster than ever before: "And they can trace it back to your facility or farm. Bad news." With 1.5 million civil suits in the US per year and an increasing number of lawyers "all looking for work", farmers are always in danger of a lawsuit. "If you ever find yourself in court, you have to have a written record. You've got to write it down."

"So," asked one attendee, "we just live with that risk?"

"We do the best we can," she responded, "to reduce the risk to an acceptable level."

The trainers stressed the importance of having a good defense in the case of a court trial over and over throughout the workshop. My favorite phrase, said the male trainer, is “If it’s not written down, it didn’t happen.” “In a court of law, if anything ever happens, worst case scenario, they’re going to be looking for written evidence. If you go into the courtroom and tell your story, bring in character witnesses, whatever, it won’t matter. If it’s not written down, it didn’t happen. You’ll be dead”. So the primary purpose of the training, as he put it, was to train attendees to create and implement a strong food safety plan: “A food safety plan provides documented evidence that you are actively taking precautions to ensure your food is safe.”

The trainers reinforced the urgency of taking precautions by reminding the attendees that, “Even though you’re doing all the same things on your farm that you’ve always done, that doesn’t mean that there can’t be a problem... There is a risk to consumers, and we want to do everything we can to have a food safety program that will reduce those risks to the absolute minimum that we can reduce them to.” So despite best efforts, some risk to consumers—and ultimately to growers and handlers themselves—will persist. This messaging echoes the hazard mastery paradigm imperatives of constant vigilance and continuous improvement while personalizing these imperatives through the specter of liability.

The trainers urged attendees to remember that if, called into court, “you’ll be dead if you’re skimping on the treatment or trying to bypass rules”, especially if there is an outbreak or death. “To me,” the trainer reiterated, “it’s way more important to have a strong food safety program than to meet some regulations, to do the best we can so people don’t get sick and we don’t lose our business or go to jail... because if anything bad ever happens and you get called into court, you want to be able to say to the people in the courtroom that you did your job right.” And the best way to demonstrate that “you did your job right”, he continued, is to provide documentation. “If it’s not written down, it didn’t happen,” as the saying goes in the auditing world. “A food safety plan provides documented evidence that you are actively taking precautions to ensure your food is safe,” and furthermore, it looks “professional.” The implication, of course, being that mimicking the form of food safety practiced by the large-scale farms and their corporate buyers is the only way to be a “real” player in the farming game.

Modes of Acculturation

Each of the above examples of food safety training reveals moments of resistance to acculturation as agrifood operators and workers react to the displacement of existing cultures, values, priorities, knowledges, and relationships. The strategies deployed to overcome or subvert these resistances are manifold: from the threat of a lost job, bankruptcy, or jail time to the promise of better pay, tighter teamwork, and the simple satisfaction of having simply done the right thing, trainers demonstrate remarkable flexibility and complexity in the modes of acculturation deployed to enroll actors into the food safety apparatus. Analyzing these strategies provides insight into how consent is manufactured through training and socialization.

The first counter-resistance strategy apparent from the above examples is to stimulate anxiety among industry actors by pointing out the nearly endless number of ways that pathogens can contaminate food products on the farm, the packing house, and other locations along the supply chain; they draw directly upon the urgency of public danger produced by the “sewer state” and its techno-institutional surveillance and detection network (see Chapter 2). For growers, this may be illustrated through stories of contaminated water (irrigation, flood, or wash water), animals (even birds and insects), employees (who might be sick, forget to wash their

shoes, or fail to properly wash their hands), equipment and tools, soil amendments, and so forth. For indoor facilities, such as packing houses or processing plants, accounts of the tenacious persistence of biofilm-forming bacteria such as *Listeria* reinforce the perception that contamination could spring from literally anywhere in the operating environment. The effect is to raise the threat of contamination to the top of the priority list.

The second strategy is to make public danger personal. For owners and operators, connecting the proliferation of food safety hazards to potential consequences such as damaged reputations, expensive recalls, bankruptcy-causing lawsuits, revocation of operating licenses and even criminal proceedings drives this point home through coercion. Appeals to pride, innovation, altruism, building positive public relations, and comparing favorably to rival companies can spur acceptance via conversion. On the side of managers and workers, coercion and conversion are wielded through different sticks and carrots. Many examples were brought up in the train-the-trainer case, but the strategy is evident even more explicitly in training documents. To give one example, the first module in the Arizona LGMA training kit, which closely mirrors that of the CA LGMA, directs trainers to pose the following rhetorical question to workers:

What would happen to this company and to your jobs [if there is an outbreak caused by leafy greens]?

The ranch would close and workers in the leafy greens industry would be laid off because people could not buy the product. This means that you and your family would be directly affected by a leafy greens outbreak. (AZ LGMA 2010).

Through these strategies, food safety acculturation individualizes the accountability for foodborne illness and outbreaks experienced at the population level, pushing the responsibility of control onto operators and workers who can only stay ahead through continuously heightened vigilance. Combined with the sense of constantly proliferating hazards, this produces the effect of a compliance treadmill⁶⁹, where actors have to run just to stay in place.

Consignment to the treadmill is further reinforced by subtle devaluation of the tacit, experience-based knowledge held by practitioners, whether they be owners, managers, or workers. Workers, for example, are expected to adhere to the chain-of-command:

Do not improvise. If you are not sure about something, talk to your supervisor. If you see something wrong, immediately let your supervisor know about the situation. (AZ LGMA 2010).

The implication is that their tacit knowledge is inferior, and when in doubt they must defer to the higher-order knowledge of their superiors, who in turn defer to the expertise of off-site food safety professionals, whose authority ironically increases proportionately to their distance of remove from the farm field. The universal imperative to document any and all food safety related activities also undermines the authority and credibility of operators' context-specific, situated knowledges. The need to write everything down, to always be able to account for one's decisions and actions to an auditor or inspector delegitimizes years of experience, personal relationships, and good judgment as grounds for trust. Safety, authority, legitimacy are all displaced to locations outside the level of the operation, meaning that external experts crank the treadmill. When they say run, the only response left to operators is to ask, How fast?

A Core Tension

From this analysis of modes of acculturation, it is evident that food safety trainers employ strategies of counter-resistance ranging from outright disciplinary coercion to “soft” cultural conversion. All of these examples of resistance and counter-resistance, however, stem from the same underlying friction: food safety acculturation is a process of constantly navigating the tension between a techno-scientific imaginary of control and a political imaginary of free agency.

One central contradiction embedded within the apparatus relates to the perpetual problem for liberal democratic government—how to strike a balance between the liberal commitment to *individual* free action and the *collective* desire for public order which gives rise to the desire for control. Traditionally, science offered a coherent basis for good government by rendering citizens and the aggregate effects of their actions ‘visible’ to government, which allows for central planning and goal-setting; at the same time, science claimed to ward against arbitrary abuse of state power by tying that power to the now visible, therefore transparent, ‘objective facts’, to which citizens can in turn hold government accountable (Ezrahi 1990).⁷⁰ The technical standards produced by the elite epistemic community described in Chapter 4 are an example of this type of arrangement between science and the state. However, citizens as rational actors within this arrangement are also free to dissent, to be “skeptical reflexive observers” (Ezrahi 1990, 127) who may question the validity and appropriateness of the underlying ‘facts’ as presented by the experts—the “decline of coherence as a norm or an ideal of public action” can result (ibid, 283). In other words, empowering people (like farmers) to voluntarily accept standards as a rational basis for action *also* empowers them to reject standards and question expert knowledge. From the perspective of powerful elites—government regulators, big agribusiness, food safety experts—empowerment is thus a double-edged sword.

The god-trick and the Prometheus-trick are strategies for these elite actors to protect themselves from this danger to their authority and power. Evidence of the first imaginary can be seen in the general approach to food safety training as a matter of correcting a perceived “knowledge deficit” among agrifood operators and workers (J. S. Parker et al. 2012): the hazard mastery paradigm and its expert proponents possess a knowledge that is produced as universal through a god-trick. Within this imaginary, only this expert knowledge is evaluated or important, and there is a clearly implied hierarchy between those who hold the knowledge and those who need to learn it. The second imaginary, meanwhile, originates from the apparatus’s entanglement with the neoliberal subjects who must be governed only at a distance, and “with the grain”. Such subjects—in this case managers, trainers, foremen, workers—must be free to autonomously decide and act, a role not wholly possible under a strict hierarchy. Evidence of this imaginary slips through in advice not to condescend to workers and in admissions, such as that quoted above, that “Farmworkers are extremely skilled, and their experience and knowledge can be refined to reduce risk at the point of harvest.” So food safety acculturation must walk a knife’s edge between these two imaginaries, both upholding the sanctity of the hazard mastery paradigm and its sociotechnical imaginary of control via discipline *and* empowering the neoliberal subject to self-govern as envisioned in the political imaginary of free agency. In short, there is a discipline/empowerment paradox.

On the one hand, farmers and farm workers are empowered to decide how to implement food safety in the unique settings of their fields and farms; we have seen the way that trainers frame food safety culture to legitimize the unique knowledges and experience that practitioners bring to food safety. On the other hand, farmers and workers must still comply with the rigid

structure of discipline and control, must still worry about passing audits and protecting themselves with paperwork, and so despite their apparent freedom to perform food safety work in the ways they best see fit, their discretion is actually sharply delimited by the apparatus. These constraints are normalized, however, because of how they integrate with existing power relations within agrifood supply chains. Food safety pressures are simply folded into the existing market forces and contractual arrangements through which produce buyers (supermarkets, wholesale brands, foodservice providers) already exercise control over many, if not most, produce farms. In short, food safety exerts a new power to shape farmer and worker behaviors and worldviews as they are acculturated to the mastery paradigm, but this power is filtered through and disguised within existing supply chain relationships. Thus, the Prometheus-trick can be formulated as embedding the universal knowledge of the hazard mastery paradigm within the decisions and actions of actors, such that this knowledge appears to emerge spontaneously as a result of their own agency, rather than as a result of strict command-and-control hierarchy. However, those people that cannot convincingly pull off the “trick” are relegated to the realm of deviance, which is the final subject of this chapter.

Difference as Deviance

Whereas in the past standards were used largely to standardize, they are now also used to differentiate—among people, things, and processes. (Busch 2011, 199).

Food safety acculturation drives simplifications—economically, ecologically, cognitively and socially—because under this governmentality, dimensions of difference can only be understood as forms of deviance. I will return to ecological and landscape simplification in Chapter 6, but for now I will focus on the ways in which control-through-standards epistemologically excludes groups of people and categories of organization that cannot perform to the ideal-typical specifications of abstract safety. Those who are excluded must either bend themselves to conform, exit the industry, or find a way to persist in the shadowy interstices of the apparatus’ grid of control.

Farm Consolidation and Homogenization

The process of food safety acculturation is linked to what Power (2007) calls a “logic of opportunity” that emerges from the general embrace of risk governance as a mode of organizing markets and societies. In particular, he notes how this logic of opportunity gives rise to new forms of organizational actor and corporate agency:

The explosion of organizations in recent years corresponds to a new conception of organizations as actors which are complex, confident, and responsible. A mass of standards for organizational behavior, including codes of corporate governance, supports an increasingly ‘self-reflective and self-improving’ organizational actor. This moral flavor to the logic of opportunity also imagines organizations as capable of facing and managing uncertainties in a rationalized way. (Power 2007, 23).

This logic operates through the empowerment of organizations as agents of history in their own right, an empowerment derived from the need of the State to designate a lower-level entity to which the day-to-day responsibilities of knowing and controlling risks can be devolved. Thus food safety culture can be seen as a mechanism of “organization-making” much in the same way as government-backed food safety regulation is a mechanism of state-making, allowing the

neoliberal state to reproduce its own legitimacy in the face of crises of its own making (Dunn 2007). However, the organizational agency legitimized under a risk governance paradigm is of a particular type—large, centralized, hierarchical—that in its ascendance displaces other modes of growing, harvesting and distributing produce that are small-scale, decentralized, or more horizontal in structure. Food safety culture operates to render farming legible to the State by subsuming the category of “farm” into the more generic category of “organization.” This process builds onto the industrializing trajectory of agriculture and the equation of farms with factories (Fitzgerald 2003), a key driver of farm consolidation and homogenization that leaves only large-scale, vertically integrated organizations in the agrifood business.

Available evidence points to the conclusion that “food-safety regulations favor large businesses over small companies and push growers toward farm models that may align poorly with emerging markets for local and sustainable produce” (Karp and Baur et al. 2015). Such a trend would be in keeping with past experience. As Wendell Berry pointedly remarks in *The Unsettling of America*, “We have always had to have ‘a good reason’ for doing away with small operators, and in modern times the good reason has often been sanitation, for which there is apparently no small or cheap technology” (Berry 1977, 41 [1997]). In the parallel case of the meat industry, after USDA’s Food Safety Inspection Service required meat processors to adopt HACCP-based food safety systems in the mid-1990s, many small-scale processors were priced out of the new regulatory landscape and exited the industry (Wengle 2015; Dunn 2007; Dunn 2003). As Knutson and Ribera (2011) contend, the same fate could befall small-scale produce farmers and local distribution channels, despite the exemptions provided to small-scale farmers distributing to local markets under the Tester-Hagan Amendment to the 2011 US Food Safety Modernization Act. FDA’s own estimates of the economic impact of rule-making mandated by the law predict that, in the first 7 years of regulation under the Produce Safety Rule (80 Fed. Reg. 74353), large farms will pay only 1.2% of their total annual sales (avg. \$2.65M) while small farms (avg. \$320k) will pay 6.4% and very small farms (avg. \$75k) will pay 11% (Karp and Baur et al. 2015).

The Tester-Hagan amendment to the FSMA ostensibly protects a certain class of small, local farm. However, this creates a bifurcated food system that can silo small farms into a future on the margins. The exemption is predicated on annual gross sales that add up to less than \$500,000, which creates an artificial ceiling on the growth of farms specializing in local direct sales. The exemption also sows the seeds for assessing food safety through the lens of scale. Once a small-scale type of farm is reserved for the margins, that marginality will lead to increasing pressure to conform to the conventional food safety mold or make them sell out. Bifurcation does not produce a “separate but equal” system for food safety, it creates a separated hierarchy judged along the food safety continuum, of which there really can be only one. It is common to hear larger growers, processors, or food safety professionals belittle the professionalism of small farmers, claiming that operators of smaller farms lack the requisite education, training, resources, time or diligence to adequately ensure food safety.

Take, for example, the statement of the food safety manager at a mid-sized (~1,200 acres) organic farm: “I would never buy produce from a farmer's market or farm stand like that [pointing to a dilapidated market on the side of the road]... mom and pop deals, they're just not testing their water, training their people, not getting their paperwork... *safe, quality food comes from medium to large producers*” (emphasis added). Or the assertion by a food safety consultant, given to a class of undergraduate food science students, that “I will never eat anything out of a farmer's market. Personally, I'm going to buy produce at Safeway.” This is not a universal

sentiment, nor one that is unchallenged, but it is a line of argument advanced by many of the larger interests in the fresh produce industry, and one they clearly believe will resonate with policymakers and the general public. The danger, to quote James Scott (1998, 7) is that “Radically simplified designs for social organization seem to court the same risks of failure courted by radically simplified designs for natural environments.”

Simplifying Culture, Denying Metis

Food safety acculturation seeks to render agrifood actors and operations legible to the overseers of the food safety apparatus—the auditors and inspectors who monitor compliance—by simplifying and standardizing worker behavior and incentives to align with the conditions of control: constant vigilance and continuous improvement. However, the “Prometheus-trick” covers up the underlying truism that “formal order... is always and to some considerable degree parasitic on informal processes, which the formal scheme does not recognize, without which it could not exist, and which it alone cannot create or maintain” (Scott 1998, 310). Paradoxically, food safety acculturation “ignore[s]—and often suppress[es]—... the practical skills that underwrite any complex activity”, what Scott refers to as *metis* (ibid). Food safety culture denies the authentic metis that farmers and farm workers have earned over years and often decades of experience growing produce on a particular farm, supplanting it with formal training manuals, task logs, self-audits, and laboratory tests. Of course, eventually this work will inevitably produce a new metis, but one that is attuned more to the monotonous beat of bureaucracy than the complex rhythm of living farm fields and vibrant farm culture.

As I argued in Chapter 4, the work performed by standards in order to normalize a certain type of best practice spills over to normalize a certain type of *person* as well. People can be a food safety hazard in their own right, both by directly transmitting pathogens to food (recall the hand-washing exercise described in Box 1) and also through negligence and dereliction of their ‘duty’ to maintain the conditions of control. Anyone not fitting or incapable of performing conformance with this normal “kind” is by default a potential risk factor, a dangerous deviant, and a ‘bad actor’. Safety is laced with moralizing language; it is no coincidence that one of the pillars of food safety in agriculture is called *good* agricultural practices. This is not a new finding, as there is a long tradition of scholarship looking at the entanglement of politics of difference with questions of safety and purity (e.g. Bobrow-Strain 2012; Minkoff-Zern et al. 2011; Freidberg 2004). The normal, from which derives the norm, is established in contrast to the abnormal; it is the abnormal upon which normalization acts. It is a short jump from different to abnormal, and from abnormal to deviant (Foucault 2007, 62–63).

And the normal for agriculture in America, and California especially, is racialized and gendered (Ayazi and Elsheikh 2015; Alkon and Agyeman 2011; Holmes 2013; Mitchell 2012). Suspicion weighs far more heavily on food produced by non-white and immigrant farmers and farm workers, especially when they do not speak English or even speak it as a second or third language. People in elite positions who can speak authoritatively about food safety tend to use demographic differences—race, ethnicity, language, literacy, and citizenship status—to identify *who* is posing food safety risks, and therefore who needs to be controlled as a potential hazard or harbinger of hazard.

At one point during my fieldwork, I found myself chatting with the food safety manager for a large Central Coast leafy greens grower about the often overlooked food safety risk stemming from people intruding into fields. I mentioned a particularly unusual case I encountered while visiting a small farm in the Central Valley, which was located at the edge of a

rapidly expanding town and across the street from a sprawling housing development. As the farmer showed me around his fields, I noticed a pile of used condoms dumped unceremoniously at the end of one of the rows. Now at this point, I hadn't mentioned that the farmer was a person of color, an immigrant from Southeast Asia who spoke English as a second language. So I was surprised at where this food safety manager took the conversation next:

There is, and I don't want, um... I don't want to blame any culture, but I think there is an education difference and a cultural difference too in some of the Hispanic culture, people you know... and probably those that are newer to the country. 'Cause if you go to Mexico, they don't have a garbage, uh, a garbage collection system like we have, really. So I don't know if people don't realize it... um, but we had taken a bunch of legislators to look at the river, talking about river flooding and the opportunity to get in the river and do some channel maintenance, and when we looked over the bridge, somebody had thrown baaags of dirty diapers over it. And there was just dirty diapers all over the place, like right next to the river... And everyone went oooh, you know, just sooo baaad.

Later in the same interview, after the interviewee had just been telling me about an instance in which she caught “some of the guys” broadcasting poison bait in the river basin next to the field, she brought up a similar sentiment with respect to the relationship between food safety management and social difference, calling into question the “critical thinking” capabilities of farmworkers, the majority of whom have immigrated to the US from Central America to do this agricultural work:

A lot of the guys out here their education level is like maybe third grade or sixth grade and so you think sometimes too what you're telling them makes a lot of sense but their critical thinking skills and their ability to understand is really different...

These sorts of observations, often invoking the “otherness” of field workers, encode a tacit equation of difference—whether in race, ethnicity, or language—with danger. Just as “Hispanic culture” is associated with the judgment “sooo baaad” when viewed through the food safety culture lens, agricultural laborers are viewed as inferior because of their ethnicity and foreign origin make them different from the mold of the ideal food safety worker. Their riskiness is highlighted over their agency, exposing the lie of the Prometheus-trick: it is not within the power of *all* people to pursue safety in the way that best suits their operation.

Many “other” types of farm and farmer may be excluded through more round-about structural requirements of food safety. To return to a theme from Chapter 4, For example, FDA's stated tolerance for flexibility in its Produce Safety Rule seems open to accepting alternative knowledges, or metis, around risk and safety and capable of accepting alternative food-ways. But paper and practice frequently do not match up. Under the current rule, for example, a soil amendment is *untreated* if it has not “been processed to completion to adequately reduce microorganisms of public health significance in accordance with the requirements of §112.54.” Turning to §112.54:

A scientifically valid controlled physical, chemical, or biological process, or a combination of scientifically valid controlled physical, chemical, and/or biological processes, that has been validated to satisfy the microbial standard in §112.55(b) for *Salmonella* species and fecal coliforms. Examples of scientifically valid controlled biological (e.g.,composting) processes that meet the microbial standard in §112.55(b) include:

- (1) Static composting that maintains aerobic (i.e., oxygenated) conditions at a minimum of 131 °F (55 °C) for 3 consecutive days and is followed by adequate curing; and
- (2) Turned composting that maintains aerobic conditions at a minimum of 131 °F (55 °C) for 15 days (which do not have to be consecutive), with a minimum of five turnings, and is followed by adequate curing.

In addition, both of these scientifically valid composting processes only count if farmers also keep records and documentation that each of these provisions have been appropriately followed. In other words, it is not enough to compost a biological soil amendment according to these prescriptions; a farmer must also be able to prove it on paper.

At the current moment, FDA is composing a risk assessment for *untreated* biological soil amendments, including raw manure. Under the existing definitions of what it means to be “treated”, any amendment that does not meet the above criteria for both process and record-keeping would be considered raw. But do all farmers have adequate and affordable access to biological soil amendments that meet this narrow definition of “treated”? One of the attractive aspects of manure—and biological soil amendments in general—has been that they are relatively cheap and easy to acquire locally relative to synthetic fertilizers. On the ecological side, they are also more sustainable along a variety of dimensions, including resource intensity and soil health. Yet although the rule in theory allows farmers to use any “scientifically valid” treatment method, the barriers of demonstrating scientific validity are high (recall from Chapter 4 that the average cost of a CPS research project is \$168,000). In effect, they are excluded even though it appears as though FDA is opening a door for them to access the regulation. Here, then, we see the dual operation of the god-trick and the Prometheus-trick to disenfranchise and exclude small-scale producers all while covering up the underlying politics and power-relations at play. The exclusion of ‘deviants’ thus appears inevitable, normal, natural—the trick has been pulled off.

Conclusion

While acculturation is a powerful tool, it still allows for deviance, resistance and subversion. The role of discipline—whether by US Marshalls and federal prosecutors pressing criminal charges, by liability lawyers suing for damages, by powerful buyers threatening to purchase from someone else, or by “bosses” further up the chain of command within the farm organization—is ever-present, a sinister shadow that stalks the glowingly positive and seemingly empowering rhetoric of food safety culture. While the resulting human toll can be high in terms of stress due to bureaucratic tedium, anxiety over the possibility of discipline, or simply the loss of satisfaction with farming good food for people to eat, the final consequences of food safety acculturation do not stop with behavioral modification. The whole point of training and discipline is to control people so as to make them control contamination and its potential pathways. Material ecosystems and biophysical processes demand attention as the conditions of control must be inscribed into the land itself in order to maintain the illusion of mastery demanded in response to urgent public danger. At stake as well are the broader health, sustainability and resilience of both human and natural systems, which may be vulnerable to systemic risks and “food-system-borne illnesses” created and perpetuated by the apparatus itself (McMahon 2013; Stuart and Worosz 2012). In the next chapter, I turn toward this concern by analyzing the frictions that arise when formal food safety attempts to enroll non-human actors—landscapes, ecosystems, wildlife—into the network of control, and the thorny dilemma this creates for growers in translating ‘purity’ onto the babel of materiality.

6. TRANSLATION AND BABEL IN THE FIELD

In this chapter, I turn to the ways in which food safety standards do not only acculturate farmers and farm workers, but subject them to a disciplining power that works to simplify, sometimes violently, complex ecological and social diversity. I will explore the complications that arise as the formal, abstract knowledge encoded in standardized food safety procedures collides with the local, tacit knowledge and material realities of farming on the ground. At stake is the simplification of farming landscapes and agroecosystems under the totalizing “anonymous power” that standards exert to organize people and nature (Busch 2000). In Ch. 5, I examined how proselytizing food safety culture in the produce industry simplifies *people* by enrolling workers as self-disciplining subjects, reducing their autonomy, destabilizing their tacit knowledge, and further obscuring the nexuses of power and authority in the food safety apparatus. In this chapter, I examine the ways in which farmers and farm workers must nonetheless absorb the frictions that emerge as food safety standards meet the unruly liveliness of open-air vegetable fields.

I treat standards as aspirations to universalism, to draw on Anna Tsing’s theory, and specifically a universalism envisioned through mastery. When inscribed in what I call the *world of paper*, these aspirations become uprooted from their situated origins, allowing them to travel widely. But they can never really act until they become re-rooted “in the sticky materiality of practical encounters” (Tsing 2005), in other words, until they meet with friction in the *world on the ground*: “Friction gives purchase to universals, allowing them to spread as frameworks for the practice of power. But engaged universals are never fully successful in being everywhere the same because of this same friction.” (ibid, 10). Constant tension between the untidy materiality and unruly liveliness of farm fields and the ordered logic and conditions of control encoded in regulatory texts both justifies and reinforces the exercise of standardized power to bring fields that are perceived to be in disarray under order and at the same time threatens the carefully maintained illusion of control by “refus[ing] the lie that global [or universal] power operates as a well-oiled machine” (Tsing 2005, 6). Only at the field level can we observe that under a literally paper-thin veneer of comfort and control, a Babel reality seethes constantly. Disparate social objectives and worldviews clash, and it falls to growers to maintain the illusion of problem closure in the face of fundamental incompatibility between safety-as-purity and sustainability-as-diversity: abstract intentions combine with material agency to drive the unfolding history of agrifood systems. What can closer attention to this Babel tell us about the exercise of power within the industry and its broader food safety governance network? What might an imperative to constantly repress such jostling worldviews mean for resilience, justice, and sustainability among diverse growers and landscapes?

Drawing heavily on my field work with farmers in California’s Central Coast and the desert growing regions in Imperial Valley (California) and Yuma (Arizona), I focus on the institution of the “field audit”, the moment at which the bureaucratic world of paper—comprising documents, rules, standards, metrics, SOPs, guidelines, thresholds, certifications, reports, and so on—“grips” the people and landscapes that together cultivate and produce fresh vegetables. Paying special attention to the necessary friction of this grip, I attend to moments of translation—and moments of Babel—as growers, field workers, and auditors perform the ever-awkward, ever-unfinished work to reconcile the aspiration to pure food with the grounded experience of growing food in the dirt. While I tell a cautionary tale of the dangers that standards

aspiring to universal control pose to ecosystems and to social justice, I also seek to reveal the cracks in the monolithic black box of the food safety apparatus. Friction, Tsing reminds us, “sometimes inspires insurrection”.

Interlude: The Moment of Auditing

Agustin⁷¹ and I are driving in his pickup truck, my notes barely legible as I try to write around the constant jostling as he navigates the ruts and potholes of the dirt access road. He’s explaining how the last audit was supposed to include this field, but a freak rainstorm in the otherwise arid Imperial Valley made the road nearly impassable. I look back through a cloud of dust at the auditor’s less robust sedan following us—it wouldn’t take much mud to mire it.

The three of us are headed to the field inspection portion of a standard food safety audit for farmers growing leafy greens such as spinach or lettuce. Agustin and I, along with Colleen (another food safety manager for the farm), have already spent two hours with Eugene (the auditor) back at the main office, pouring over a conference table’s worth of papers—standard operating procedures (SOPs), training records, laboratory test results, satellite images, and hand-written logs from the foremen of the harvest crews—each of which Eugene patiently compared against his standardized checklist, or “scheme” in the industry parlance. While overwhelming to me, navigating the seeming labyrinth of papers was routine for them, and they chatted sociably during the entire process, exchanging jokes and the latest gossip about shared acquaintances.

The paper portion of the audit proceeded smoothly, and we left the office expecting to wrap up the field inspection quickly. Usually this would include observation of the harvest process, but the two fields selected for the audit are planted with baby greens, which are only harvested at night.⁷² So today’s field audit will just be a perimeter check to verify visually that what’s written down in the farm protocols appears to be followed on the ground. Eugene will be looking primarily for evidence of good field sanitation (e.g. properly maintained toilets and washing stations), proper management of irrigation water, potential hazards from adjacent land uses (e.g. runoff from a cattle feedlot), and “animal intrusion” from wildlife or domestic animals (see Figure 19).

There was not much to see at the first field, and after jotting down a few notes Eugene signaled for us to proceed to the last field, which Agustin and I are now approaching with Eugene in tow. We pull up next to a “portable” (a port-o-potty), which Agustin knows Eugene will want to inspect. After a brief check, he gives the field a cursory glance-over. Everything appears to be in order, but he wants to see one last thing—the location where the field managers collect samples of the irrigation water, which must regularly be tested for *E. coli* and *Salmonella*. Imperial Valley agriculture depends entirely on irrigation, and it is common practice to take water samples at the sluice gate for the canal. In this case, the sluice gate is located about half a mile away, near a distant stand of trees which Agustin points out to me.



Figure 19. In addition to traps, bare dirt buffers, fences, and regular inspection for tracks and feces, signage is required to keep pets or livestock away from fields and also to serve as a constant reminder to anyone present—employee or visitor—to be alert and on the lookout for animals in or near the leafy greens, in this case baby red lettuce in the background on the right.

We climb back in the vehicles and drive over. As I open the passenger door, the air is filled with a cacophony of bird chirps: a flock of blackbirds hundreds strong are flitting back and forth in the branches, directly above the canal. I watch Agustin’s face as he takes in the situation; he is silent, but I can see the “oh shit” in his eyes. Eugene pulls up behind us and gets out, and it’s clear that the birds immediately grab his full attention. “Are these birds low, medium or high hazard?,” he asks Agustin. “High,” responds Agustin, as there is no buffer other than an access road between the trees and the adjacent field of baby red lettuce. The presence of the flock means Agustin needs to perform immediate corrective action, even in the middle of the audit. Each man retreats into his own thoughts for several moments, and I imagine their mental gears shifting as the audit departs sharply from the routine.

The jovial atmosphere has sobered, and a palpable tension is building between the two men. Eugene excuses himself; he needs to make a phone call to his superiors. “There’s just a massive amount of birds here,” I overhear him say as the call, which will last another fifteen minutes, begins. Meanwhile, Agustin makes a call of his own. Technically, this field is under Colleen’s oversight, and he has to let her know about the birds and that Eugene has seen them and is calling it in. The call to Colleen is quick, and Agustin is shaking his head when he hangs up. She is headed over with some “bird bangers” (basically firecrackers) to scare off the birds, but it will take her a while to get here.

To occupy himself and to appear proactive, Agustin takes a black garbage bag out of his truck and begins picking up a large pile of trash that someone has left under the trees. Eugene thinks the birds are here because of this trash, he says. He told Eugene that someone comes by every afternoon to pick it up, but he thinks Eugene doesn’t believe him. Even though Agustin

clearly believes there is no connection between the birds and the garbage—I tend to agree on this point, as it looks to me like the birds have gathered to wait on the adjacent alfalfa field, which is being mowed and promises to stir up a feast of insects—he wants to demonstrate to Eugene that he’s taking immediate steps to remedy the “high hazard” situation.

When Eugene gets off the phone, Agustin confronts him. What did his superiors say? Are the birds going to be an issue? Is Eugene aware that this particular field is not technically part of the audit? Eugene says his superiors are concerned, and mentions a “red flag”, alluding to the possibility of a major deduction from the final audit report. This is like throwing down the gauntlet—such a finding, if it makes it into the report, will surely damage the farm’s reputation and cause friction with its customers. Agustin assures him that such a flock of birds has never been seen in these trees before, that it is a freak occurrence. Moreover, he urges Eugene to actually look at the leafy greens field—not a single bird has entered in the half hour we have now been here, he says. Eugene is skeptical. What about the black plastic covering the canal? It runs under the trees and along the edge of the field (Figure 20). Clearly somebody saw a problem here before, he points out, or there would have been no need to cover the water with the plastic. The water has always tested perfectly, returns Agustin, it is clear if you look at it. According to Agustin, the plastic was installed to mollify a zealous customer who worried the trees might drop detritus into the water, not on any evidence of actual animal intrusion or contamination.



Figure 20. Black plastic cover the irrigation canal next to the field of baby red lettuce (visible beyond the trees). The picnic tables just visible to the right, which are used by field workers, are the likely source of the accumulated trash.

It is unclear where their exchange might have gone from there, for at this point the flock of birds rose as one and moved to the alfalfa field (confirming my prediction). With the “hazard”

abruptly flying off, as birds will, the tension ebbs and Eugene backs down and refrains from pressing the issue. He has to write his observation of the flock into his report, he tells Agustin, but he will note clearly that the plastic was in place to protect the water supply, no birds were observed among the greens, and the flock had left and not returned. By the time Colleen arrives in what might be termed a fine mettle, ready to go toe-to-toe with Eugene and challenge any red flags he might wave about, he has clearly decided against escalating the incident further. As she prepares to give him an earful about citing hazards on a field that he wasn't auditing, he hastily extricates himself on the claim that he needs to get to his next appointment. Agustin facilitates the egress with a well-timed request to speak with Colleen off to the side.

Leaving Colleen to direct the remainder of the corrective actions at the stand of trees, Agustin and I follow Eugene back to the original field to officially conclude the audit, which requires Agustin's signature. "She's pretty angry with you," Agustin tells Eugene as he hands back the clipboard. I know, he says, but it's my ass on the line if I don't do my job. He drives off, and Agustin turns to me. Well, like I said, he tells me, you never know what random shit will happen during an audit.

Identifying and Controlling Animal "Hazards"

Such seemingly disproportionate reaction to real or potential incursions by the surrounding environment and by animals into produce fields is common. How did this intensified scrutiny of the field landscape originate, and how is it legitimated? The scheme on which Eugene based his audit contains no explicit provision with respect to a flock of birds in a stand of trees adjacent to a field. Rather, the Field Observation section of the audit checklist includes a heading for "environmental factors" (Figure 21). The priority, judging by the first question, is to ensure that animals have not defecated on the crop, but the secondary question, "No evidence of animal hazards in the field?" (FO 03a, Figure 21), presents a more ambiguous requirement. According to the California Leafy Greens Marketing Agreement (CA LGMA), an *animal hazard* is defined as "Feeding, skin, feathers, fecal matter or signs of animal presence in an area to be harvested in sufficient number and quantity to suggest to a reasonable person the crop may be contaminated" ([CA LGMA] California Leafy Green Products Handler Marketing Agreement 2016). Prior to each season, the food safety manager for the farm is responsible for evaluating each field for animal hazards "that may present a risk to the production block or crop" (ibid). At harvest, the manager or designated foreman is expected to again inspect the field with special consideration for the identified risks and reassess the hazard level.

Audit Checklist		
Field Observation		
Page & Line #/s	Question	Comments
Water Use		
	FO 01 - Are all active and inactive water sources recorded in the Water Use Audit? FO 01a - From visual inspection, there is no evidence that the water sources and distribution systems may pose a contamination risk (damage, inadequately maintained, evidence of animal activity, connection with effluent systems)? FO 01b - No other observations of improper use of water	
Soil Amendments		
	FO 02 - No evidence of undocumented use of soil amendments? FO 02a - No evidence of improperly applied soil amendments? FO 02b - No evidence of improperly stored soil amendments? FO 02c - No other observations of improper use of soil amendments	
Environmental Factors		
	FO 03 - No evidence of fecal contamination in the field? FO 03a - No evidence of animal hazards in the field? FO 03b - No evidence of non-compliance with distances as outlined in the Environmental Assessment? FO 03c - No evidence that remedial actions such as animal barriers (fences, gates, grates, etc) are not in good repair and operational? FO 03d - No evidence that worker hygiene rules have been violated during the crop cycle? FO 03e - No other observations of environmental risk factors.	

Figure 21. Excerpt from field observation section of the California LGMA audit checklist.

At this point, the fate of the crop and the field rest on the determination of the hazard level. To assist growers in deciding the hazard level, the LGMA guidance provides a branching decision tree.⁷³ Importantly, factors determining the hazard level do not solely comprise physical evidence of animals in the field, but also include general characteristics of the animals, specifically: whether they aggregate (i.e. flock), migrate (increasing the likelihood of spikes in animal density), or are capable of transporting pathogens from sources like manure piles or feedlots to produce fields. Thus although the flock of birds we encountered during the audit was never observed to enter the lettuce field, the very fact that the birds were flocking, seasonally migrating, and airborne elevated them to a higher hazard level, at least according to the decision tree.

The hazard level does not solely determine what happens to the crop, however. While a low hazard determination generally triggers minor corrective actions, such as continued monitoring of the situation, even a medium or high hazard may require little more than buffering the affected area of the field with a no-harvest zone. The width of the buffer can be as little as 3-5 feet, and may destroy only a small fraction of the harvestable crop. However, according to the decision tree, “if the area cannot be effectively buffered” the entire block or field may have to be abandoned, representing a major loss of harvestable crop.⁷⁴ An intruding land animal, such as a pig or deer, leaves a well-defined path that can be effectively buffered. Birds, on the other hand, can cover an entire field, calling into question the effectiveness of any attempt to buffer their intrusion or limit their potential for intrusion.

For this reason, following the paper logic laid down in the guidance document, the stakes of a bird hazard can be much higher for the grower—up to and including plowing under an entire field’s worth of crops if the contamination cannot be isolated—than they would be for other “environmental factors”. Even for an operation growing on dozens of sites, losing a whole field is a significant financial hit in light of very tight margins in agriculture; for smaller farms, such a loss could be devastating. Seen in this light, the tension between Eugene and Agustin, and Colleen’s aggressive challenge to Eugene, is understandable as a contestation over putting paper into practice. Agustin and Colleen were reacting to Eugene’s intimation that the field was not “effectively buffered”.

Moreover, the stakes for the grower are not limited to this season's harvest. Should a field gain a reputation among customers⁷⁵ for elevated risk of animal intrusion, the repercussions can haunt the grower for years. A few days before the audit I described, another grower showed me an abandoned field; he no longer used it because his customers didn't like its proximity to a small pond that birds were using for nesting (Figure 22). Recently, one of those customers (a major global brand) had called him up and wondered if he shouldn't be concerned about the field *adjacent* to the abandoned field as well. At this rate, the grower told me, he wouldn't be growing on any field. "Anything gets to Brawley [the name of the area]," he said. Is it going to be, he continued, that "the whole Imperial Valley's prohibited because it's part of the Pacific flyway? At some point, where's the balance? Where do we stop? Unless I'm going to have a greenhouse and grow everything indoors."



Figure 22. A small pond, created when the nearby river overflowed its banks during a flood, in which egrets and seagulls are roosting. The abandoned field is located at the top of the embankment on the left side.

Interrelated Tensions: Safety and Conservation

With the future of entire fields on the line, growers face a stark choice: lose productive land or find a way to conclusively eliminate the animal hazard (in the same way that growing everything indoors would). While the guidance on paper is couched in the language of monitoring, prevention, and corrective action—interventions with seemingly minimal ecological impact—the underlying logic of food safety audits and metrics incentivizes growers to engage in

more directly deleterious on-farm practices. And the known evidence points to the active operation of this logic on the ground.

Initial survey work among growers in California's Central Coast following the 2006 *E. coli* outbreak in spinach (see Chapter 1) revealed that many had been asked to remove non-crop vegetation (i.e. potential animal habitat) and begin trapping, poisoning, or fencing out animals around fields (Beretti and Stuart 2008). "Growers are being put in the unfair position," warned the study's authors, "of choosing between being able to sell their crops or protecting the environment." A study of aerial photographs funded by The Nature Conservancy—which has an ongoing interest in conserving the biodiverse Central Coast riparian and marine ecosystems that are intimately intertwined with farm fields—showed a 13% reduction in riparian habitat in the Salinas Valley (the primary area for growing leafy greens) in the 5-year period following the 2006 outbreak (Gennet et al. 2013). A more recent 2014 survey conducted among California Farm Bureau members found that many produce growers continue to remove vegetation around fields, poison and trap for wild animals, and install wildlife deterrent fences specifically because of a food safety concern (Baur et al. 2016). Removing habitat and destroying animals that might spread pathogens to fields directly impairs water quality, due to the loss of filter benefits from vegetation and increased sedimentation from erosion, and threatens biodiversity (e.g. through poisoning non-target species) (Lowell, Langholz, and Stuart 2010). Indirectly, the "cumulative and synergistic environmental effects related to food safety" (ibid) may have additional, more far-reaching implications that are not well-understood or documented (Karp and Baur et al. 2015).

Journalists have picked up on the emerging controversy of "the war against nature", as one academic article put it (Stuart 2008). Dan Charles, reporting for *National Public Radio* (NPR), aired a piece entitled "Your Salad: A Search for Where the Wild Things Were" in April 2012, followed up by "How Making Food Safe Can Harm Wildlife and Water" a few days later. A transcribed excerpt from the first piece reads:

But many environmentalists, and even some vegetable growers, believe that this campaign for food safety has also been reckless and sometimes needlessly destructive. Among them is Bob Martin, general manager of Rio Farms, in King City [Salinas Valley]. Martin grew up here and has grown vegetables for nearly his whole life. He doesn't call himself an environmentalist, but when food safety experts from the big food buyers told him to clear away vegetation on hillsides, he refused. "People know me as a fighter; I'm not going to give in to everything," he says. "It goes against my nature to have the scorched earth policy. To have bare banks, so every time it rains you've got to bring in a bulldozer and push the dirt back up. Makes no sense! Erosion control is a healthy thing and it's necessary." What really gets him frustrated are demands that seem contradictory or even self-defeating. For instance, he always liked having hawks or owls around, because they help control the mice. But now, those birds are seen as a threat, too. "I mean, it's frowned on to put up an owl box. The food safety people say, 'Owls poop, too.' OK. But what do they poop? They poop out the mouse that you didn't want in your salad!" Martin says. "Everything we do is conflicting! It seems like we can't do anything right!"

Variations of Martin's story abound. Every grower I have interviewed in my research has protested, with varying degrees of intensity, a senseless—from their perspective—request made of farmers in the name of food safety. At the field level, a clear conflict exists between the

conditions of control recognized under the hazard mastery paradigm and the lively diversity and stubborn autonomy of ecosystems and the land itself. The one-two punch of the god-trick and the Prometheus-trick enable expert technocrats to largely ignore the characteristic frictions created at the outermost edges of the food safety apparatus, however, meaning that the need for people on the ground to work with these frictions is never formally recognized in guidelines and standards. As I argued in Chapter 5, because the official narrative of food safety turns a blind eye to the impossibility of uniformly controlling all potential routes of contamination in actual fields and facilities, it discounts the skill and expertise required to, as Timmermans and Epstein (2010) put it, “tinker” standards into place.

The Co-management Initiative

As this discord crept into the produce safety discourse, a loose coalition of local stakeholders working in and around the Central Coast—representing farm advisors, local government officials (e.g. county agricultural commissioners), conservation NGOs, academic scientists, growers, and industry groups—began to speak of seeking synergy between conservation and safety. Borrowing a term from natural resource governance, where it referred to shared decision-making over a given resource pool, cooperative extension agents based at UC Davis organized a group of academics, government officials, and industry representatives⁷⁶ to meet in 2007 to discuss options for *co-management* of food safety and water quality (Crohn and Bianchi 2008). The meeting organizers specifically sought to establish research priorities, following the underlying assumption that conflict between controlling pathogens while preserving water quality resulted first and foremost from a lack of information. As one expert intimately involved in these early meetings asserted, “Better information will lead the way,” (GV-06). Of course, as in the case I analyzed in Chapter 4, this sentiment omits the caveat that “information” is never universal, but rather situated within a particular place and time and among a particular epistemic community.

From the outset, the co-management discourse has avoided conflict by framing the tension between food safety and environmental conservation as a lack of (1) scientific information, (2) awareness of existing information, and (3) effective communication among producers, buyers and regulators. As the co-management approach has evolved to a broader understanding of conservation that includes wildlife and soils, the initiative has therefore focused its efforts on new research, education campaigns, and better dialogue. The most comprehensive report produced on the subject⁷⁷ states that co-management is “science-based, adaptive, collaborative, commodity-specific, and site specific” (Lowell, Langholz, and Stuart 2010). The report starts from a place of cooperation and assumed agreement:

“Many growers and a wide consortium of regional experts believe that “co-management” for food safety and environmental protection represents the optimal path forward, albeit one that faces several key obstacles. Co-management is defined as *an approach to minimize microbiological hazards associated with food production while simultaneously conserving soil, water, air, wildlife, and other natural resources*. It is based on the premise that farmers want to produce safe food, desire to be good land stewards, and can do both while still remaining economically viable.” (italics in original, Lowell, Langholz, and Stuart 2010).

Ironically, at the same time as the *Safe and Sustainable* report declares the on-the-ground tension between food safety and sustainability to be resolved, it punts the task of problem closure back to growers at the field level:

The main point is to provide useful, concrete guidance for accomplishing both food safety and ecological health, rather than make blanket statements about practices being appropriate or inappropriate, or prioritizing one goal to the detriment of the other. (Lowell, Langholz, and Stuart 2010).

In recognizing that “blanket statements” on paper can never do justice to the full range of untidy and unruly landscapes in which growers and field workers operate, the report counter-intuitively cedes its authority to intervene in the existing power relations at the heart of the tension on the ground. Apparently following the lead of food safety trainers, who like to remind producers that they need to document their work by reciting the maxim, “If it’s not written down, it didn’t happen”, the emerging co-management initiative seems compelled to encourage growers to document ways in which they manage for both safety and conservation. But it is unclear who is interested in reviewing, or who will value, co-management documentation. Consider that conservation practices are approached as opportunities awaiting recognition: the implication is that although these opportunities may not be readily apparent when gazing at production landscapes through a food safety lens, with education and outreach their synergy and benefit will shine through. But upon whom is the onus of enlightenment placed? The cover sheet for the University of California’s Cooperative Extension (UCCE) resources on co-management—the “useful, concrete guidance”—states:

Growers who can communicate their sustainability objectives and auditors who are adequately trained in recognizing key conservation strategies in and adjacent to production fields are better prepared to engage in realistic and frank discussions of co-management strategies as they appear in the production environment. (UCCE n.d.).

While both growers and auditors are named (but not buyers), it is clear that the burden is presumed to be upon growers to initiate the “realistic and frank discussions of co-management strategies as they appear in the production environment”. Auditors have little incentive to seek adequate training in agricultural conservation science and ecology.⁷⁸ Their official job description is solely to verify that the farm is operated in accordance with the audit scheme. Discretion to interpret the meaning of what they see in the production environment—in essence, to translate—is not in their job description. As one experienced auditor and trainer put it, “The auditor should not have, there should not be any auditor variability. They should have almost no personal judgment, they should be auditing to a strict standard.” Another auditor I interviewed explained, “We are there to really verify the facts”, to observe and to record. When I asked if an auditor can clarify the rules listed in the scheme, he replied negatively. “We cannot give anybody any advice... we are not subject matter experts.” So co-management in practice amounts to a one-way street: it falls to growers to “communicate their sustainability objectives” to auditors, but the latter are bound by prevailing organizational policy and professional norms not to contribute their own thoughts or expertise to the discussion. As Eugene in the above vignette poignantly illustrated, auditors in the field do nonetheless react to what they observe, yet such inevitable slippages from “pure” observation into intervention cannot be officially acknowledged. Any attempts by a grower to engage auditors on the topic of co-management, therefore, far from being “realistic and frank discussions,” are pre-framed as clandestine and possibly under-handed dealings.

A close examination of the guidance documents provided to growers confirms the imbalance of responsibility and discretion within which co-management must be negotiated. The UC Food Safety webpage,⁷⁹ under the heading “Co-management Practice Resources”, lists: “A series of resource sheets for food safety auditors that describe conservation practices commonly used in agriculture’s production environment.” However, each of the thirteen sheets provided is organized as though it were providing a script for growers to explain their operation to auditors.⁸⁰ For example, in the worksheet on vegetative barriers, the advice given reads:

In some audit standards these practices may help producers to demonstrate knowledge of the impacts of farming on the environment including the movement of bioaerosols, and/or water quality impairments from sediments and nutrients. They may trigger concerns about animal activity, fecal contamination, proximity to habitat for wildlife.

For an audit that includes conservation criteria, such as GlobalG.A.P., demonstrating knowledge about conservation may give a grower bonus points on the final report, but a more rigorously safety-oriented audit, such as LGMA, gives no points for conservation. It is unclear how demonstrating ecological awareness on the latter type of audit will in any way alleviate the concerns that may be triggered with respect to animal intrusion. In other words, the co-management approach fails to find purchase within the larger regulatory structure of the apparatus because it does not directly address the conditions of control or contribute to the “purity” of food. Co-management offers no convincing incentives for pursuing conservation, and is thus largely irrelevant when considered from within the mastery worldview.

The guidance on the other twelve sheets is similarly vague and fails to address concretely the heart of the conflict. While these guidance sheets may help growers explain why a particular practice relates to conservation, they say nothing about why an auditor should care to hear the explanation in the first place. Instead, such scripts encourage growers to enter a grey area of dialogue and interpretation that is not officially governed or sanctioned by the audit protocol. While it seems straightforward on paper, given the uneven negotiating power between growers and buyers, especially when mediated by auditors who are present as observers and not as conversationalists, a communication-based approach to co-management is a precarious position on which to hang the fate of a reconciliation between food safety and conservation.

Problem Closure in Practice?

In light of the title of the *Safe and Sustainable* report, it might seem that co-management would be integrally about merging sustainability with health at a deep philosophical level of commitment. In practice, however, food safety operates as a self-contained system of logic that fails to recognize the possibility of other legitimate social objectives. Not surprisingly, co-management has gained only limited traction in industry discourse and regulatory texts; and in nearly every case, its usage does not convey a holistic integration of human and environmental health and still places safety—in the mastery sense of the word—at a higher priority than environment. A search of articles from 2006 to 2016 published in *The Packer*, one of the leading nationwide trade publications for the fresh fruit and vegetable industry, yielded five articles in which co-management was defined or discussed (Appendix B). Three articles simply publish the public comments submitted to FDA by several influential industry groups. In all three, sustainability is at best a second-tier priority, and co-management a potential distraction. The comment from the Wegman’s supermarket chain summed up the overriding sentiment: “sustainability is nice, food safety is a necessity.” The Produce Marketing Association (PMA)

hedged its bets by calling for more research before any definitive action be taken to balance safety with sustainability, claiming that otherwise it would be “a political and emotional issue”. Two later articles, one in 2015 and the other in 2016, present co-management in a more positive and encouraging tone, citing recent research showing, in the words of one of the lead researchers, that “the farms that had removed the most habitat actually had greater instances of pathogens, including E. coli and salmonella.”

A search of the other leading nationwide trade publication, *The Produce News*, turned up only two articles mentioning co-management between 2006 and 2016, both times in the context of research awards given out by the Center for Produce Safety (see Chapter 4); neither short article defined or discussed the term (Appendix B). Likewise, a search of the meeting minutes of the Food Safety and Technology Council of the United Fresh Produce Association⁸¹, the largest national lobby group for the industry, found zero instances of “co-management” or “conservation”, and only six cursory mentions of sustainability; perhaps not surprising given the association’s reference to co-management as a distraction in its 2010 public comments to FDA.

I found seven articles mentioning co-management in *Food Safety News*, an online news source founded by prominent lawyer Bill Marler, who has represented victims of foodborne illness in numerous national outbreaks. Again, however, the overall message on how to balance safety with sustainability is very mixed. Two initial articles mention co-management in passing, as one element in a laundry list of concerns to be addressed in guidance and regulation. A more substantive treatment comes in 2011 with an article authored by Michele Jay-Russell, a research scientist at the University of California, Davis (and colleague of the originators of the co-management movement) and one of the Center for Produce Safety’s awardees. Titled “Feral in the Fields: Food Safety Risks from Wildlife”, the article refers to co-management as “a proactive and positive step forward in managing food safety risks from wildlife” and hails the initiative as “an example of successful collaboration.” Jay-Russell does not address if or how wildlife benefited from the arrangement, nor does she expound upon why or how the collaboration has been successful, or even for whom.

In 2012, however, Daniel Cohen, an agricultural consultant and owner of a research and development based in Davis, California, published a scathing op-ed on the LGMA and food safety reform in general. He strongly criticizes the entire approach to reforming food safety for fresh produce, calling it “upside down and backward” because it ignores the source of pathogens—“urban environments and animal production”—as well as the cross-contamination and hazard magnification role of large, centralized processors. He calls this a “processor-favoring approach” that puts all the pressure to control pathogens on farmers and fields, which means they “basically have to sterilize the farm environment”, an “impossible” mission leading to “ecological, social and strategic disaster.” He points to co-management as a great first step, but concludes “That is not where we are, right now.” Despite his strong stance, Cohen’s argument for a more profound commitment to co-management seems to have remained largely an outlier.

References to co-management in *Food Safety News* several years later again presented a tepid and equivocal message. Reporting on the 2015 annual meeting of the International Association of Food Protection (Siegener 2015), the next article covered a debate between a representative from FDA and a representative from General Mills over the (leading) question, “Is sustainability treading on food safety?” The FDA representative noted that, following the framing in the *Safe and Sustainable* report, “co-management opportunities exist throughout the supply chain which could combine food safety and sustainability programs.” No further details

are given on exactly *how* such programs could combine, suggesting that the term again has become a lip-service phrase. The 2016 profile of food safety trainer Atina Diffley, who specializes in consulting for small-scale growers, drives home the current state of ambiguity over the true priorities of co-management. Reporting from the site of a training in Washington state, the article cites Diffley as telling the trainees that, even though ““There can be many food safety benefits to co-management,” farmers need to take care: “Even so, because wild life could create food safety risks, measures should be taken to minimize wildlife incursions into growing fields.” Diffley then cautions farmers not to remove conservation habitat, citing the aforementioned research by Karp (2015) showing that doing so may increase food safety risks. What farmers are supposed to *do* with these contrasting pieces of advice is unclear. As seen with the guidance from UC ANR, the overall message of co-management is that the responsibility rests squarely on farmers to sort out the tension and ambiguity.

Co-management has also made only cursory inroads into food safety guidance and standards. In 2011, the head of LGMA announced a formal commitment to co-management, which “underscores the idea that the LGMA Metrics can be implemented on farms without damage to the environment” (Horsfall 2011), but as of 2016, the metrics and guidance have not been revised to provide concrete recommendations on how to prioritize food safety without eliminating wildlife and its habitat near fields. The above-mentioned decision tree for animal hazards does note, toward the end, “If necessary, consult with state and regional experts (see Appendix Z) to develop co-management strategies to prevent recurrence”. In the glossary, the CA LGMA guidance offers the same definition of co-management as the *Safe and Sustainable* report; the main document provides no additional details. Turning to Appendix Z, the CA LGMA still does not detail co-management strategies, but rather leaves it to growers to contact the listed government officials—from agencies such as the EPA, the USDA’s Natural Resources Conservation Service, the California Department of Fish and Game, or California’s Regional Water Quality Control Boards—to find means to “comply with the metrics in a way that is compatible with environmental protection and permitting requirements” (CA LGMA 2016, App. Z). It seems unlikely that most farmers would even try contacting these officials for help, given their time and resource constraints.

FDA has adopted similarly superficial language around co-management in its Produce Safety Rule, the first federal regulation to set on-farm production standards. Acknowledging that public comments “expressed concern that the proposed rule, if finalized, would adversely affect wildlife, including threatened or endangered species,” the agency responded by stating: (1) that FDA “encourages” co-management of food safety and environmental protection and (2) that the final rule would clarify that “farms are not required to take measures to exclude animals from outdoor growing areas, destroy animal habitat, or otherwise clear farm borders” (FDA 2014). Nowhere does FDA actually discourage farmers from taking these measures, leaving open the implication that although destroying habitat may not be required, it may nonetheless be a practical compliance strategy. Especially given the common industry viewpoint that government regulation is just a “minimum standard” that businesses should seek to exceed (Yiannas 2009, 34–35), and given the tenor of industry comments to FDA in which they clearly articulated co-management as a secondary priority and possible distraction, FDA’s lukewarm acknowledgement of a need for balance seems unlikely to ease the tension or buffer farmers from the heat of friction.

Without ready guidance—and, in effect, permission—from official channels for balancing food safety and conservation in produce fields, translation from paper to practice defaults to

doing what is best for business: prioritizing food safety. From a grower standpoint, to do otherwise would risk losing crops and even entire fields. So slippage must occur in translating the tidy, cooperative co-management plan on paper into the tightly constrained and decidedly untidy situation growers face daily in their fields. But even if the universally-aspiring conditions of control are “never fully successful in being everywhere the same” (Tsing 2005, 10), the mastery worldview does find some purchase within local agricultural norms and knowledges, a cultural surface against which friction becomes productive, halting the slippage from turning into a full revolt against the food safety apparatus. However, this friction also warps and distorts the clean universal message of control, and especially the weak call for co-management, in ways that expert technocrats did not predict. To examine the underlying dynamics of this unexpected consequence, I turn next to an examination of the historical attitudes toward and treatment of wildlife and non-crop vegetation in California’s agricultural lands. As I will argue, pursuing safety by removing animals and their habitat from the farm landscape is a response in historical continuity with a deeply-rooted and state-backed tradition of pest eradication in American and Californian agriculture.

No Place for Weeds and Varmints

Food safety is a big issue for us. We love the diversity on our farm, but... The fellow doing the checking told me that if we didn’t want to have an issue we needed to have bare ground, no habitat... Our buyers want to see clean fields, no rodents, no coyotes, no wildlife at all on the fields... *—Mid-scale California tomato farmer and board member of California State Board of Food and Agriculture, October 2015*

Tensions run high between food safety and conservation not just because of a lack of information, awareness, or communication. A long-standing, independent cultural norm of pest control also “grips” the farming places into which experts would like the conditions of control to take root. The elephant in the room, so to speak, is a much older and persistent struggle between the commercial agriculture production model and the land and ecosystems in which it is embedded. “Agriculture is an environmental problem,” writes Henke, of two dimensions: first, how to master unruly ecosystems to consistently produce desirable crops, and second, how to mitigate the detrimental side-effects of mastery (2008, 143–45). Achieving mastery, he elaborates, takes priority, and the industrial agriculture complex—growers, farm advisors, agricultural scientists, input providers—is loath to overturn or revolutionize established forms of mastery, such as powerful pesticides, simply to mitigate what is perceived as a secondary impact, such as water pollution.

Extending Henke’s argument, I suggest that industrial agriculture prioritizes environmental mastery over environmental sustainability due to a hierarchical dichotomy between economic production and ecological reproduction.⁸² Within this framework, novel pathogens, as naturalized agents that threaten economic production, are interpreted by the produce industry as a first-order environmental problem that must be mastered. As I will argue in this section, the strategy of mastery employed in produce safety today takes its shape from pre-existing forms of mastery, namely a general intolerance toward animals and non-crop vegetation that (appear to) interfere with crop yield. Collateral damage to the landscape’s capacity for ecological reproduction, as a second-order problem, has largely been discounted and overlooked in the face of a deeply-rooted penchant to treat wild plants and animals as simply weeds and varmints.

Over half a century ago, Aldo Leopold summed up the problem in a line: “There is, as yet, no sense of pride in the husbandry of wild plants and animals” (Leopold 1949, 168). There is also, I would add, no prospect of profit, either. Donald Worster has noted that, “In the history of progressive agriculture [dating from the 18th century], wild creatures had never counted for much. They failed to conform to the farmer’s productive purposes and so were seen as useless when not seen as a threat” (Worster 1994, 268). Wild plants have faced the same discrimination. In his essay “Illinois Bus Ride,” written in the late-1930s, Aldo Leopold wrote a short moralizing anecdote on the matter:

A worried farmer, his fertilizer bill projecting from his shirt pocket, looks blankly at the lupines, lespedezas, or Baptisias that originally pumped nitrogen out of the prairie air and into his black loamy acres. He does not distinguish them from the parvenu quack-grass in which they grow... Were I to ask him the name of that white spike of pea-like flowers hugging the fence, he would shake his head. A weed, likely. (Aldo Leopold, “Illinois Bus Ride”, in *A Sand County Almanac*, 1949).

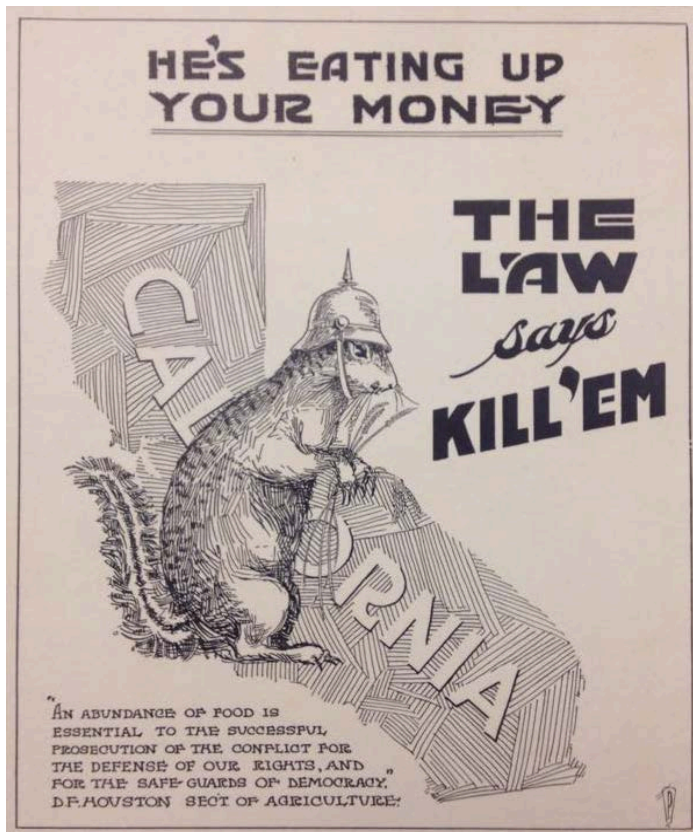


Figure 23. WWI-era broadside promoting a statewide “squirrel week” to kill California ground squirrels (1918). Imagery evokes a war on agricultural pests commensurate with the war on Germany through attiring the illustrated squirrel with a spiked helmet typical of German soldiers. Other posters in this same campaign boast commentary from the US Food Administration chief Herbert Hoover and endorsement by California governor William Stevens, and one poster exhorts school children to participate in the squirrel hunt. Source: BANC PIC 2014.002, The Bancroft Library, University of California, Berkeley.

The progressive, scientific agriculture worldview—capable only of perceiving instrumental value—has been reinforced and entangled with the modern state.⁸³ Beginning at the turn of the 20th century, the American Progressive Movement—“motivated by a strong, highly moralistic sense of mission to clean up the world around them”, including the environment (Worster 1994, 265)—brought the full power of the federal government to bear upon pests that might threaten agricultural productivity. (California participated as well: see Figure 23). Under President Theodore Roosevelt, the federal government launched “an official program to rub out the varmint and to make America safe from its depredations” (ibid, 262). The varmint-eradication campaign—epitomized in the national Predator and Rodent Control (PARC) program (Dunlap 1988)—formed one strand of a

multi-pronged and decades-long concerted effort to scientifically rationalize agriculture and bring its efficiency up to the “factory” standard (Fitzgerald 2003). The land and its ecosystems must be made to fit the product (crops) and their market, not the other way around.

California has played a unique role in the history of agricultural mastery as the place where “the earliest notions of industrial farming were first cultivated” (Fitzgerald 2003, 16). As Richard Walker has argued, California agriculture from the outset embraced capitalist, industrial forms of production, and the “typical farmer in California has been a money-oriented, businesslike operator” (Walker 2004, 79). While such broad generalization inevitably fails to capture the heterogeneous plurality of grower approaches to farming, Walker’s account does suggest reasons why California growers may be particularly attuned to viewing their farms through a managerial and bookkeeping lens focused on efficiency, legibility, uniformity, and the bottom line. To the extent that wild plants and animals fail to translate into a credit in the accounting book or a clear contribution to product yield, farmers in California may be more likely to see them as weeds and varmints deserving of mass eradication (as has happened before, see Figure 24 and Figure 25).



Figure 24. Fresno jackrabbit harvest 1893 California. “Jackrabbits often ravaged orchards and vineyards. Fresno settlers soon saw their profits decreasing and organized a campaign to deal with the problem... Between 1888 and 1897 there were 217 public drives alone in California accounting for approximately 500,000 dead rabbits.” Source: San Joaquin Valley Library System. Accessed on Calisphere, October 24, 2015: <http://calisphere.cdlib.org/item/ark:/13030/kt1v19q1gj/>

The impact of food safety reforms on the disposition of California farmers toward wildlife and non-crop plants cannot be understood outside of a deeper understanding of this long-

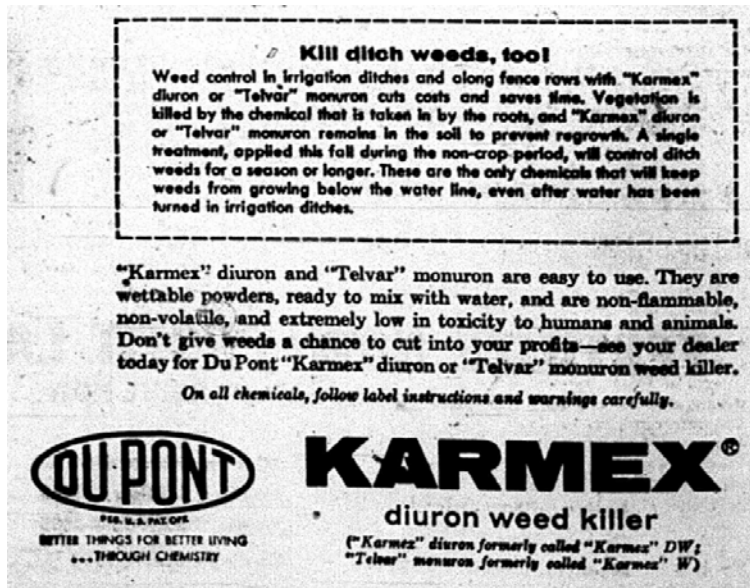


Figure 25. Part of an advertisement for Karmex[®] weed killer, produced by the DuPont chemical company, which appeared in a full-page spread in the *Fresno Bee*, a local newspaper from California's Central Valley, on November 16, 1958. The ad prompts farmers to "Kill ditch weeds, too!", referring to vegetation growing *outside* of fields in irrigation ditches or along fence rows. The herbicide is promised to "control ditch weeds for a season or longer."

standing relationship between the farmers and the Federal and state governments. In particular, it is critical to acknowledge that the State has, in the context of agriculture, assumed epistemic authority over deciding precisely what is beneficial for and what is harmful toward agriculture, and specifically through the narrow lens of optimizing economic production. With respect to wildlife, the half century from the 1880s to the 1920s witnessed the rise of Federal authority in this domain (see, e.g., Cameron 1929; Dunlap 1988). The USDA's work during this time period consistently focused on suppressing pests and promoting pest-controllers (ecological, mechanical, and chemical, though chemical means of control for both pests and weeds

dominated the toolkit post-WWII).

In carrying out this purpose, the agency set a strong and lasting precedent for the State to be the final authority on which side of the pest line a particular species would fall. Execution of such a determination—whether it be an eradication or a conservation campaign (as in USDA's Natural Resources Conservation Service [NRCS])—developed in a cooperative mode between the state and local private actors (as discussed at length by Cameron [1929]), but the underlying epistemic authority lay in the end with government-backed scientists. It is my argument that this long-standing historical relationship informs the ways in which California growers today interpret food safety guidance and advice on good agricultural practices (GAPs): as determinations of what counts as weeds and varmints, i.e. as pests to be removed from the farm. Unique to the past decade, however, the newly intensified pressure to produce the safest food possible has shifted the very definition of "pest" to encompass any animal with the potential to transmit fecal matter to crops, not only any animal with the potential of eating crops or damaging soils. FDA, which oversees food safety in fresh produce agriculture, has previously defined "pest" for the purposes of its good manufacturing practices (GMPs) as "any objectionable animals or insects including, but not limited to, birds, rodents, flies, and larvae" (21 CFR §110.3.j). By extension, in the context of GAPs, any non-crop vegetation that may harbor such an animal also poses a threat. And farmers know, from long experience and state propaganda, that when an environmental factor threatens their crops, the safest course of action is to eliminate the threat. There is no place for weeds and varmints on the farm.

A Legacy of Unapologetic Extermination

Today, the legacy of these state-backed, warlike eradication campaigns lives on in a vigorous and violent response toward weeds or varmints that threaten crops. Application of synthetic herbicides to kill all non-crop vegetation is ubiquitous across industrial agriculture, but wildlife that is seen as a pest is likewise the target of eradication. To take one recent, albeit over-the-top, example, the August 2015 edition of *The Farm News*, the Kern County (California) Farm Bureau's monthly newspaper, a front page headline reads, "Ag Farmers Handle Threat to Livelihood Unapologetically". The threat? Burrowing rodents, which farmers are "handling" with the aid of, apparently, explosives:

In any business, threats to livelihood are attacked aggressively. So when burrowing rodents start killing crops and reducing yield in the ag business, farmers don't think twice about eradicating them from their operation... [F]armers and even the pest control companies they hire are blowing up these pests and their tunnels because it makes good business sense to do so.

While this particular example is likely tongue-in-cheek, striking a chord more resonant with the offbeat comedy of *Caddyshack* than a serious journalistic effort, it nonetheless provides a poignant example, through its hyperbolic appeal to its audience's sensibilities (farmers are much more likely to use the "less violent" alternative of poison bait), of the way in which existing threads of discourse on California agriculture legitimate, and even to an extent celebrate, an antagonistic relationship between farmers and the environment in which they grow their crops. The implication is that farming is a business, presumably as opposed to a wilderness reserve or wildlife park, and farmers will not and should not hem or haw over how to manage their land, and by extension the ecosystems and wildlife inhabiting it. According to this discursive thread, if any aspect of the environment threatens the bottom line—in this case crop yield—a farmer will not hesitate to remove that aspect, literally with explosive force. Framing the tradeoffs between the agricultural environment and farm business viability as a struggle for mastery leaves little room for nuanced, negotiated practices that seek balance in the ways that the co-management advocates recommend. This may explain why co-management seems to have made only modest headway into the discourse around produce safety in California and nationwide.

Not all growers are drawn to or comfortable with the expedience of eradication techniques such as bombing rodent tunnels, however. There are certainly growers who prioritize maximum production and profit over environmental protection, but as Brodt et al. (2006) demonstrated, at least among California almond and winegrape growers, there are other distinct groups of growers whose primary motivations are better described as environmental stewardship or community engagement (roughly, livelihood and social interaction over profit). The heterogeneity of grower perspectives on wildlife and non-crop vegetation has been documented in the context of specific on-farm practices, as well. In another study examining how California growers in Yolo County (Central Valley) manage their field edges (e.g. scrape/disc, mow, apply herbicides, leave natural vegetation, plant/manage hedgerow), Brodt et al. (2009) identified growers on both ends of the spectrum in roughly equal measure. There were those who "expressed a distinct preference for 'clean' (weed-free or vegetation-free) edges" and those who expressed a "mixture of sheer interest and esthetic enjoyment in seeing plants and associated vertebrate wildlife... [that] led some to retain naturally occurring trees."

In his works on “social learning to put agroecology into action” (Warner 2006; Warner 2007; Warner 2008), Keith Warner has convincingly demonstrated that even the most business-minded California farmers can appreciate and value the multiple potential benefits of a more holistic ecological approach to farming, it just depends on how that approach is framed. To that end, Warner identified three distinct “discourses” on reducing agrochemicals that found traction—or creative friction—among growers; he labeled these discourses agroecological populism, green agromanagerialism, and ecorational technology (2008). Agroecological populism appealed to farmers who feel they “had lost control over their farming practices to outside experts” by promising a better integration of practices “in harmony” or “balance” with nature, a stewardship ethic tied into a culturally-held farm aesthetic, and an overall improvement in the basic satisfaction of farming. Green agromanagerialism speaks to the “business pragmatism” that is held to be a virtue among many farmers, especially at the larger scale; again, though, this discourse speaks to more than simple profit maximization, incorporating the idea of multiple use values, improved crop quality, “green” or “sustainable” product marketing opportunities, reduced operating costs from external inputs, and substituting knowledge for technology or agrochemicals. Even the ecorational discourse, although it supports a mastery-like “technology intensive approach” and “makes no appeal to social ideals for growers”, nonetheless makes a broader claim to serving the public interest through improved environmental protection; this discourse is most similar to how co-management is most often presented in guidance, regulation and media.

It would seem that, framed properly, co-management could similarly find traction and “grip” with produce growers. In the context of food safety, many farmers are sympathetic to the idea of co-managing for multiple social goals. And most California growers do feel responsible for good environmental stewardship on their farms (Stuart 2009; Baur et al. 2016). But growers operate in a tight web of structural constraints that influence the extent to which their values and preferences can translate into practice, and in what forms. In addition to local, state and federal rules covering chemicals, water, soils, labor, wildlife, and so forth, farmers must comply with detailed requirements from their customers, which in the case of large marketing, retail, and foodservice firms may cover not just the product but the production environment itself.⁸⁴

The impacts of controlling farms for their animal and plant hazards can be long-lasting. In 2013, I sat down to discuss food safety and ecosystem services with the senior management at Organic Fields (a pseudonym), a large organic growing operation in the Salinas Valley. From what they had seen, after the 2006 outbreak, many growers in the area significantly cut back habitat and removed a lot of vegetation from around their fields. After the heightened sense of crisis passed and the urgency of making immediate corrective action faded, those growers eased off and a lot of vegetation “creeped back.” Regrowth has also been promoted by the regional water quality control boards, which have been pushing growers to re-vegetate bare ground (to control erosion). However, “it hasn't grown back the same.” In part this is due to changing management: Organic Fields now favors low-standing ground cover that provides habitat for desirable insects, but which is not suitable for birds and rodents. To this end, the company also treats beneficial habitat as an “annual crop”—they “grow” pest control seasonally. As such, they have few permanent hedgerows or any higher/denser vegetation immediately surrounding their fields. Where possible, they do try to allow for denser, treed habitat near riparian zones, provided those areas can be isolated from active fields. They ask “how close can we get?”, but err on the side of not too close: Organic Fields maintains a significant boundary, comprising bare dirt buffers and fencing, around all of its leafy greens fields. Thus, while habitat loss “is not as bad as

it was [post-2006],” neither is it the same habitat. This cleared and reduced habitat supports a narrower variety of species and ecosystem services compared to the past (Karp, Gennet, et al. 2015; Karp et al. 2016; Gennet et al. 2013).

Conclusion

Growers face a perplexing conundrum. On the one hand, public agencies (e.g. USDA's NRCS, UC Cooperative Extension) and conservation NGOs (e.g. The Wild Farm Alliance and The Nature Conservancy) exhort growers to preserve the land, promote biodiversity, and control the wide range of environmentally deleterious effects of agriculture. On the other, growers are told by food scientists, state agencies such as LGMA and FDA, and their buyers that the environment can readily contaminate their crops: a flood, a deer, a frog, windblown dust, a flock of birds all can carry *Salmonella* or human-pathogenic *E. coli* onto the edible portion of crops. The very presence of any of these factors in or near a field may require grower to destroy their crops, the source of their livelihood. A historically typical (and, it is worth noting, precautionary) response to such a threat is to remove it from the landscape, but eradication techniques can and do draw public scrutiny (see Figure 26). Amidst conflicting guidance and pressure, the translation of the clean world of paper—in which environmental conservation can co-exist peacefully with food safety—to the world on the ground is anything but smooth and predictable.

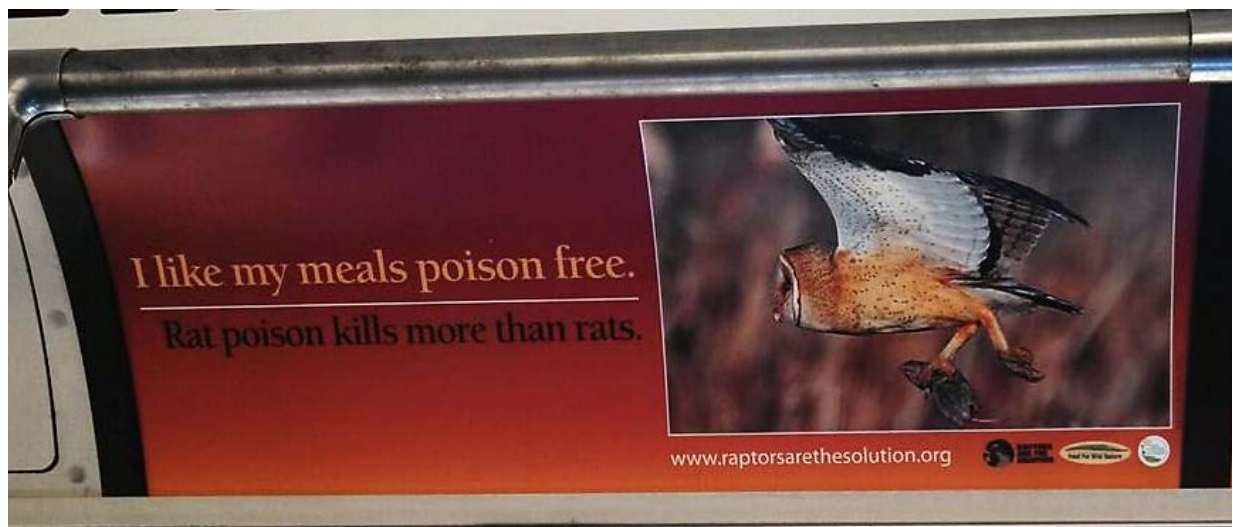


Figure 26. Anti-rodenticide advertisement on public bus, Oakland, CA, 2014.

Furthermore, California farms are not organizationally simple. Rather they are complex business and social networks often involving scores of people who may be only loosely in communication with one another, let alone approach the landscape with the same goals and worldview. This makes for another layer of friction between paper universals and situated practice. Take, for example, a story from one Salinas Valley food safety manager, speaking of the ways in which the field crew manages pests:

I really don't want to contribute to [poison baiting]. And I see the guys sometimes don't [trails off]... they seem to do all kinds of things. Not that long ago, the very first place we stopped at, the guys had put out some bait along the river. And I called our PCA [pest

control advisor], and I was like, ‘What are they doing...?’ They’re like broadcasting bait all over the place. They’re not really putting it in the traps, they’re like throwing it down next to the bait stations. I actually made them come and clean it all up because I thought it was so awful.

As this example illustrates, perspectives on the proper relationship of the farm to wildlife and non-crop vegetation may vary dramatically even among the workers, managers and owners of that farm. Such heterogeneity can result in further friction, and thus unpredictable opacity and potential Babel (sometimes literally, in the case of multiple linguistic barriers between experts and fieldworkers; see Chapter 5), when those practices are called upon to account to the world of paper.

The conflicts observed during the audit may be interpreted as responses to the resistance met in attempting to translate texts to fields (and vice versa). As always, the bureaucratic aspect of food safety—what I have referred to as the world of paper—“is always underpinned by collusion and intimacy” (Mathews 2011, 4) with the world on the ground. Careful focus on such mundane interactions as audits and harvest inspections reveals that food safety regulators—whether they be public or private sector, third-party or in-house—wield only, again drawing on Mathews, an “uncertain authority” and a “halting, vulnerable power” over the working people and landscapes that produce vegetables. When nature, in lively displays of unruliness, slips free of the grid of compliance, it is laborers on the ground who answer for it—or don’t. The interesting question then, is to what extent growers and field workers consent to account for the living materiality of farm landscapes that articulate with bureaucratic forms of knowledge only through constant slippage. Auditors, government inspectors, and visiting buyers all visit the farm a handful of days of the year, at most. Growers, field managers and workers are constantly in and out of their fields, monitoring and observing. Why should they consent to be governed by the world of paper, when the agents who created that world primarily learn what goes on in the field through growers’ and workers’ own accounts?

Pressure to embrace the bureaucratic discipline of paper, to really embrace “food safety culture”, emanates from multiple sources. The forces of acculturation, the threat of liability and criminal charges, fear over lost access to critical market channels, peer pressure, and so forth certainly play their parts. That said, paper is the universal medium of translation. Texts allow powerful state and retail actors to convey their demands, expectations and threats to the field, and documents also convey information from the field back up the chain to regulators and the organizations purchasing the produce. The ubiquitous signs posted in and around fields (and packing houses, processing plants, etc.), for example, exist in a dual role, both to remind workers of the centrality of paper as an organizing force in their lives but also to signal order and compliance to anyone visiting the farm. Consider the following story related to me by the food purchasing manager for a large California hospital system:

I went to C___ Farms, and I was really impressed. I had never seen this. I get out of my vehicle to visit one of their farms that they work with, that they support, and right at the roadside there is this sign, and it says, “Danger! Peligro!”—Spanish and English—and I thought it was a pipeline underground, before excavating you know, because it looked like that. But no, it wasn’t that. It had dogs, with a circle and the slash, and that this was a food safety zone. And I was very impressed by it... That farm was practicing, had gone through its food safety program, and was putting all that they had learned into practice.

Signs such as the “No Animals!” warning referenced above (Figure 19) are as much a signal to those visiting a field for inspection as those working in and around it.

But what is at stake? To summarize, growers are expected to translate the untidy materiality and unruly liveliness of the field environment—in which squirrels run through fences, birds flock among the lettuce, frogs shelter in the dew gathered on weed-subduing black plastic, and rivers overflow their banks—for auditors who in turn must translate these accounts into the rigid rules of audit scheme and standard best practices, which in turn inform government regulators and the powerful end-chain buyers. The heterogeneity of landscapes, fields, farmers, and auditors leads, on close inspection, to an unpredictable Babel rather than the smooth, standard discipline imagined by policy designers and conveyed to a public concerned about dangerous pathogens.

So there is an element of necessary (from a grower’s perspective) pretense—even, possibly, deception—occurring during the translation from paper to practice that covers up the fundamental disarticulations in grand visions for agrifood systems. Rather than holistic system transformation toward safety and/or sustainability, fresh produce agriculture is engaged in mere “repair” work that patches of symptoms—and largely maintains the status quo—without addressing root structural causes (Henke 2008). It is important, however, to recognize that what happens at the field level is entangled with the latter stages of the supply chain, where a parallel pattern of recalcitrance has been documented. In the face of growing recognition that foodborne illness outbreaks represent a “systemic risk” of industrial production—on par with the extensive documentation of environmental systemic risks—Stuart and Worosz (2012) have argued that the food processing industry in particular (which is heavily consolidated in the hands of a few major firms) uses “techniques of neutralization” to avoid accusation, shift blame, and generally resist substantive change to the underlying status quo of industrial production. A state of Babel masked by the appearance of standard discipline behooves the holding pattern sought by such entrenched interests. There is an “anonymous power” at work in food safety standards, but it is not some benign invisible hand that operates only to protect public health.

7. BEYOND SAFETY

“How close can Mother Nature be without being dangerous?” asked the grower.

“And what kinds of mother nature?” added his food safety manager.

In 2015, the restaurant chain Chipotle—which prides itself on serving local and sustainable “food with integrity” and had recently announced a plan to go GMO-free—was struck by a series of foodborne illness outbreaks. From Seattle to Boston, hundreds of customers were sickened by *E. coli*, norovirus, and *Salmonella* linked to Chipotle products. The company’s reputation and stock price plummeted, leading some observers to question not only if the once-thriving chain would recover, but also if its commitment to sustainable ingredients had become an Achilles’ heel. Writing for *Vox* magazine, journalist Timothy Lee reported, “Chipotle’s commitment to using fresh ingredients from local farms makes it more vulnerable to foodborne illnesses” (Lee 2015). Unlike large, centralized suppliers of canned and frozen foods, Lee noted that Chipotle sources from “a wide variety of local suppliers that may not have the capacity for stringent quality controls.” He cited another article from the *Chicago Tribune*, which began, “Chipotle is fresh – and suddenly, that’s a problem.” The reporting continued,

Now in the wake of the *E. coli* cases, Chipotle is tightening its supplier standards and re-evaluating its local produce program, which dates back to 2008. The pullback hits at the heart of Chipotle’s culture and marketing, which has touted its support of sustainable agriculture. (Giammona and Patton 2015).

Ezra Klein, a prominent journalist also affiliated with *Vox*, commented on his Facebook feed, “Chipotle’s food safety crisis is depressing in part because it stems from some of the things Chipotle was trying, unusually, to do right — like buy from smaller farms that sell fresher, more environmentally sustainable produce.” The reverberations of this apparent, although “depressing”, lesson reached far beyond Chipotle. Soon after the crisis hit, the director of a major food service operator for the Silicon Valley tech industry told me,

I predict that the recent Chipotle experience is going to change practices across the industry. I may still make exceptions [for small farms working toward food safety certification], but we’re never going to let farmers sell off the back of the truck to any chef the way they did. Chefs from independent restaurants will still go to farmers’ markets as they’ve been doing for a long while, but food service operators are going to change where this is currently the practice.

In other words, for many in the fresh produce industry, Chipotle’s calamity served as yet another warning against the perils of mixing sustainable and local sourcing with food safety. The initial deployment of food safety for fresh produce agriculture manifested as a “war against nature”, argued Stuart (2008), in which growers took extreme measures to eliminate vegetation and wildlife in and around their fields. While the early excesses of the post-2006 crackdown on pathogens were moderated and softened over time, the underlying premise that food must be separated from any possible contamination has, as I have shown in previous chapters, become more firmly entrenched and normalized throughout the industry. The Chipotle example has simply reinforced the long-held assumption among many food safety experts that bigger, more industrial operations are better at waging the “war on pathogens”. In other words, that centralized, standardized, and automated preventive measures are the best way to control

contamination and protecting consumer-citizens against the dangers of the ubiquitous ‘wild’ pathogens living ‘out there’.

It is time to contextualize this basic narrative within our broader imaginaries of nature and the human place in nature. Amidst a cornucopia of choice in American food markets, a growing awareness of the entanglement of wild nature with human health via our agrifood system has raised the stakes for deciding what we *should* eat. The recent controversy over whether to consider the carbon footprint of food in setting federal dietary guidelines (i.e. the food pyramid) highlights the extent to which beliefs about what is safe or healthy to eat are embroiled in a politics of nature (Halper 2015). Nature can be enrolled “as another field for the exercise of power”, to quote Leo Marx (1964), and viewing the relationship between nature and food safety in this way, rather than simply as a “war”, opens new avenues of understanding the trajectory of the food safety apparatus.

In this concluding chapter, I argue that, at its heart, the apparatus works continuously to render fields and farming landscapes as spaces of unruly nature against which technologies of control can be rationalized and justified. However, invoking nature is a double-edged blade, for pursuing mastery also invites rebellion. If we do not act first to revolutionize our collective imaginaries for safety, working to adopt a holistic and regenerative stance of partnership toward the non-human actors which we have been seeking to master, we run the risk that these actors themselves will rise up and overthrow the boundaries we have set for them, resulting in catastrophe. We must profoundly broaden and deepen the scope of food safety governance, change the very ways in which we frame safety and danger to mesh inclusively with other societal goals, if the future of US agriculture is to be sustainable and resilient in the long term. To suggest how this might be accomplished, I review the ways in which the politics of nature are framed by the dominant food safety apparatus, and propose alternative ways to frame this politics that can take our society toward new horizons of health, justice, and well-being.

The Imperative to Master Wild Nature

FoodSafety.gov—“your gateway to Federal food safety information”—cautioned consumers against the dangers of unpasteurized milk in its May 15, 2015 blog post:

“Back to nature” – that’s what many Americans are trying to do with the foods that we buy and eat. We are shopping at farmer’s markets, purchasing organic food, participating in food cooperatives (or co-ops), and even growing our own food. In addition, many people are eating food with minimal processing.

However, raw milk and products made from it (including soft cheese, ice cream, and yogurt) can pose severe health risks, including death. That’s because raw milk has not undergone a process called pasteurization that kills disease-causing germs, such as *Campylobacter*, *E. coli*, and *Salmonella*.

The rhetorical structure employed in this blog post reveals how the food safety apparatus frames the problem as one in which wild microbes (and even the unruly guts of domestic cattle) threaten to disrupt the carefully maintained boundary between dependable cultivars and chaotic, unpredictable pathogens. Ignoring that boundary—willfully or unintentionally—is a transgression. And the perceived stakes of a transgression are high: as one food safety manager at a large organic farm put it, “With pathogenic *E. coli*, one cell can kill you.” Achieving food safety, it seems clear, requires an impermeable divide between the ‘safe’ and the ‘unsafe’,

between the vegetable field and wild nature. Standardized safety protocols create a clear boundary between the messiness ‘out there’ and the controlled space of the field, within which boundaries the industry can demonstrate that its interventions—wildlife fences, poison-bait traps, water monitoring, etc.—actually result, reliably, in food that will not make people sick.

But the field, like Boyle’s air pump⁸⁵ or PulseNet’s surveillance gathering system, always leaks. Wildlife digs under, leaps over and flies around fences. Crops need irrigation water and fertilizers brought in from outside to grow. Field workers have to pick the leafy vegetables, often by hand, during the harvest. All of these objects and substances must transgress the imagined impermeable boundary that the food safety experts operating under the hazard mastery paradigm will into being around the field, and around the entirety of the agrifood system. To contain the seemingly rampant dangers posed by all of these routes by which contamination can trespass into the sanctified field, the produce industry and government regulators must contain that leakage and reassure the public that, for all practical purposes, the food system is purified when the conditions of control are met. The protocols of hazard mastery, in other words, seek to produce a societal consensus around mastery and trust in the idea of sanitized fields. The control achieved through containment allows farmers and industry to intervene in a way that produces certifiable and dependable results: food we can trust in.

However, the corollary to producing a safely sanitized field is the production of an unsafe wilderness outside—i.e. a constantly overflowing sewer (Dunn 2007)—and the aura of control is premised on human agency’s capacity to overcome the agency of wild nature through the levers of science and technology. Thus industry, and government regulators as they become entangled through their responsibility in overseeing industry, cannot allow nature to act on its own, because that would constitute a breach of the safe, ordered space in which only humans are allowed to initiate action. Any material breach of that boundary, like an outbreak, disrupts the proper order, dissolves the aura of safety, and dispels the belief in safe food, while at the same time undermining public trust in the current character of the produce industry and government overseers and threatening extant power relations. Thus when an outbreak scares the public, the response is always to identify the bad actor (e.g. an animal or a rogue producer), expel the offending contamination, and reestablish trust.

In analyzing official responses to the 2006 *E. coli* outbreak in spinach, Delind and Howard found that, “The prevailing message was that *science* [and those who set the scientific agenda] *can handle whatever nature throws at it*. The tools for managing the crisis are at hand, and the public should be reassured” (2008, emphasis added). Powerful and unruly as the forces of nature might be, the hazard mastery paradigm promises to hold those forces in check, through purification of wild(er)ness into the purified realm of social control. In summary, the boundaries enforced on the farm in the name of food safety serve to both subordinate natural processes to human control; and to enroll regulators, retailers, and consumers into a consensus that the boundaries do, in fact, enclose the elusive safe space that in turn produces safe food.

The Problem of Internal Nature

Though the concept of nature in Western culture has changed dramatically over time, its usage has consistently been entangled with cultural understandings of the sources of safety and danger in the world. Opinion has oscillated between understanding nature as a source of plenty (e.g. a garden) and as a source of peril (e.g. a wilderness). As an example of the former, the Romantics and Transcendentalists thought of nature as beneficent (Cronon 1996), as in the

following passage from *Lines Composed a Few Miles above Tintern Abbey*, composed by William Wordsworth at the close of the 18th century:

Knowing that Nature never did betray
The heart that loved her; 'tis her privilege
Through all the years of this our life, to lead
From joy to joy...

However, people have just as often used nature to name the menacing forces in the world. Even when not explicitly sinister, nature has been characterized as a destabilizing or dangerous force in need of taming and “civilizing” through the application of rational human reasoning. The scientific management view of nature, which underwrites the hazard mastery paradigm, embodies a modern version of this philosophy. Namely, safety can be achieved through ritual purifications that separate the uncontrolled environment (i.e. wild nature) from the controlled factory-like farm field. Such a philosophy traces its roots to the late sixteenth and early seventeenth century writings of Francis Bacon, who perhaps first articulated a narrative of human progress through reason and science, which would free humanity (at least the wealthier strata) from material suffering through the rational domination of nature (Merchant 1980).⁸⁶ So strong is this ascendancy narrative that its proponents see technological fixes as solutions to problems arguably caused by “technologies of hubris” in the first place (Jasanoff 2003). The hazard mastery paradigm rests on the unshakeable belief that the systemic immunodeficiency of corporate industrial agriculture can be “repaired” through further application of science and technology (Henke 2008). This belief does not necessarily operate mutually exclusively from a socially progressive imaginary. Karl Marx and Friedrich Engels, bastions of Leftist theory and action, famously believed that science could correct the ills of capitalism: mastery of nature’s laws, they believed, would emancipate humanity by giving us mastery over our own social organization and allowing us to make our own history (Merchant 2008, 47, 49, and 56).

The logical fallacy of this belief was pointed out by philosophers of the Frankfurt school (Merchant 2013, 164), who observed a widespread contradiction: “Enlightenment, understood in the widest sense as the advance of thought, has always aimed at liberating human beings from fear and installing them as masters. Yet the wholly enlightened earth radiates under the sign of disaster triumphant...” (Horkheimer and Adorno, 1944, quoted in Merchant 2008, 59). The Frankfurt school and its acolytes reasoned that disaster proliferated despite the ascent of scientific and technological prowess precisely *because* humans achieved that prowess through treating nature as merely an instrumental means to some pre-given end. Treating external nature as a thing to be used, they argued, had implications for humanity’s relationship to our internal nature: “The production of an endless parade of technological improvements maintains the subjection of people’s internal natures by chaining them to the manufacturing process. As aggression against external nature accelerates, the technological connection renders people’s internal natures increasingly passive” (Merchant 2008, 19). In summation, “the domination of internal nature makes possible the domination external nature, which in turn leads to the domination of human beings” (ibid, 18). The promise of freedom is thereby belied.

Translated to the case of food safety, this fundamental contradiction manifests through the way that safety (sought through mastery over pathogens) may actually compromise health (through suppression of our internal microbial nature). The contradiction is unavoidable given the boundary-crossing nature of food. We must consume and digest food to sustain our bodies, our internal natures, but with each bite we also risk allowing a dangerous contaminant from

external nature to enter our bodies, threatening illness or even death. But to draw a bright line around microbiological organisms is also problematic because humans require beneficial microbes that live in our digestive tracts to properly digest our food. Recent research indicates that human microbial communities are much more complex and diverse than previously imagined (The Human Microbiome Project Consortium 2012), and emerging evidence indicates that industrialized diets change our symbiotic microbial partners, leading to potential health effects and complicating our understanding of pathogenicity (e.g. Ley 2010; Flint 2012; Clemente et al. 2012).⁸⁷ We want safe food, but also need healthy food. Within the hazard mastery paradigm, however, the former eclipses the latter. As the architects of mastery seek to acculturate the entire produce supply chain to embrace the suppression of dangers originating in external nature, they simultaneously suppress the regenerative and vital metabolic pathways that connect our living selves to living landscapes and ecosystems through the medium of food.

Food safety experts promote standardized interventions—wildlife fences, bare ground buffers, exhaustive water and soil testing, rubberized and metallized everything—that all work to create a clear boundary between the messiness ‘out there’ and the controlled space of the field; these purifying efforts are supposed to produce a sense of trust and comfort among the consuming public. But to put this sort of safety into practice is to engage in a project for ordering the world. It is to divide people, objects, places, substances, and so forth into clear categories proclaimed ‘safe’ or ‘dangerous’. Dictionary.com defines *safe* as “(1) secure from liability to harm, injury, danger, or risk: *a safe place*, (2) free from hurt, injury, danger, or risk: *to arrive safe and sound*, (3) involving little or no risk of mishap, error, etc.: *a safe estimate*, and (4) dependable or trustworthy: *a safe guide*.” The first three define safety according to a binary; safety takes on meaning only in contrast to that which is *not* safe. Declaring something safe means simultaneously declaring something else unsafe (dangerous, hazardous, or harmful). We see this organizational force in the common belief that food should be clean, free from dirt. Since “dirt offends against order”, as the anthropologist Mary Douglas phrased it (2002 [1966], 2), keeping food pure entails separating out the dirt. This basic belief was encoded in the original Pure Food and Drug Act, which prohibited producing or selling any food, “If it consists in whole or in part of a *filthy*, decomposed, or putrid animal or vegetable substance” (emphasis added). Today, this belief manifests insidiously through a behavioral pattern that Andrew Szasz has coined the “inverted quarantine”, which occurs when individuals come to believe that the “whole environment is toxic, illness-inducing” and the only form of protection is by “isolating themselves from their disease-inducing surroundings” (Szasz 2007, 5).⁸⁸ In all cases, maintaining a firm boundary between (filthy) dirt and (pure) food is thought to produce stable order, and thus also produces safety in the sense of the fourth definition, that which is dependable and trustworthy.

Prominent food writer Michael Pollan captures the essence of the contradiction inherent in such separation clearly in his book *Food Rules* (2009). In direct refutation of the sanitary field approach, his eighteenth rule states unequivocally, “Don’t ingest foods made in places where everyone is required to wear a surgical cap.” Ironically, food safety regulations generally require just this behavior. LGMA, for example, requires harvest crews to wear hairnets and latex gloves. While the hazard mastery paradigm produces safety by separating wild external nature (dirty hands) from a to-be internal nature (food), seen in an alternative frame, that sort of dominating order also undermines healthfulness by fostering ‘unnatural’ practices. In Pollan’s rulebook, sanitary is unnatural, and unnatural is unhealthy.

This contradiction between healthfulness and safety appears time and again in critiques pointing out the dangers when the food system strays too far from nature. In contrast to the myth of progress through domination, there is a strong belief that partnership with wild nature can produce *healthfulness* for both people and ecosystems:

Agriculture is a human endeavor based on biological processes, and nature cannot be eliminated from the equation. Food safety will not be achieved simply by monitoring and killing bacteria—it must come from a food system that values human relationships and environmental stewardship. (NSAC 2009).

Some take the argument further and contend that humans should follow nature's lead and adjust our industries and economy to follow the rhythms and patterns of ecological processes rather than coerce ecosystems to conform to factory-like production and maximize profits. Corey Rennell, the founder of a health food business called CORE Foods, made this very case in an article he wrote for *Huffington Post*:

We know that all animals consistently rely on raw food, lots of water, regular sleep and exercise. *These lessons from natural history are the most powerful tools we know.* Don't get fooled by efforts to make them more complicated. Return to these principles every time you consider new food products, supplements, diets and even new scientific studies. Despite their claims, most of these things have hidden interests other than your health. (Rennell 2011, emphasis added).

In other words, all food was once a living part of nature; pretending it can be purified and the farm field sanitized is a dangerous delusion, and probably represents a hidden agenda masquerading as health advocacy. Many farmers, handlers and distributors of fresh produce expressed to me various levels of indignation over the implicit hypocrisy of 'crying wolf' on environmental risks at the farm level while glossing over the systemic risks of industrial agriculture. To take one example, a farm advisor working to expand markets for local produce asked,

How can you possibly say that more biodiverse farms are more dangerous? It seems that centralization is dangerous, that a total lack of diversity is dangerous, right? That's why you see so many recalls in meat products. We're sterilizing our world, and I think that's a big problem too.

Biodiversity is a source of protection, he argued, against the danger posed by large-scale, factory-like farming. From this standpoint, health correlates with the wildness of food—its inner liveliness—such that it can actively partner with human bodies and the symbiotic bacteria living within us to properly digest and receive sustenance. Implicit in this logic is the belief that the lessons and components of healthy eating can be found in nature. It is not pathogens, then, which contaminate food and should be separated out through purification, but rather the active meddling of corporate industrial practices that compromise health by denying our internal natures. From this frame of reference, profit-driven corporate agribusiness may lead people astray, but wild nature is a reliable guide—leading us “from joy to joy”—to which we can turn for safety and protection in dangerous times. Pollan again puts it bluntly: Rule #19, “If it came from a plant, eat it; if it was made in a [manufacturing] plant, don't” (2009).

The message of this alternative framing of food and human health is that external nature is not to be feared, but embraced and accommodated—its wildness complements the wildness within our own bodies, our internal nature. So perhaps what drives resistance to the laboratory-

factory-farm is not the sacrifice of humility and wonder for hubris and mastery, but rather that humans, along with ecological landscapes and our fellow species, will cease to be wild—that we will sanitize ourselves along with our agrifood systems, and thereby surrender our agency to the apparatus.⁸⁹

Toward Regenerative Partnership

We all strive for safety, prosperity, comfort, long life, and dullness... A measure of success in this is all well enough..., but too much safety seems to yield only danger in the long run. (Leopold 1949, 141).

The epistemic community of industry-aligned food scientists and microbiologists that I have named the “architects of mastery” insist that society should consent to their dominating imperative to control dangers originating in wild nature. But this is not the only possible stance toward the relationship of nature to safety, as suggested by Aldo Leopold’s suggestive cautionary note quoted above. In contrast to the mastery paradigm, I would like to turn toward the idiom of regenerative partnership to illustrate the possibility for an alternative route toward safe food. In tracing the contours of what such an alternative “thought collective”⁹⁰ might entail, I draw on Dahlberg’s (1993) concept of regenerative food systems and Merchant’s (2013) partnership ethic. What is common to both threads is a rejection of pure binaries—which, ironically, are central to both the hazard mastery paradigm and its mainstream critics—and an acceptance of plurality, messiness, and diversity.

Dividing the world into strict safe/unsafe or healthy/unhealthy spaces and practices or internal/external natures engages in a process of purifying the world into binaries. Either formulation invites hybridizing slippages that proliferate interdependently and in proportion to the intensity of effort to purify (Latour 1993). What is important to recognize is that the work of producing a binary also produces a *polarization* of the world—a separation into positive and negative—that creates a hierarchy of power, a “moral economy” determining who is ‘good’ and who is ‘bad’ (Busch 2000). And this marks the most pressing problem with the polarization of attitudes toward agrifood systems—the belief that pure forms are possible, and are furthermore desirable in both nature *and* people. Such a cognitive premise denies all experience with practical, day-to-day grounded experience, which, like a flock of birds in a field, embody elements of both chaos and order, calling into question the utility of either point of reference.

Regardless of particular socially-constructed categories of danger and safety, wild and controlled, food in whatever form it takes is one substance which must cross the boundary that we imagine to exist between environment and body. Acknowledging the cognitive limitations of this human-nature boundary and learning to accept contaminating ‘transgressions’ as contextual negotiation or compromise rather than slippages of control would yield more valuable insight into how new pathways for agrifood systems might be envisioned and pursued based on shared understandings rather than divergences.

Widespread enrollment in a “thought collective” held together by mutual commitment to a regenerative partnership across the agrifood governance network might provide a flexible medium for precisely this type of pursuit. For Merchant, a partnership ethic offers an escape from binaries like safe|dangerous: “rather than being either dominators or victims, people would cooperate with nature and each other in healthier, more just, and more environmentally sustainable ways” (7). For Dahlberg, the sticking point revolves around, “The basic

discontinuities between current industrial structures—which are complicated, but inflexible—and the adaptive institutions needed for sustainable and regenerative food systems...” (Dahlgren 1993, 98). He theorized that in order to move toward truly regenerative food systems, a fundamental shift in thinking—encompassing ontologies, epistemologies, and normativities—is required. The crux of his argument rested on the premise that the diversity and redundancy of “activity at the ground level—unique local expressions—contained the adaptive possibilities that could offer stability to higher, more abstract levels of a system and resilience to the system as a whole” as DeLind (2010) summarizes it. She goes on to imply a connection between Dahlberg’s concept of contextuality in the social-ecological sense to the domain of governance and political economy through the notion of flexibility:

Flexibility is understood to reside at the local level, in the vast numbers of small places, in their innovation and in the overlap of their many functions... Diversity and redundancy (or conversely the relative absence of uniformity and instrumental efficiency) are at home in real lived places. Letting these places speak for themselves and listening to them carefully (i.e., less partially) are much of what Dahlberg [1993] meant by “contextual analysis.” (DeLind 2010).

In the context of governance networks, flexibility, experimentation, and adaptiveness find purchase as desirable system aspects in their own right, as keystones of both democratic legitimacy/anchorage and administrative effectiveness, for much the same reasons DeLind and Dahlberg explain (see, e.g. Sørensen and Torfing 2005; Sabel and Zeitlin 2012; Timmermans and Epstein 2010). Flexibility allows for, perhaps even requires, that governance tolerate diversity—a state of being which is at odds with the homogenizing tendency of standards. In many ways, the energy created by friction between the desire for flexibility and the need for standards drives the design and evolution of the food safety apparatus. Just as pathogens and wild animals threaten to disturb the ‘normal’ order of yield-maximizing industrial agriculture, so too do the efforts of farmers and sustainability-minded activists to find flexible ways to ensure safety disturb the ‘normal’ operation of the hazard mastery paradigm. A regenerative partnership idiom precisely eschews the long-standing fixation with the ‘normal’ and the ‘optimal’, setting aside both moral designations in favor of a pluralist tolerance for multiple pathways toward health, justice, prosperity, and general well-being.

A partnership ethic furthermore assumes a posture of humility that reserves some agency for non-human nature, and therefore accepts those “others” as only partly knowable; a certain ineffability will always exist. Such an ethic would embrace Jasanoff’s “technologies of humility” (2003), which “acknowledge the limits of prediction and control” through “institutionalized habits of thought that try to come to grips with the ragged fringes of human understanding—the unknown, the uncertain, the ambiguous, and the uncontrollable.” Gunderson and Holling’s (2001) concept *panarchy* provides a useful mental model to consider the ramifications of humbly participating in a regenerative partnership thought collective. The model starts from the following premises: (1) the world is complex and full of surprises, (2) surprises should be taken as opportunities for creative adaptation, (3) resilience is a positive system characteristic that facilitates adaptation, and (4) all processes are interdependent and span multiple spatial and geographic scales. Within this worldview, agrifood systems inescapably cycle through phases of growth, stability, disturbance, and reorganization. From the standpoint of the panarchy model, the hazard mastery paradigm’s efforts to preserve and prolong stability indefinitely only set the system up for bigger and more traumatic disturbances, for example larger and more deadly outbreaks of foodborne illness.

A partnership ethic also means accepting human evolutionary intra-actions with the organisms and ecosystems—at the landscape as well as microscopic scales—that help us provision ourselves with food.⁹¹ As environmental historian Edmund Russell observes:

We have largely ignored... the impact of ecological changes and public health measures on the constitutions of other species. By changing the environments in which organisms live, we have changed the selective regimes in which they evolve. In some cases, the resulting evolution has forced humans to interact with versions of those species in very different ways. (Russell 2003).

What Russell highlights—through reference to the long-term dynamic intra-actions that we call evolution—is another form of hubris: the failure to recognize potential forms, scales and temporalities of agency that lie beyond the framing assumptions of an apparatus. The architects of mastery fall into this trap by failing to imagine the long-term, systemic repercussions of their campaign for rigid control. Diana Stuart has argued that “New food safety measures created by the produce industry attempt to sterilize production sites... Despite its intent, this war on nature may not have the desired effects and could actually serve to increase risks to human health” (2008). Moreover, a myopic fixation with mastering food-borne disease has blinded governance toward what Martha McMahan coins “food-system-borne diseases”, including chronic malnutrition, toxic residues, and ecological crises from the local to global scales. “Food-system generated risks... do not show up on any food-safety test,” she continues, but “they increasingly shape the food supply of many of the world’s poorest people” (McMahan 2013).

By contrast, approaching agrifood systems with humility through a partnership ethic leads to imaginaries for radically different modes of (re)producing food. Rather than idolizing stability and mastery—tipping the balance of continuity and change too far toward the former—partnership accepts periodic disturbances, and tries to work with them. In the context of food safety, this means tolerance for some periodic illness in order to mitigate the severity and scale of more extreme outbreaks. This line of thinking was expressed in one of the early papers that attempted to address foodborne illness from an agroecological perspective, which accepts many of the premises of partnership ethics:

One could make a case that, just as we want some level of exposure to infectious agents—or simulated exposures such as vaccination—to maintain the resilience of our immune system, so we may want to tolerate the smaller disease outbreaks that come with a more decentralized agrifood system... In this sense at least, a little bit of food poisoning is probably a good thing. It helps us to keep up our personal immunity as well as our capacity to respond to outbreaks, and serves the crucial role of reminding all participants in this shortened, more visible, food chain about the inherent risks of eating our environments. (Waltner-Toews 1996).

The author’s statement that periodic, low-level contamination events might actually be desirable reflects a worldview that accepts that contamination events will happen regardless of human attempts to control them; Waltner-Toews expects that greater control and lower frequency of outbreaks might correlate with higher severity, which could be worse overall. The basic idea is similar to the lesson learned in forest management over the past century—preventing all forest fires leads to a build-up of undergrowth that will eventually lead to a massive wildfire that can burn millions of acres and leave vast swathes of land desolate for years. If instead managers practice prescribed burning, many low-intensity fires can keep fuel density low and avoid those massive burns. The agroecologist, like his prescribed-burn-advocating

analogs in forestry, argues that the food system should allow more small disturbances, i.e. low-intensity infections. Healthfulness, then, relates to resilience and adaptability, and should be understood as a direction for dynamic growth rather than as a fixed state that society strives to maintain in the face of destabilizing wild nature.

To summarize, if we were to act in congruence with the regenerative partnership idiom, efforts to govern the agriculture and food system with a mind to safety and health should seek,

“not to eliminate the danger, but to manage it. It is not to take our food (and ourselves) out of context—to sanitize, standardize, and codify—but to keep it (and us) in context, in situ and continually adjusting... This is our security. The closest we can come to food safety is to know who we are, where we are, and what we are eating” (Delind and Howard 2008).

Though absolute knowledge remains forever elusive in this ontology, people should be given the choice to consent or not to the risks inherent in a socio-ecological food system, and that includes those risks presented by synthetic chemicals, economic monopoly, and biodiversity loss in addition to infectious pathogens. In contrast to the hazard mastery paradigm’s core assumption that science can defend society against whatever dangers nature throws at it, the partnership ethic assumes that communities in partnership with nature can diffuse danger into tolerable background perturbations. Ultimately, this is a societal question of “how to live democratically and at peace with the knowledge that our societies are inevitably ‘at risk’” (Jasanoff 2003). This is a tall order, though, for it implies that we try the novel approach to eschew mastery altogether, “to have no master at all” (Latour 1999, 298).⁹²

Conclusion

We are constantly reminded that eating fresh fruits and vegetables is healthy for us. But in the face of repeated outbreaks of foodborne illness linked to fresh produce, whether these foods are *safe* for us has become an entirely different, and difficult to answer, question. In the name of food safety, both government and industry leaders are working to propagate far-reaching policies intended to prevent human pathogens from contaminating crops at the farm level, but these policies meet friction on the ground. Controlling dangerous pathogens and protecting public health are not the only goals served by expanding food safety regulation—food safety also serves to discipline and order people and nature for other purposes. Food safety experts, capitalizing on the lack of available science upon which to base standards, carve out for themselves a monopoly in setting and interpreting food safety standards. And government agents wield their expanded policing powers primarily to make examples of a few bad actors in order to shore up public confidence in the food system and the government’s ability to protect its citizens, but fail to address the structural problems and risks inherent in a uniform, corporate, and industrial mode of agribusiness. Furthermore, food safety governance carries hidden costs and burdens for agrifood workers and agricultural ecosystems, not to mention lost opportunities to pursue other diverse trajectories for sustainable, healthy food systems. Zealous fixation on driving the risk of microbial contamination toward an always out-of-reach “zero” blinds us to the structural problems and risks inherent in the food system status quo and stifles alternative pathways for growing and distributing food that is ecologically, economically, or culturally sustainable and resilient. The narrow scope of existing food safety policy must be broadened and developed holistically with other societal goals envisioned over the long term.

The stakes of changing our agricultural and food systems are immediately tangible for most people. Americans are interested in the food we eat: we want to know where our food comes from, how it is grown and handled, by whom, and ultimately whether we can trust that it is healthy and safe for us to eat. As much as this dissertation addresses theoretical gaps related to abstract concepts such as distributed governance, agency, and power, it also speaks to these concrete and pragmatic concerns. Consumer-citizens demand food that is safe and healthy to eat, that is accessible and affordable, that is grown sustainably, organically and fairly, and that is enjoyable and satisfying. Meeting these many demands is neither a simple nor uncontested task. Demanding standards that all producers must meet cannot account for the ways in which standards inevitably standardize, overriding potentially important local, contextual differences. Demanding more science cannot account for the ways that the pertinent questions and the level of acceptable uncertainty are chosen, and demanding more accountability from farmers and farm workers cannot resolve the disconnect between those outcomes that we can measure and those outcomes that we actually desire. If nothing else, this dissertation contributes to a broader social conversation by pointing out that food safety—and the future of agrifood systems more generally—is not a topic that can be safely left for experts and bureaucrats to sort out technocratically. Rather, the question of what/whose health and for whom/what must be an active public conversation and debate.

Notes

- ¹ According to Freidberg (2004, 5–6), the term “food scare” refers to “episodes of ‘acute collective anxiety,’ set off by reported risks of invisible food-borne pathogens and resulting, typically, in plunging sales of the suspect products.” Caswell (2006) argues that sudden panic arises because public notification of foodborne danger frequently seems to “pop out of nowhere” with little context or logical continuity “because [dietary risks] are covered in the media only occasionally (and then with high frequency) when something dramatic has happened.” What sets off the scare, then, is not so much “proven danger”, Freidberg notes, but rather the sudden perception that the risks inherent in the food supply “are neither well understood by science nor well regulated by government.”
- ² FDA (1998) defines fresh produce as any fruits or vegetables “sold to consumers in an unprocessed or minimally processed (i.e. raw) form.” In my usage of ‘fresh produce’ I also include “fresh-cut produce”, which is “altered in form by peeling, slicing, chopping, shredding,” etc. (FDA 2008) for sale to institutions like school and hospital cafeterias or, increasingly, directly to consumers looking for the convenience of ready-to-eat salad mixes and similar pre-processed fruits and vegetables (see, e.g. Charles and Aubrey 2016).
- ³ Marketing agreements are customized arrangements initiated by industry but facilitated by USDA and state departments of agriculture. According to the USDA’s Agricultural Marketing Service (www.ams.usda.gov), marketing agreements exist to “help producers and handlers work together to solve marketing problems that they cannot solve individually.” Such agreements have been in use since the early 1930s, but historically were used only “to improve the market power of producers” by setting standards for quality, packaging, size, weight, etc. (Wood 1961). The LGMA marks a novel use of such agreements to regulate product safety, a proactive industry work-around reached during a time where Federal authority over produce agriculture was virtually non-existent but threatening to rapidly expand (see Endres and Johnson 2011; Shekhar 2010).
- ⁴ Although the law was not finalized until 2011, earlier versions had been drafted years earlier (for a detailed account of the law’s passage, see Strauss 2011). Furthermore, efforts to reform Federal food safety oversight had been ongoing for years. The Government Accountability Office (GAO) repeatedly criticized the existing national food safety system since at least the early 1990s, finding that it “hampers and impedes efforts to address public health concerns associated with existing and newly identified food safety risks” (GAO 1994), is “fragmented, characterized by a maze of often inconsistent legal and regulatory requirements” (GAO 1997), and “patchwork structure”, “cobbled together over many years,” “that cannot address existing and emerging food safety risks” (GAO 2001). GAO also called out the need for specific Federal action on produce safety in 2008 (GAO 2008). That FDA would take the lead, however, was not a foregone conclusion. Prior to the passage of the FSMA, a national marketing order (a compulsory, nationwide form of the marketing agreement reached through the LGMA) was planned under USDA’s executive authority, and only abandoned after the US legislature acted (Endres and Johnson 2011).
- ⁵ One effect of the sovereign state stepping back into the role of meta-governor is to decouple public policy from strictly territorial (i.e. tied to geographic area) boundaries. In theory, this deterritorialization allows for multi-scalar and even a-scalar arrangements for setting policy goals and carrying them out. It also, however, further blurs the line between public and private interest, the separation of which is a long-standing foundation on which the legitimacy of democratic governments has been anchored.
- ⁶ This, perhaps, marks the primary distinction between an alternative framework such as resilience, and the mastery associated with industrial agriculture. While regulating volatility is generally desirable in many social and ecological systems, “the emphasis for California’s growers is on creating the conditions for a reliably *maximal* crop rather than just stable yields” (Henke 2008, p. 186).
- ⁷ My usage of *technique* is drawn from Dean’s notion of the *techne* of government, or more specifically the “technologies of government” which are the technical means and instruments which constitute authority and effect rule. Dean maintains that the *techne* is “necessary, somewhat autonomous and irreducible” to values, discourse, or frames; technical means are both empowering and constraining, in that they “are a condition of governing and often impose limits on what it is possible to do.” (Dean 2009; see also Dean 1996).

- ⁸ For example, in 13th century-England, the King would appoint two chamberlains to check the treasurer's book-keeping. "The chamberlains of the receipt had as their primary function the keeping of 'counter-rolls,' of receipts and issues of the [treasurer of] the exchequer. Hence there were normally three duplicates of these rolls..." For such an official, it was "his essential duty to 'keep the counter-roll,' which acted as the chief check upon the keeper's [treasurer's] book-keeping." (Tout 1920, 35–36). Adopted through the French *contreroule*, this archaic meaning survives today in the modern office of comptroller.
- ⁹ One stage of the complex sequence of biochemical reactions that comprise the widely-used polymerase chain reaction (PCR) method for measuring microbial contamination in fresh produce.
- ¹⁰ Foucault regarded the apparatus as a strategic formation "that at a given historical moment has as its major function the response to an urgency" (Agamben 2009, 2). The food safety apparatus is oriented with respect to just such an urgency, namely the threat of foodborne human pathogens and the sickness and death they can cause. The strategic function crystallizes around the mastery worldview (see Chapter 3), a stable social imaginary of the boundary between "the world created by us and the world we imagine to exist beyond our control" (Jasanoff 2004, 21). This imaginary represents a distinct 'settlement' between the natural agency of hazards (the driving urgency) and the social agency of control (the strategic response). However, a co-productionist approach "does not assign an a priori causality in the generation of new settlements", seeking rather to reveal the "mutual constitution of arrangements and closures that are epistemic as much as normative" (Curnutte and Testa 2012). Hence when I refer to "urgency" and "response" within the apparatus, the sense of causation and effect that emerges is itself produced, an artifact of food safety work performed simultaneously along scientific, technological, political, and cultural dimensions.
- ¹¹ See also *e.n.* 26.
- ¹² The perception of danger from food is not only socially constructed, but crucially *publicly* constructed. Danger, in this sense, is endemic to public discourse: "Fear of poisoning has never been reserved for the world's great and powerful. It is a collective fear, shared socially" (Ferrières 2006, xi).
- ¹³ The cultural fixation over 'purity' with respect to food and who produces, prepares, and handles it dates back much further than the American Progressive movement, of course. See, for example, Madeleine Ferrières' history of food fears from the Middle Ages to the twentieth century, especially her accounts of food prohibitions levied against "those pariahs of the medieval mindset (Jews, lepers, and prostitutes)" (Ferrières 2006).
- ¹⁴ In this way, the food safety movement dovetailed with the trajectory of epidemiology in locating its ideal authority at the level of the nation-state, i.e. the Federal Government in the US. "From [the Manhattan Project and Los Alamos] stems the era of big science, a science wrapped in high technology that can only be sustained by government. Epidemiology shares in this evolution. Much of modern epidemiology must be on a large scale because of the demands inherent in its new ambitions" (Susser 1985), which were in line with the society-spanning ambitions of the food safety laws and norms established during the Progressive Era.
- ¹⁵ The original 1906 law defined "adulterated" foods in six ways: if any substance were (1) mixed with the food "so as to reduce or lower or injuriously affect its quality or strength" or (2) "substituted wholly or in part" for the food; (3) if a valuable constituent of the food were removed or "abstracted" from it; (4) if the food's appearance were altered to conceal damage or inferior quality; or if the food contained (5) "any added poisonous or other added deleterious ingredient which may render such article injurious to health" or (6) "a filthy, decomposed, or putrid animal or vegetable substance."
- ¹⁶ Harvey Wiley, chief chemist of the Bureau of Chemistry (the antecedent to today's FDA) from 1883 to 1912 and a key author of the Pure Food and Drug Act, was one of the most prominent figureheads and proponents of the purity frame of reference, and a famous nay-sayer of the danger posed by microbes. According to Levenstein, "Wiley was raised with the idea there was something immoral about how 'pure food' was denatured once if left the farm gates" (2012, 62). For Wiley, "the 'pure' in the Pure Food Act... meant food that was free of 'poisons'—chemical additives that were either injurious in themselves or ones that masked foods that had deteriorated and become 'poisonous'" (66).
- ¹⁷ For an explanation of spokespersons and obligatory passage points in actor-networks, see Callon (1986).
- ¹⁸ In the related field of medicine, Sturdy and Cooter (1998) argue, "The new [laboratory] sciences were valued because they offered an effective way of ordering and managing, at one and the same time, both the natural phenomena of disease and the social and cultural relations of medicine." The laboratory sciences dovetailed nicely with administrative rationality in multiple fields, then, which helps explain how microbiologists and their

laboratories have so solidly established themselves as an obligatory passage point in multiple actor-networks, of which foodborne disease surveillance, classification and detection constitutes only one.

¹⁹ In Hardy's alternative phrasing, "On the one hand bacteriology modified and challenged the traditional techniques of epidemiology; on the other it extended its environmental concerns." (Hardy 2001).

²⁰ The repercussions of this fundamental atomization of foodborne disease are wide-ranging. As DeLind and Howard point out, if we "treat each crisis as an independent occurrence", we also "disguise the fact that uniformity or atomization... are themselves extremely dangerous" (2008), precluding the possibility of structural and/or emergent "food-system borne disease" (McMahon 2013). Ironically, under the food safety apparatus, public danger is articulated almost entirely in reference to the individual and autonomous—that is, neoliberal—subject.

²¹ While a detailed discussion of the full process of this shift is beyond the scope of this chapter, the commentary by G.M. Dack in her introduction to her book *Food Poisoning*, first published in 1943 with new editions in 1949 and 1956, is instructive (Dack 1956). "Although food poisoning may result from a diverse group of inciting agents," she writes, "there is still a tendency to disguise the causative agent under the blanket term 'ptomaine' poisoning [taken from the Greek *ptoma*, or 'corpse']... There is neither a specific entity nor a group of substances which can be properly called 'ptomaine'; therefore, the term is unscientific and meaningless." The use of the generic word ptomaine reflects the relative unimportance that the early adulteration epistemology gave to knowing the precise agent that caused illness—it was enough to know that illness resulted from a 'force of nature', as Satin put it, that the producer or merchant should have protected his or her customers against. Again, Dack supports this inference in her next paragraph, stating that "there is a popular tendency to associate food poisoning with putrefaction," a state of decay that is obvious with the basic human senses of sight, smell, taste and touch. Putrefaction would indicate impurity, and that was sufficient to define danger. However, for Dack, that definition lacked specificity according to the emerging norm of rational justification: "It is now known that putrefaction in a food does not necessarily give rise to the toxic substances involved in food poisoning". Impurity, then, is not the cause of illness, but an intermediary state produced by the 'true' cause—the toxic substances which are produced by pathogens such as *Clostridium botulinum*.

²² The etiology of terms used to speak of illnesses associated with pathogenic bacteria is complicated and often messy, reflecting the ongoing normative and ontological negotiations around disease, danger, and safety. "Food poisoning" itself was a compromise term of the 1880s, appearing in the British public health lingo in 1889 only *after* the British central medical department had instituted a system for collecting information about outbreaks of gastroenteritis (Hardy 1999). They used the term in quotation marks, signaling their intention to both discredit and supplant earlier theories of gastroenteritis, such as 'ptomaine' poisoning (see *e.n.* 2121). While 'poisoning' did not exactly capture the agency of living bacterial pathogens infecting human bodies, keeping the reference served to retain the association with gastroenteritis that would be familiar to the broader population of health practitioners, not all of whom were yet enrolled in the nascent germ theory revolution, and also to the general public.

²³ This shift is in keeping with a widespread, though precarious, belief that science is "capable of delivering a true picture of the physical world", a trust which over the course of the 20th century led to a situation in which "the legitimacy of American regulatory decisions uniquely depends on rational justification," and more specifically, "scientific rationale" (Jasanoff 2012, 104).

²⁴ Excluded from this provision are all products covered by the Federal Meat Inspection Act and the Poultry Products Inspection Act and therefore under the jurisdiction of USDA's Food Safety Inspection Service (FSIS). It should also be noted that federal government authority is constitutionally limited to interstate trade—food products produced and sold entirely within the boundaries of a single state are not subject to federal authority, but lie within the jurisdiction of state regulatory agencies.

²⁵ In general, "Neither intent nor guilty knowledge is an essential element of the offenses created by most food statutes and ordinances" (36A Corpus Juris Secundum, *Food* §45, 2014).

²⁶ With the emphasis on technology *and institutions* becoming coupled together, I seek to more carefully walk the fine line described by Thomas Hughes: "Technological systems, even after prolonged growth and consolidation, do not become autonomous; *they acquire momentum*. They have a mass of technical and organizational components; they possess direction, or goals; and they display a rate of growth suggesting velocity" (T. Hughes 1987, 76, emphasis added). These characteristics may lend the system the appearance of independent agency, but do not mean that "technology drive[s] history" (Smith and Marx 1994). That said, the momentum of large technological systems constrains the forms of agency that people may practice, locking them in to particular

tools, expectations, and behaviors. For example, tightly coupled systems are highly vulnerable to the breakdown of a single component, making accidents “inevitable, even ‘normal’” (Perrow 1999) when operating complex technologies (and institutions). Perrow’s notion of the “normal accident” is one instantiation of the ways in which technological momentum shapes the ways in which humans perceive the boundaries of our own agency.

- ²⁷ USDA-FSIS’s *Food Safety Information* pamphlet for chicken goes so far as to state, “Most foodborne illness outbreaks are a result of improper handling or contamination when meals are prepared. Sanitary food handling and proper cooking and refrigeration should prevent foodborne illnesses” (USDA-FSIS 2014).
- ²⁸ As of August 2016, FoodNet collects information from every county in seven states—Connecticut, Georgia, Maryland, Minnesota, New Mexico, Oregon, and Tennessee—and county clusters in three additional states, including the Bay Area of California, upstate New York, and the greater Denver area. (CDC 2015c).
- ²⁹ There are many strains of *Escherichia coli*, most of which do not cause illness in people (and are in fact necessary denizens of the intestines that aid in proper digestion). Several dangerous strains have evolved to be pathogenic in people, most dangerous of which are Shiga toxin-producing *E. coli*, or STEC as they are commonly known. *E. coli* 0157:H7, the pathogen behind the 2006 spinach outbreak, was the first documented STEC, identified in 1982, and to date the most virulent strain. Shiga toxin, also produced by *Shigella* (a species of which is responsible for dysentery), is the primary cause of bloody diarrhea in the US, and can lead in severe cases to a kidney condition known as hemolytic uremic syndrome (HUS), which is the primary cause of death from STEC infections. (CDC 2015b).
- ³⁰ This system, known as the National Notifiable Diseases Surveillance System (a separate entity to FoodNet), dates back at least to 1879, when Congress first began collecting information about diseases that commonly caused epidemics at the time (e.g. cholera, smallpox). Over the next several decades, the reporting procedures were standardized and by 1928, all state health departments had been enrolled to cooperate with the effort. In 1955 the Council of State and Territorial Epidemiologists, representing public health officials across the country, was formed with the responsibility of defining and maintaining the list of reportable conditions within states and deciding which to report to CDC, which began its weekly reporting duties in 1961. (CDC 2015a).
- ³¹ The CDC runs the PulseNet Methods Development Laboratory specifically to develop “new technologies and procedures for subtyping organisms that might supplement or eventually replace [the current standard procedures]” (Boxrud et al. 2010).
- ³² Culturing bacteria is the slowest step of DNA fingerprinting—taking anywhere from 12 to 16 hours in most cases—and many clinical laboratories are transitioning to culture-independent diagnostic tests for determining which pathogen has caused a patient to become ill. This means that the clinical labs often do not keep a live bacterial sample to send to PulseNet laboratories for DNA fingerprinting, posing a major challenge for the system. Public health administrators are concerned that the raw information stream required to run the surveillance network could dry up (Boxrud et al. 2010). CDC is actively seeking to develop whole genome sequencing procedures that can be run directly on the raw sample (from a patient, food product, or environmental swab), but the agency estimates that these procedures are still years away from becoming standard for PulseNet (CDC 2016).
- ³³ Understood in this way, mastery as I use it here operates simultaneously as (1) a Cartesian *ontology*, which assumes that “things as they are” exist distinctly from our perceptions of them, (2) a mechanistic and reductionist *epistemology* that seeks understanding by breaking down the world around us into component parts as though the universe were a clockwork, and (3) as an anthropocentric *normativity* that presumes human agency is unique and supreme, basically that humanity’s rightful place is dominion over all of creation. This is less a descriptive definition of mastery as it is a guiderail for analysis, in the same way that *co-production* for Jasanoff (2004) is an “idiom” or *ontonom* for Mol (2012) is a “methodological tool”.
- ³⁴ In considering contemporary implications of her history, Tomes cautions, “I am convinced that the achievements of the early twentieth-century public health movement are not nearly so secure as we once thought” (1999, xiv), incidentally precisely capturing the gospel’s latent function: supplanting security and comfort with ever-present anxiety and doubt just as the sewer state perpetuates contamination as it purifies.
- ³⁵ For an excellent discussion of the relation of standards to moral economy, see Busch (2000).
- ³⁶ Consumer advocates argued that the agency regularly turned a blind eye when industry cut corners in fulfilling its responsibilities to protect consumers from foodborne hazards. A group of students organized by consumer rights and environmental activist Ralph Nader, known colloquially as “Nader’s Raiders”, conducted investigations into the FDA during 1968 and 1969. After interviewing hundreds of agency staff and reviewing

numerous official documents, the group published their findings in the scathing 1970 report, *The Chemical Feast: The Ralph Nader Study Group Report on Food Protection and the Food and Drug Administration*. The controversy led to Congressional hearings, a White House conference on potential reorganization of federal oversight for food safety in 1969 (IOM and NRC 1998), and two critical investigations by the US General Accounting Office (GAO 1970; GAO 1972). A series of high-profile botulism poisoning cases in 1970 put even further pressure on the agency.

- ³⁷ This circularity resembles the “experimenter’s regress” coined by Collins (Collins 1985). Both tests and experiments are “an exercise in skill” that depend on whether the technician performed the test (or the scientist performed the experiment) competently (Pinch 1994). As “there is no independent measure of competence”, it is impossible to know whether, for example, a negative test result means that there truly is no contamination, or whether the laboratory technician made a mistake. A test, like an experiment, cannot unequivocally resolve uncertainty or controversy.
- ³⁸ The panel formally eschewed a “zero tolerance” policy in the report, but did not preclude the expectation of “zero detection” as an implicit objective of control. The report defined a target threshold as “the most that can even be assured with a measurable degree of confidence” (Kupchik et al. 1971, emphasis added). The report went on to recommend rapid and widespread dissemination of any new technologies or laboratory testing methods with greater sensitivity (lower probability of false negatives) or reliability, even at the cost of reduced specificity (higher probability of false positives). This recommendation established the precedent for continuous improvement in technological capacity to identify hazards at an ever more fine-grained scale. Food safety regimes still grapple with the ambiguity between zero tolerance and zero detection and the persistent tension between commonsense understandings of what it means to be free of harmful substances and the reality of technical limitations of detection and purification (Wilson and Worosz 2014). For example, the July 2015 annual meeting of the International Association for Food Protection featured a session, featuring speakers from Cargill and the United Fresh Produce Association, titled, *Chasing “Zero”: How Likely to Reach Success?*
- ³⁹ Guzewich uses “high risk” to refer to “Establishments that serve foods most frequently associated with foodborne illness”, the determination of which “is why food-borne disease surveillance is an essential first step” for any hazard control program.
- ⁴⁰ The agency cited “new stresses and challenges”—including new technologies, distribution and consumption patterns, and potential hazards—as the reason for exploring new rulemaking options. Of particular note in the context of my argument in Chapter 2, FDA wrote that, “One of the most important challenges to FDA’s current food safety assurance program is the increasing number of new food pathogens. *Although food borne illness has always been a public health problem, such illness appears to be on the rise, and new pathogens are appearing. In addition, because foods are more extensively processed and handled, there is now a greater opportunity for food to be contaminated*” (59 FR August 4, 1994, emphasis added).
- ⁴¹ Food safety experts sought continual improvement in part by turning attention to upstream suppliers and their production processes. By way of example, one early paper on applying HACCP to shellfish processors, predating the 1995 FDA seafood rule by nearly a decade, sought to introduce the model as a response to the “lack of widespread consumer confidence resulting from outbreaks of gastroenteritis” linked to bivalves (West 1986). Importantly, the authors justified the need for intervention based on the “potential” for large outbreaks, acknowledging that “relatively few” have actually occurred. The authors began their systemic hazard assessment with primary production (that is, harvesting shellfish in water). They listed the “sanitary quality of growing waters” as a critical control point which should be regulated by bacteriological surveys of growing areas, a clear spatial and temporal extension of the environmental control principle crafted for food processing. From an early date, then, the HACCP model encouraged industry professionals and government regulators to focus on upstream, environmental conditions during primary production as potential sources of hazard.
- ⁴² It remains unclear precisely how FDA will police this provision regarding validation. The rule simply states “You may establish and use an alternative to any of the requirements... provided you have adequate scientific data or information to support a conclusion that the alternative would provide the same level of public health protection as the applicable requirement...” (21 CFR §112.12b). The rule goes on to specify that data “may be developed by you, available in the scientific literature, or available to you through a third party”, provided that the scientific basis is documented, but the rule also states that operators “are not required to notify or seek prior approval from FDA regarding your decision to establish or use an alternative under this section (21 CFR §112.12c). Presumably FDA is operating under a ‘shadow of hierarchy’ principle—while Federal inspectors

will not actively monitor validation procedures, operators will comply out of fear that the responsibility and liability will rest with the operator in the case that a control measure fails to prevent contamination.

- ⁴³ Hazard analysis is defined as a highly technical “process of collecting and evaluating information on hazards and conditions leading to their presence to decide which are significant for food safety and therefore must be addressed in the HACCP or Food Safety Plan” (FSPCA 2016). According to the Code of Federal Regulations, validation is defined as “Obtaining and evaluating scientific and technical evidence that a control measure, combination of control measures, or the food safety plan as a whole, when properly implemented, is capable of effectively controlling the identified hazards” (21 CFR 117.3).
- ⁴⁴ “Relativism and totalization are both ‘god tricks’ promising vision from everywhere and nowhere equally and fully, common myths in rhetorics surrounding Science,” writes Haraway. The god-trick occurs when any scientific endeavor—which must always be situated in a particular place at a particular time and among a particular social milieu—“pretend[s] to disengagement: to be from everywhere and so nowhere, to be free from interpretation, from being represented, to be fully self-contained or fully formalizable.”
- ⁴⁵ From 2014-2015, I interviewed 8 members of the CPS Board of Advisors and Technical Committee. To clarify the source of the quotes used in this chapter, I have coded individual respondents with capital letters, A, B, etc.
- ⁴⁶ Western Growers Association is a trade association whose members provide about 50% of domestic fresh produce in the US. The Produce Marketing Association represents produce growers, packer-shippers, marketers and distributors, and other companies in the fresh produce supply chain, all told a \$550 million industry in the United States (according to the association’s own estimate).
- ⁴⁷ Taylor Farms is best known for its pre-packaged salad mixes, but also markets a wide variety of fresh-cut and ready-to-eat vegetables to both retail and foodservice outlets. For reference, the company has 10,000 employees.
- ⁴⁸ Quotes in this paragraph cite the Center for Produce Safety website, www.centerforproducesafety.org, accessed on October 19, 2016.
- ⁴⁹ One of the few projects that sincerely evaluated co-management practices was funded in the 2014 cycle to evaluate if falconry is effective at deterring pest birds that can vector pathogens: “Results from this study will be communicated widely in the leafy greens growing community to inform the industry of the potential viability of using falconry as an environmentally benign—or even beneficial—approach to non-lethal nuisance bird control.”
- ⁵⁰ “Land-grant” universities are so named because they were built on land donated by the Federal government under the Morrill Act of 1862, on the condition that they teach, among other practical skills, agriculture. Their importance for agriculture was extended by the Hatch Act of 1887, which established agricultural experiment stations at each land grant university, and again by the Smith-Lever Act of 1914, which established the nationwide cooperative extension service to serve as a line of communication between land-grant universities and farmers and “bring U.S. agriculture into the industrial age” (Henke 2008, 22).
- ⁵¹ Thomas Gieryn introduced the notion of “boundary work” to call attention to the social practices that demarcate science from non-science in order to preserve the “cognitive authority” attributed to science. Boundary work, for Gieryn, is “the attribution of selected characteristics to the institution of science (i.e., to its practitioners, methods, stock of knowledge, values and work organization) for purposes of constructing a social boundary that distinguishes some intellectual activity as none-science,” and thus of lesser authority (Gieryn 1995, 405). In the context of CPS, I use boundary work to underline how the Center’s advisory board and technical committee actively seek to control knowledge production through labeling some evidence and findings as ‘science’ while leaving others out, implying that those are ‘non-science’, and therefore irrelevant, because “to label something ‘not science’ is to denude it of cognitive authority” (Sheila Jasanoff 1990, 14) in other words, CPS is a gate-keeper at boundary of food safety science and everything else. However, this gate-keeping requires active work and maintenance. As Geiryn goes on to note, “*Boundary-work abounds* simply because people have many reasons to open up the black box of an ‘established’... representation of science—to seize another’s cognitive authority, restrict it, protect it, expand it, or enforce it” (Gieryn 1995, 407). Thus boundary work demarcating science from non-science is entangled with the social construction of a boundary between politics and non-politics, an observation that led Jasanoff to argue that these ever-contested boundaries, and the natural and social orders they seek to create, co-produce one another.
- ⁵² When I attended the 2014 symposium in Los Angeles, my reduced (student-academic) registration fee was \$330 plus another \$600 in travel expenses. For the 2015 symposium in Atlanta, general admission started at \$480.

When I asked interviewees about who they thought was missing from CPS's ideal audience, many cited small and medium-sized farmers. It's hard to imagine many producers at that scale pulling together the funds *and* the time off from overseeing their farms to attend. Transparency, while laudable, does not translate automatically to equitable access.

- ⁵³ To clarify, a riparian zone or area is the vegetative interface between a stream or river and land. Riparian zones often contain dense vegetation, relatively high biodiversity and serve as important corridors for wildlife movement. Farms tend to be in valleys, and most fields border a waterway of some type, whether endemic or man-made (i.e. from irrigation drainage).
- ⁵⁴ *The role of riparian zones in bacteria dispersal to produce farms*. Jan. 1, 2012 - Mar. 31, 2014, award number 2012-181. \$319,316.
- ⁵⁵ "Validation of geospatial algorithms to predict the prevalence and persistence of pathogens in produce fields to improve GAPs." 2014 funding cycle, Award Number 2014-338. \$291,023.
- ⁵⁶ I have witnessed firsthand on several occasions how birds drive growers—and auditors—into conniptions. Whether it be a rogue flock of geese or a freak swarm of starlings, birds are generally regarded as flying fecal bacteria bombers that can rain ruin across acres of leafy green field at a time.
- ⁵⁷ Yuma, located in the far southwest corner of Arizona next to the Mexico and California borders, is a major US winter growing zone for fruits and vegetables, including leafy greens.
- ⁵⁸ *2014 CPS Symposium: 10 Lessons Learned*. Center for Produce Safety, <http://www.centerforproducesafety.org/resources.php>. Accessed June 14, 2015.
- ⁵⁹ In the field of medicine, the "hygiene hypothesis" has been posited to explain an apparent inverse correlation between infectious disease illnesses and allergic or autoimmune illnesses (Yazdanbakhsh, Kremsner, and van Ree 2002). Basically put, the prevalence of antibiotics, vaccinations and improved hygiene in wealthy societies may inadvertently negatively impact the immune system by altering the human microbiome. The same hypothesis may apply for non-human species as well (Little et al. 2010).
- ⁶⁰ The theoretical advantages of "process-oriented regulation" (see Gilad 2010) or "management-based regulation" (Coglianese and Lazer 2003) have been extensively covered in the literature, along with critiques illustrating the limitations of risk-based regulation that prevent regulatory regimes based on that framework from being truly "responsive" to the situated contexts and needs of the industries and activities they seek to regulate (Black and Baldwin 2010; Braithwaite 2011).
- ⁶¹ I refer here to the literature on management-based regulation (Coglianese and Lazer 2003), meta-governance (Gilad 2010), meta-regulation (C. Parker 2006), and self-regulation (C. Parker 2002). Common to all of these literatures is a feeling that policy should focus on regulatory goals rather than rules. "Systems which attempt only to ensure non-participatory obedience to technical rules set by the state are not ideal" (C. Parker 2002, 27), because they are too fixed and rigid (i.e. non-responsive to changing technological or societal conditions), too blunt and costly, and too adversarial (i.e. do not cooperate with industry and thus sow mistrust and perversely encourage resistance and non-compliance). All of these regulatory schemes argue for the necessity of neoliberal techniques for "governing at a distance" (Rose and Miller 1992) that rest on an assumption of the inherent internal regulatory capacity of organizations and individuals: "It means recognizing that organizations already have significant internal systems, or at least capacities, for regulating employee conduct, supplier relations, management of environmental health and safety risk and other issues, regardless of external regulatory intervention... [an organization] is both an appropriate object of democratic responsibilities and an appropriate subject for responsive self-regulation" (C. Parker 2002, 29). Crucially, to be effective, private sector actors under a meta-governance regime must be *free to act* (and by extension, free to *not* act or to resist) if they are to self-regulate in this way.
- ⁶² "Acculturation." Dictionary.com. *Online Etymology Dictionary*. Douglas Harper, Historian. Online: <http://dictionary.reference.com/browse/acculturation>, accessed March 04, 2016.
- ⁶³ It should be noted that most foremen rise up through the ranks of field workers. They are promoted based on their years of experience, language skills, leadership potential, and relationship of trust with the upper levels of management and ownership. Increasingly, however, foremen are expected to receive formal training on how to instill food safety culture in the field workers under their watch.
- ⁶⁴ STOP Blog: Conversations & Collaborations. November 1, 2014. "Frank Yiannas Talks About Getting to the Path of Food Safety as a Social Norm." Accessed online, http://www.stopfoodborneillness.org/candc-frank_yiannas/.

- ⁶⁵ Frank Yiannas, *Food Safety Culture*, <http://www.foodsafetyculture.com/>.
- ⁶⁶ It is worth noting that two training workshops were held that day. The one I attended in the morning was held in English, while the afternoon was devoted to another three-hour session all in Spanish (at which I was not present) in the same location.
- ⁶⁷ The use of *verify* in the context of food safety training is one example of a term borrowed from the hazard mastery paradigm for use in the context of spreading food safety culture, and further evidence of the slippage between technoscientific imaginaries of control and sociocultural imaginaries of autonomy.
- ⁶⁸ I return to the idea of food safety as a communication strategy again in Chapter 6, when I examine the nascent co-management approach to balancing food safety with environmental conservation and, more generally, sustainability. To presage my argument there, approaching food safety as a mode for communicating one's unique position and approach puts a tremendous onus of work on the farmer to persuade and convince others of the validity and appropriateness of their practices, and does little to address the structural blind-spots to this sort of validation work that are built into the apparatus through its myopic focus on safety first to the exclusion of other values.
- ⁶⁹ My use of the treadmill metaphor owes its origin to the concept of the "technological treadmill", which Willard Cochrane used to explain how and why the rapid technological advances in US agriculture during the 20th century nevertheless left most farmers poorer and more vulnerable with each additional adoption of a novel technology (Cochrane 1993, 427–29).
- ⁷⁰ Yaron Ezrahi posited that by turning to science as the basis of good government, the State finds several simultaneous solutions (1990, 23–27). Science provides 'facts' which serve as a basis upon which rational free actors can deliberate and create order through a decentralized process of rational adjustment and negotiation. In the case that deliberation breaks down into fractious groups or works too slowly, elite experts can use science to "see" collective patterns for the state, and can use that vantage point to guide the rest of society toward harmonious order through rational public administration. Unlike Foucault's panopticon, however, science permits two-way vision, letting the citizens 'see' the technical operation of the state and rendering the state legitimate by appeal to an external 'objective' referent. Lastly, science reassures us that, if all attempts at top-down control fail, there is still hope because rational actors behaving self-interestedly in a free market can spontaneously produce order in the aggregate. All three accounts of free action coexist in the modern art of government, argues Ezrahi, which allows for tremendous flexibility.
- ⁷¹ All names used are pseudonyms unless otherwise noted.
- ⁷² Baby greens—usually packaged as pre-washed and ready-to-eat salad mixes in supermarkets—are much more fragile than mature, whole-head greens. To delay wilting, it is common practice to harvest baby greens at night (generally from about 6pm to 2 or 3 in the morning) to take advantage of the cooler ambient temperatures.
- ⁷³ The CA LGMA provides seven total decision trees, including three on agricultural water and three on soil amendments. No specific source or citation is given to support the decision trees, though as with all CA LGMA standards, the authority rests with the LGMA technical committee, which in 2016 comprised 18 members, 16 representing packer-shippers and 2 representing private consulting companies. The Technical Basis document (CA LGMA App. B, last updated in 2007), states that "The metrics developed for assessing animal intrusions in production fields were based on best professional judgment about proper assessment and corrective actions." The basis document also requires that "a trained food safety professional be involved in decisions related to animal intrusion." Such a person should have a "a sound background in basic microbiology, chemistry, and statistics" and also, have "At a minimum... some training in relevant fields of science including but not limited to biology, food science, chemistry, and botany."
- ⁷⁴ Crop loss due to detected food safety hazards is not uncommon. One large organic grower I spoke with, referred to in this manuscript as Organic Fields, estimated that during times of peak risk (basically when temperatures are high), they might have to throw out %40-50 of a harvest. Primarily, this is due to receiving a positive laboratory test for *E. coli* on a crop sample taken a week or so before harvest. They take random samples out of every harvest batch, ~2000 lbs. each, and if a laboratory test comes up positive for a dangerous pathogen, they dispose of the whole batch. In their words, they are interested in "anything we can find to do that can reduce that loss."
- ⁷⁵ In the case of California farms, the customers are at least one step removed from the end consumer. Farms may sell to brokers, wholesalers, packing-shipping houses, and/or retailers (e.g. Costco, Wegman's, Safeway) or foodservice firms (e.g. McDonald's, Chipotle). In addition, these businesses may sell product amongst

themselves. It is not uncommon for a major retailer to receive produce through multiple channels—broker, wholesaler, packer-shipper—depending on the season, crop, availability and demand. Often, the major firms at the end of the chain—the WalMarts and McDonalds of the world—operate as supply chain “captains” (Busch 2007; Busch 2010b) setting the management priorities for all of their upstream suppliers. As Crohn and Bianchi (2008) observe, “produce from large farms is generally contracted by large marketers or restaurant and supermarket chains. These organizations are enormously influential because they retain the right to reject crops that do not meet their requirements.” In the context of global food supply chains:

“[Supply chain management] involves abandoning, or perhaps subsuming, the economic theory of the firm in favour of the entire supply chain seen from the vantage point of the supply chain captain, that is, the firm that leads the chain. In the case of the agrifood sector the captains that have emerged have been largely supermarkets... Such captains take on the role of organising the chain from acquisition of raw materials all the way to purchase by final consumers. However, in order to accomplish that goal as well as to protect their reputations, the captains demand that their suppliers adhere to a set of stringent standards. Moreover to ensure that the suppliers adhere to the standards; to avoid the costs of checking; and so as not to cast themselves in the role of police officers, the lead firms require that some third party certify that the suppliers are operating in conformity with the standards” (Busch 2010a).

- ⁷⁶ It is not clear who was involved in this event. The authors of the article reporting on the results merely write, “over 100 specifically invited food safety and water quality leaders met for 3 days in San Luis Obispo, California.” The authors of the report are affiliated with UC Cooperative Extension.
- ⁷⁷ The *Safe and Sustainable* report, published in 2010, was sponsored by the The Pew Charitable Trusts, which contracted the Nature Conservancy to run the project. The lead authors include a USDA scientist and two academics, while the advisory committee includes a full slate of stakeholders from conservation NGOs, county government, industry associations, farms, and academia.
- ⁷⁸ The produce safety certification regime has expanded so rapidly that there is a general shortage of qualified and knowledgeable auditors. Many private certification companies and even government regulatory agencies draw their auditors and inspectors from contexts other than agriculture. Auditors may thus have little to no experience in agriculture, rather having spent their time in processing facilities or inspecting feedlots or aquaculture operations. Auditors are likely to know virtually nothing about vegetable growing, let alone agricultural conservation on vegetable farms.
- ⁷⁹ Online at, http://ucfoodsafety.ucdavis.edu/Preharvest/Co-Management_of_Food_Safety_and_Sustainability/. Accessed October 10, 2016.
- ⁸⁰ Categories discussed as “co-management opportunities” include: constructed wetlands; cover crops and vegetative barriers; hedgerows; irrigation ditches and tailwater systems; irrigation water storage; managing animal movement (e.g. fences); sediment basins; soil amendments with organic materials (i.e. compost or mulch); sprinkler and micro-irrigation systems; vegetated practices adjacent to fields; vegetated practices for wildlife (i.e. conservation habitat); vegetated practices near streams (i.e. riparian habitat); and windbreaks and wind barriers. These categories encompass 27 specific practices, of which 18 (4) relate to erosion control, 3 (1) to improving soil quality (increase soil organic matter or infiltration), 4 (0) to conserving water, 9 (4) to filter out sediments draining off the field, 8 (3) to filtering other pollutants (pesticides, nutrients), 1 (7) to providing beneficial habitat for insects/predators, 5 (10) to improving wildlife habitat, 1 (1) to reducing production costs, and 3 (2) to reducing food safety risks. The numbers in parentheses indicate when the guidance associates the practice with a secondary benefit to that conservation or production objective.
- ⁸¹ United Fresh is the largest national association for the fresh produce industry, and plays a major lobbying role across the country, including input to FDA’s rule-making processes, as well as serving as a clearinghouse for information and strategy for the industry. The Food Safety and Technology Council has over 130 members, representing growers, handlers, distributors, wholesalers, retailers, foodservice, smaller marketing associations (e.g. Western Growers Association, Canadian Produce Marketing Association), laboratories, auditing and consulting firms. The Council has met eight times from January 2013 through June 2015. The meeting minutes are extensive, averaging nine pages of single-spaced text.
- ⁸² Economic production describes a system of thought that values aspects of the farming landscape that are instrumental to crop production. Ecological reproduction, conversely, describes a system of thought that interprets value more holistically, taking into consideration the way in which different aspects of the farming landscape maintain and renew the conditions of production. The two systems of thought are not necessarily

mutually incompatible, but contradictions arise when social structures systematically elevate economic production over ecological reproduction. Assuming a hierarchy in which production trumps reproduction leads to, as Henke (2008, 6) describes it, “a practical interest in a kind of mastery of the world” in which “the ability to effectively control people and things is a critical source of power.” For an in-depth discussion of the general dichotomy between production and reproduction and the resulting dominating approach to nature, see Merchant (1989, Ch. 1; 2008, Introduction).

- ⁸³ An explanation of the full scope of the utilitarian ethic applied to federal land management and natural resources policy during the Progressive era is beyond the bounds of the current discussion, but the outlook was most quintessentially articulated by Gifford Pinchot, the first Chief of the US Forest Service and a key voice that shaped the USDA’s environmental philosophy, in his assertion that resources should always be managed for the greatest good (e.g. building homes, providing timber, water, etc.) for the greatest number of people, over the long run. In short, to have value, nature needed to be used, and it the government would be serve its citizenry by taking charge over the management of that use (through the formation of the US Forest Service). In many ways, the Progressive approach marked a technocratic and managerial interpretation of the older Lockean philosophy of land and property—that people create property by mixing their labor with the land—which was used to justify settler colonialism across America and the US government’s policy of granting “unused” land to white settlers, rationalizing this violent appropriation of land from indigenous peoples because those peoples were not “using” the land, that is, were not mastering it according to the patterns and forms recognized and valued by settlers. For an excellent discussion of how this rationalization first played out during colonial times in New England, see Cronon’s *Changes in the Land* (Cronon 1983) and Merchant’s *Ecological Revolutions* (Merchant 1989). The point, in both cases, was that land (and by extension, wildlife, plants, and ecosystems) that did not directly contribute usable products for human (i.e. white settler) “prosperity” were considered to have no value, or possibly even negative value if it impaired production; for example, most wetlands and swamps across the country were drained during the late 19th and 20th centuries to make the land “productive”. And the role of the State was to promote and reinforce the transformation of land—and whatever animals and plants lived on that land—into productive forms.
- ⁸⁴ The literature on supply chain management (SCM) and private regulation in global food provisioning has grown rapidly in the past decade (e.g. Bain et al. 2013; Henson and Reardon 2005; Henson 2011; Busch 2007; Loconto and Busch 2010). (see also note 75).
- ⁸⁵ The Enlightenment established the revolutionary principle of empirical science, that “the solidity and permanence of matters of fact reside in the absence of human agency in their coming to be” (Shapin and Schaffer [1985] 2011, 23 [1985]); in other words, truth exists in pure nature and can only be adulterated by people. To conduct science meant to control all aspects of the experiment so tightly that no ambiguity could muddy the observed phenomena or lead to subjective bias. Therefore, when Boyle wanted to discover definitive properties of air and vacuum, he built an elaborate (for the time period) mechanical device to create an isolated environment in which to run experiments, his air pump. The pump itself consisted of a glass globe from which Boyle and his assistants could extract the air, creating a vacuum inside. The globe, once sealed, would then serve as a carefully controlled space: all “external” factors which might bias the intended observation would be locked safely outside its walls, producing what Boyle claimed to be reliable observations of phenomena *on the inside*. However, the seal was not perfect. No matter how hard Boyle tried to stop it, the air pump leaked. And as the outside air slipped in, so did a tendril of doubt. To stabilize a factual claim, based on inescapably indeterminate empirical observation, meant that Boyle had to establish a collective standard of appropriate certainty supported by legitimate public consent (ibid, 24). In other words, Boyle was among the first to navigate a core ambiguity in empirical science: to quote Bruno Latour, “When things are true they hold... When things hold they start becoming true” (1987, 12). Boyle realized he had to convince others that his air pump could reveal credible facts, for only through collective social belief could a fact be produced and, crucially, naturalized. In other words, the project of ordering nature into the controlled space of the air pump was part and parcel to the project of ordering people to agree that the air pump’s vacuum was under control.
- ⁸⁶ Bacon expressed this ascendancy-through-science narrative most succinctly and explicitly in his utopian story, *The New Atlantis*, in which he describes an ideal society, Bensalem, which is guided by a society of “wise men”, named Salomon’s House, that “is the very eye of this kingdom” and “the noblest foundation... that ever was upon the earth.” In the story, the head of Salomon’s House tells the protagonist, “The end of our foundation is the knowledge of causes, and secret motions of things; and *the enlarging of the bounds of human empire*, to the effecting of all things possible” (emphasis added). As the introductory note to the digital Project Gutenberg edition observes, “in Solomon’s House we have Bacon the scientist indulging without restriction his

prophetic vision of the future of human knowledge... Bacon always had an eye to utility. The advancement of science which he sought was conceived by him as a means to a practical end the increase of man's control over nature, and the comfort and convenience of humanity” (Bacon 1627).

- ⁸⁷ In addition, Michael Pollan has written extensively in the popular press on the subject of microbiome diversity, health, and industrial food, indicating a rising public awareness of such concepts as probiotics and gut microbes (see Pollan 2013; Pollan 2015).
- ⁸⁸ Szasz also points out that this belief is “implicitly based on denial of complexity and interdependence” (2007, 222).
- ⁸⁹ This is precisely the danger that Agamben warned of in reviving Foucault’s *dispositive* (apparatus), that people will become trapped by “the triumph of the *oikonomia*, that is to say, of a pure activity of government that aims at nothing other than its own replication” (Agamben 2009, 22). If the apparatus operates as a machinery to sanctify the food system by subjectifying everyone to food safety culture, then “profanation is the counter-apparatus that restores to common use what sacrifice [in the name of purity] had separated and divided” (ibid, 19).
- ⁹⁰ Sheila Jasanoff has noted that Kuhn’s popular concept of the *paradigm* conspicuously leaves out the people responsible for forming and maintaining that paradigm; the notion is too static, too stale, and too devoid of social relations to serve as the basis for adequate critique. Rather, Jasanoff promotes Ludwik Fleck’s concept of the *thought collective*, which recognizes that “cognition is a collective activity” (Sady 2012). For Fleck, “A thought collective is defined... as a community of persons mutually exchanging ideas or maintaining intellectual interaction... Members of that collective not only adopt certain ways of perceiving and thinking, but they also continually transform it—and this transformation does occur not so much ‘in their heads’ as in their interpersonal space” (ibid).
- ⁹¹ I intentionally invoke Karen Barad’s concept of intra-action, “the mutual constitution of entangled agencies”, to highlight how humans, microbes, landscapes and ecosystems do not simply act dialectically upon one another, but rather act *through* each other, sometimes literally engaging in a mutual entanglement of biophysical substance as well as activity (Barad 2007). Russell’s call to trace “evolutionary history” (2003), I would argue, is a step toward the worldview of *agential realism* that Barad is proposing.
- ⁹² “We have exchanged masters many times,” writes Latour, “We have shifted from the God of Creation to Godless Nature, from there to *Homo faber*, then to structures that make us act, fields of discourse that make us speak, anonymous fields of force in which everything is dissolved—but we have not yet tried *to have no master at all*.”

References

- Adams, C.E. 1990. "Use of HACCP in Meat and Poultry Inspection." *FOOD TECHNOLOGY* 44 (5): 169–70.
- Adams, Deborah, Kathleen Fullerton, Ruth Jajosky, Pearl Sharp, Diana Onweh, Alan Schley, Willie Anderson, Amanda Faulkner, and Kiersten Kugeler. 2015. "Summary of Notifiable Infectious Diseases and Conditions - United States, 2013." *MMWR. Morbidity and Mortality Weekly Report* 62 (53): 1–122. doi:10.15585/mmwr.mm6253a1.
- Agamben, Giorgio. 2009. *What Is an Apparatus? : And Other Essays*. Stanford, Calif.: Stanford University Press.
- Alkon, Alison Hope, and Julian Agyeman. 2011. "Introduction: The Food Movement as Polyculture." In *Cultivating Food Justice: Race, Class, and Sustainability*, edited by Julian Agyeman and Alison Hope Alkon, 1–20. MIT Press.
- Allos, Ban Mishu, Matthew R. Moore, Patricia M. Griffin, and Robert V. Tauxe. 2004. "Surveillance for Sporadic Foodborne Disease in the 21st Century: The FoodNet Perspective." *Clinical Infectious Diseases* 38 (Supplement 3): S115–20. doi:10.1086/381577.
- Ayazi, Hossein, and Elsadig Elsheikh. 2015. "The Farm Bill Report: Corporate Power and Structural Racialization in the US Food System." Berkeley, CA: The Haas Institute for a Fair and Inclusive Society, University of California, Berkeley. <http://haasinstitute.berkeley.edu/farm-bill-report-corporate-power-and-structural-racialization-us-food-system>.
- Ayers, Edward. 1907. "What the Food Law Saves Us From: Adulterations, Substitutions, Chemical Dyes, and Other Evils." In *The World's Work*, edited by Walter Hines Page and Arthur Williams Page. Vol. 14. Doubleday, Page & Company.
- [AZ LGMA] Arizona Leafy Green Marketing Committee. 2010. "The Arizona Leafy Greens Food Safety Training Kit." Phoenix, AZ.
- Bacon, Francis. 1627. *The New Atlantis*. Ebook #2434. Project Gutenberg. <http://www.gutenberg.org/files/2434/2434-h/2434-h.htm>.
- Bain, Carmen, Elizabeth Ransom, Vaughan Higgins, and others. 2013. "Private Agri-Food Standards: Contestation, Hybridity and the Politics of Standards." *International Journal of Sociology of Agriculture and Food* 20 (1): 1–10.
- Barad, Karen Michelle. 2007. *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning*.
- Bauman, Howard E. 1974. "The HACCP Concept and Microbiological Hazard Categories." *Food Technology* 28 (9): 30-.
- . 1995. "The Origin and Concept of HACCP." In *HACCP in Meat, Poultry, and Fish Processing*, edited by A. M. Pearson and T. R. Dutson, 1–7. Springer US. http://dx.doi.org/10.1007/978-1-4615-2149-5_1.
- Baur, Patrick, Laura Driscoll, Sasha Gennet, and Daniel Karp. 2016. "Inconsistent Food Safety Pressures Complicate Environmental Conservation for California Produce Growers." *California Agriculture* 70 (3): 142–51.

- Beard, T. D. 1991. "HACCP and the Home - The Need for Consumer Education." *FOOD TECHNOLOGY* 45 (6): 123–24.
- Beretti, Melanie, and Diana Stuart. 2008. "Food Safety and Environmental Quality Impose Conflicting Demands on Central Coast Growers." *California Agriculture* 62 (2): 68–73.
- Berry, Wendell. 1977. *The Unsettling of America: Culture & Agriculture*. Third. San Francisco ;[Great Britain: Sierra Club Books.
- Black, Julia, and Robert Baldwin. 2010. "Really Responsive Risk-Based Regulation." *Law & Policy* 32 (2): 181–213. doi:10.1111/j.1467-9930.2010.00318.x.
- Bobeng, B.J., and B.D. David. 1978. "HACCP Models for Quality Control of Entrée Production in Hospital Foodservice Systems. I. Development of Hazard Analysis Critical Control Point Models." *Journal of the American Dietetic Association* 73 (5): 524–29.
- Bobrow-Strain, Aaron. 2012. *White Bread: A Social History of the Store-Bought Loaf*. Boston: Beacon Press.
- Bowker, Geoffrey C., and Susan Leigh Star. 1999. "Sorting Things out: Classification and Its Consequences." <http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=13186>.
- Boxrud, David, Timothy Monson, Tracy Stiles, and John Besser. 2010. "The Role, Challenges, and Support of Pulsenet Laboratories in Detecting Foodborne Disease Outbreaks." *Public Health Reports*, 57–62.
- Braithwaite, John. 2011. "Essence of Responsive Regulation, The." *UBCL Rev.* 44: 475.
- Brandl, Maria T. 2006. "Fitness of Human Enteric Pathogens on Plants and Implications for Food Safety1." *Annual Review of Phytopathology* 44 (1): 367–92. doi:10.1146/annurev.phyto.44.070505.143359.
- Brandl, Maria T., and George W. Sundin. 2013. "Focus on Food Safety: Human Pathogens on Plants." *Phytopathology* 103 (4): 304–5. doi:10.1094/PHYTO-103-4-0304.
- Bricher, Julie Larson. 2007. "Jack in the Box: Fostering Food Safety Through Great Partnering." *Food Safety Magazine*, July. <http://www.foodsafetymagazine.com/magazine-archive1/junejuly-2007/jack-in-the-box-fostering-food-safety-through-great-partnering/>.
- Brodth, Sonja, Karen Klonsky, Louise Jackson, Stephen B. Brush, and Sean Smukler. 2009. "Factors Affecting Adoption of Hedgerows and Other Biodiversity-Enhancing Features on Farms in California, USA." *Agroforestry Systems* 76 (1): 195–206. doi:10.1007/s10457-008-9168-8.
- Brodth, Sonja, Karen Klonsky, and Laura Tourte. 2006. "Farmer Goals and Management Styles: Implications for Advancing Biologically Based Agriculture." *Agricultural Systems* 89 (1): 90–105. doi:10.1016/j.agsy.2005.08.005.
- Bryan, F. L. 1990. "Hazard Analysis Critical Control Point (HACCP) Systems for Retail Food and Restaurant Operations." *JOURNAL OF FOOD PROTECTION* 53 (11): 978–83.
- Busch, Lawrence. 2000. "The Moral Economy of Grades and Standards." *Journal of Rural Studies* 16 (3): 273–83. doi:10.1016/S0743-0167(99)00061-3.
- . 2007. "Performing the Economy, Performing Science: From Neoclassical to Supply Chain Models in the Agrifood Sector." *Economy and Society* 36 (3): 437–66. doi:10.1080/03085140701428399.

- . 2010a. “Can Fairy Tales Come True? The Surprising Story of Neoliberalism and World Agriculture.” *Sociologia Ruralis* 50 (4): 331–351. doi:10.1111/j.1467-9523.2010.00511.x.
- . 2010b. “Standards, Law, and Governance.” *Journal of Rural Social Sciences* 25 (3): 56–78.
- . 2011. “Standards Recipes for Reality.” <http://site.ebrary.com/id/10509223>.
- Busch, Lawrence, and Carmen Bain. 2004. “New! Improved? The Transformation of the Global Agrifood System.” *Rural Sociology* 69 (3): 321–46.
- Busch, Lawrence, and Arunas Juska. 1997. “Beyond Political Economy: Actor Networks and the Globalization of Agriculture.” *Review of International Political Economy* 4 (4): 688–708. doi:10.1080/09672299708565788.
- [CA LGMA] California Leafy Green Products Handler Marketing Agreement. 2016a. “Farming Leafy Greens.” *LGMA*. <http://www.lgma.ca.gov/about-us/farming-leafy-greens/>.
- . 2016b. “Commodity Specific Food Safety Guidelines for the Production and Harvest of Lettuce and Leafy Greens.” www.lgma.ca.gov.
- Callon, Michel. 1986. “Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St. Brieuc Bay.” In *Power, Action and Belief. A New Sociology of Knowledge?*, edited by John Law. Vol. 32, Sociological Review Monograph. London: Routledge & Kegan Paul.
- . 2007. “What Does It Mean to Say That Economics Is Performative?” In *Do Economists Make Markets? : On the Performativity of Economics*, edited by Donald A. MacKenzie, Fabian Muniesa, and Lucia Siu. Princeton: Princeton University Press.
- Calvin, Linda. 2007. “Outbreak Linked to Spinach Forces Reassessment of Food Safety Practices.” *Amber Waves* 5 (3): 24.
- Cameron, Jenks. 1929. *The Bureau of Biological Survey: Its History, Activities and Organization*. Baltimore, Md.: Institute for Government Research: Service Monographs of the United States Government No. 54. Johns Hopkins Press.
- Caswell, Julie A. 2006. “A Food Scare a Day: Why Aren’t We Better at Managing Dietary Risk?” *Human and Ecological Risk Assessment: An International Journal* 12 (1): 9–17. doi:10.1080/10807030500428520.
- Caswell, Julie A., and Neal H. Hooker. 1996. “HACCP as an International Trade Standard.” *American Journal of Agricultural Economics* 78 (3): 775–79. doi:10.2307/1243303.
- [CDC] US Centers for Disease Control. 2006. “Multistate Outbreak of E. Coli O157:H7 Infections Linked to Fresh Spinach (FINAL UPDATE).” <http://www.cdc.gov/ecoli/2006/spinach-10-2006.html>.
- . 2012a. “Principles of Epidemiology | Lesson 1 - Section 11.” *Principles of Epidemiology in Public Health Practice, Third Edition: An Introduction to Applied Epidemiology and Biostatistics*. May 18. <http://www.cdc.gov/ophss/csels/dsepd/ss1978/lesson1/section11.html>.
- . 2012b. “Multistate Outbreak of Listeriosis Linked to Whole Cantaloupes from Jensen Farms, Colorado.” Final Update. <http://www.cdc.gov/listeria/outbreaks/cantaloupes-jensen-farms/>.

- . 2015a. “History and Background | NNDSS.” *National Notifiable Diseases Surveillance System (NNDSS)*. May 6. <https://wwwn.cdc.gov/NNDSS/history.aspx>.
- . 2015b. “General Information | E.coli | CDC.” *Centers for Disease Control and Prevention*. November 6. <http://www.cdc.gov/ecoli/general/index.html>.
- . 2015c. “About FoodNet.” *Centers for Disease Control and Prevention - Foodborne Diseases Active Surveillance Network (FoodNet)*. December 7. <https://www.cdc.gov/foodnet/about.html>.
- . 2016a. “National Enteric Disease Surveillance: The Listeria Initiative.” National Center for Emerging and Zoonotic Infectious Diseases, Division of Foodborne, Waterborne, and Environmental Diseases. https://www.cdc.gov/listeria/pdf/listeriainitiativeoverview_508.pdf.
- . 2016b. “Whole Genome Sequencing (WGS).” *PulseNet*. February 11. <http://www.cdc.gov/pulsenet/pathogens/wgs.html>.
- . 2016c. “Frequently Asked Questions | About | PulseNet | CDC.” *Centers for Disease Control and Prevention - PulseNet*. February 16. <http://www.cdc.gov/pulsenet/about/faq.html>.
- . 2016d. “Pulsed-Field Gel Electrophoresis (PFGE).” *PulseNet*. February 16. <http://www.cdc.gov/pulsenet/pathogens/pfge.html>.
- . 2016. “The Future of PulseNet.” *PulseNet*. Accessed October 26. <http://www.cdc.gov/pulsenet/next-generation.html>.
- [CDFA] California Department of Food and Agriculture. 2015. “California Agricultural Statistics Review, 2014-2015.” <https://www.cdffa.ca.gov/statistics/PDFs/2015Report.pdf>.
- [CDHS] California Department of Health Services, and [FDA] US Food and Drug Administration. 2007. “Investigation of an Escherichia Coli O157:H7 Outbreak Associated with Dole Pre-Packaged Spinach.” Sacramento, CA.
- Charles, Dan, and Allison Aubrey. 2016. “As Bagged Salad Kits Boom, Americans Eat More Greens.” *NPR Morning Edition*, July 12. <http://www.npr.org/sections/thesalt/2016/07/12/485098252/as-bagged-salad-kits-boom-americans-eat-more-greens>.
- Cichy, R.F. 1982. “HACCP as a Quality Assurance Tool in a Commissary Food-Service System.” *International Journal of Hospitality Management* 1 (2): 103–6.
- Clemente, Jose C., Luke K. Ursell, Laura Wegener Parfrey, and Rob Knight. 2012. “The Impact of the Gut Microbiota on Human Health: An Integrative View.” *Cell* 148 (6): 1258–70. doi:10.1016/j.cell.2012.01.035.
- Clinton, William. 1997. “Memorandum on the Food Safety Initiative. Memorandum for the Secretary of Health and Human Services, The Secretary of Agriculture.” *Weekly Compilation of Presidential Documents* 33 (40): 1479–80.
- Clogher, Paula, Sharon Hurd, Dina Hoefler, James L. Hadler, Lauren Pasutti, Shaun Cosgrove, Suzanne Segler, et al. 2012. “Assessment of Physician Knowledge and Practices Concerning Shiga Toxin–Producing Escherichia Coli Infection and Enteric Illness, 2009, Foodborne Diseases Active Surveillance Network (FoodNet).” *Clinical Infectious Diseases* 54 (suppl 5): S446–52. doi:10.1093/cid/cis246.

- Cochrane, Willard Wesley. 1993. *The Development of American Agriculture: A Historical Analysis*. 2nd ed. Minneapolis: University of Minnesota Press.
- Coglianesse, Cary, and David Lazer. 2003. "Management-Based Regulation: Prescribing Private Management to Achieve Public Goals." *Law & Society Review* 37 (4): 691–730. doi:10.1046/j.0023-9216.2003.03703001.x.
- Collins, H. M. 1985. *Changing Order: Replication and Induction in Scientific Practice*. London; Beverly Hills: Sage Publications.
- [CPS] Center for Produce Safety. 2016. "About CPS." Accessed November 1. <http://www.centerforproducesafety.org/about.php>.
- Critzer, Faith J, and Michael P Doyle. 2010. "Microbial Ecology of Foodborne Pathogens Associated with Produce." *Current Opinion in Biotechnology* 21 (2): 125–130.
- Crohn, David M., and Mary L. Bianchi. 2008. "Research Priorities for Coordinating Management of Food Safety and Water Quality." *Journal of Environmental Quality* 37 (4): 1411–18. doi:10.2134/jeq2007.0627.
- Cronon, William. 1983. *Changes in the Land: Indians, Colonists, and the Ecology of New England*. New York: Hill and Wang.
- Cronquist, Alicia B., Rajal K. Mody, Robyn Atkinson, John Besser, Melissa Tobin D'Angelo, Sharon Hurd, Trisha Robinson, Cynthia Nicholson, and Barbara E. Mahon. 2012. "Impacts of Culture-Independent Diagnostic Practices on Public Health Surveillance for Bacterial Enteric Pathogens." *Clinical Infectious Diseases* 54 (suppl 5): S432–39. doi:10.1093/cid/cis267.
- Curnutte, Margaret, and Giuseppe Testa. 2012. "Consuming Genomes: Scientific and Social Innovation in Direct-to-Consumer Genetic Testing." *New Genetics and Society* 31 (2): 159–81. doi:10.1080/14636778.2012.662032.
- Dack, Gail Monroe. 1956. *Food Poisoning*. Chicago: University of Chicago Press.
- Dahlberg, Kenneth. 1993. "Regenerative Food Systems: Broadening Scope and Agenda of Sustainability." In *Food for the Future: Conditions and Contradictions of Sustainability*, edited by Patricia Allen, 75–102. New York: Wiley.
- Davis, Russell J, Carolyn Bower, and Robert D Hursh. 1987. *American Law of Products Liability 3d*. Rochester, N.Y.; San Francisco, Calif.: Lawyers Co-operative Pub. Co. ; Bancroft-Whitney Co.
- Dean, Mitchell. 1996. "Putting the Technological into Government." *History of the Human Sciences* 9 (3): 47–68.
- . 2009. *Governmentality : Power and Rule in Modern Society*. London; Thousand Oaks, Calif.: SAGE.
- DeLind, Laura B. 2010. "Are Local Food and the Local Food Movement Taking Us Where We Want to Go? Or Are We Hitching Our Wagons to the Wrong Stars?" *Agriculture and Human Values* 28 (2): 273–83. doi:10.1007/s10460-010-9263-0.
- DeLind, LauraB, and PhilipH Howard. 2008. "Safe at Any Scale? Food Scares, Food Regulation, and Scaled Alternatives." *Agriculture and Human Values* 25 (3): 301–17. doi:10.1007/s10460-007-9112-y.

- Demortain, David. 2008. "Standardising through Concepts: The Power of Scientific Experts in International Standard-Setting." *Science and Public Policy* 35 (6): 391–402. doi:10.3152/030234208x323325.
- . 2011. "Modelling Regulation: HACCP and the Ambitions of the Food Microbiology Elite." In *Scientists and the Regulation of Risk: Standardising Control*, 112–41. Edward Elgar Publishing, Incorporated. <http://books.google.com/books?id=yzHDIhfTtuwC>.
- Douglas, Mary, and Aaron B. Wildavsky. 1982. *Risk and Culture : An Essay on the Selection of Technical and Environmental Dangers*. Berkeley: University of California Press.
- Dunlap, Thomas R. 1988. *Saving America's Wildlife*. Princeton, N.J.: Princeton University Press.
- Dunn, Elizabeth C. 2003. "Trojan Pig: Paradoxes of Food Safety Regulation." *Environment and Planning A* 35 (8): 1493–1511.
- . 2007. "Escherichia Coli, Corporate Discipline and the Failure of the Sewer State." *Space and Polity* 11 (1): 35–53.
- Elliot, Dan. 2013. "FDA: Criminal Case Shows Food Safety Is Paramount." *USA Today*, September 27. <http://www.usatoday.com/story/news/nation/2013/09/27/fda-food-safety-cantaloupe-listeria/2884867/>.
- Endres, A Bryan, and Nicholas R Johnson. 2011. "Integrating Stakeholder Roles in Food Production, Marketing, and Safety Systems: An Evolving Multi-Jurisdictional Approach." *J. Envtl. L. & Litig.*
- [EPA] U.S. Environmental Protection Agency, Department of Health and Human Services, and U.S. Department of Agriculture. 1997. "Food Safety from Farm to Table: A National Food-Safety Initiative -- A Report to the President."
- Ezrahi, Yaron. 1990. *The Descent of Icarus: Science and the Transformation of Contemporary Democracy*. London: Harvard University.
- FDA. 2014. "FSMA Proposed Rule for Produce Safety: Information on Specific Provisions." WebContent. Center for Food Safety and Applied Nutrition. <http://www.fda.gov/food/guidanceregulation/fsma/ucm415226.htm#Animals>.
- [FDA] US Food and Drug Administration. 1997. "Hazard Analysis and Critical Control Point Principles and Application Guidelines."
- . 1998. "Guidance for Industry: Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables." <http://www.fda.gov/food/guidanceregulation/guidancedocumentsregulatoryinformation/produceplantproducts/ucm064574.htm>.
- . 2008. "Guidance for Industry: Guide to Minimize Microbial Food Safety Hazards of Fresh-Cut Fruits and Vegetables." <http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/ProducePlantProducts/ucm064458.htm>.
- . 2014. "Produce Safety Standards." <http://www.fda.gov/Food/GuidanceRegulation/FSMA/ucm304045.htm>.
- FDA [US Food and Drug Administration]. 2015. "Final Regulatory Impact Analysis, Final Regulatory Flexibility Analysis, and Unfunded Mandates Reform Act Analysis for the Standards for the Growing, Harvesting, Packing and Holding of Produce for Human Consumption." Docket No. FDA-2011-N-0921.

- <http://www.fda.gov/downloads/AboutFDA/ReportsManualsForms/Reports/EconomicAnalyses/UCM472330.pdf>.
- [FDA] US Food and Drug Administration. 2016a. “Whole Genome Sequencing (WGS) Program.” WebContent. June 23.
<http://www.fda.gov/Food/FoodScienceResearch/WholeGenomeSequencingProgramWGS/>.
- . 2016b. “GenomeTrakr Fast Facts.” WebContent. *Whole Genome Sequencing (WGS) Program*. October 19.
<http://www.fda.gov/Food/FoodScienceResearch/WholeGenomeSequencingProgramWGS/ucm403550.htm>.
- Ferrières, Madeleine. 2006. *Sacred cow, mad cow : a history of food fears*. New York: Columbia University Press.
- Fitzgerald, Deborah Kay. 2003. *Every Farm a Factory : The Industrial Ideal in American Agriculture*. New Haven: Yale University Press.
- Flint, Harry J. 2012. “The Impact of Nutrition on the Human Microbiome.” *Nutrition Reviews* 70 (suppl 1): S10–13. doi:10.1111/j.1753-4887.2012.00499.x.
- Flynn, Dan. 2016. “Letter From the Editor: The New Normal.” *Food Safety News*, May 22.
<http://www.foodsafetynews.com/2016/05/letter-from-the-editor-24/>.
- Fone, Dan. 2012. “Human Behavior’s Role in Food Safety.” *Food Processing*, May 21.
<http://www.foodprocessing.com/articles/2012/human-behavior-role-in-food-safety/>.
- Food Safety News*. 2015. “Report: About 20-30 Percent of Foodborne Illness Victims File Lawsuits,” May 26. <http://www.foodsafetynews.com/2015/05/report-about-20-30-percent-of-foodborne-illness-victims-file-lawsuits/>.
- Foucault, Michel. 2007. *Security, Territory, Population: Lectures at the Collège de France, 1977-78*. New York: Palgrave Macmillan.
- Freidberg, Susanne. 2004. *French Beans and Food Scares: Culture and Commerce in an Anxious Age*. New York, N.Y.: Oxford University Press.
<http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=138224>.
- [FSPCA] Food Safety Preventive Controls Alliance. 2016. “Preventive Controls for Human Food, First Edition.” Version 1.2.
http://www.iit.edu/ifsh/alliance/pdfs/FSPCA_PC_Human_Food_Course_Participant_Manual_V1.2_Watermark.pdf.
- [FSWG] President’s Food Safety Working Group. 2009. “Food Safety Working Group: Key Findings.”
<http://www.foodsafetyworkinggroup.gov/ContentKeyFindings/HomeKeyFindings.htm>.
- [GAO] US Government Accountability Office. 1970. “Government Operations: Need To Reassess Food Inspection Roles Of Federal Organizations.” B-168966. US Government Accountability Office. <http://www.gao.gov/products/A90864>.
- . 1972. “Dimensions of Insanitary Conditions in the Food Manufacturing Industry.” B-164031(2). BUSINESS REGULATION AND CONSUMER PROTECTION: US Government Accountability Office. <http://www.gao.gov/products/096596>.

- . 1994. “Food Safety: A Unified, Risk-Based Food Safety System Needed.” T-RCED-94-223. <http://www.gao.gov/products/GAO/T-RCED-94-223>.
- . 1997. “Food Safety: Fundamental Changes Needed to Improve Food Safety.” RCED-97-249R. <http://www.gao.gov/products/RCED-97-249R>.
- . 2001. “Food Safety and Security: Fundamental Changes Needed to Ensure Safe Food.” GAO-02-47T. Washington, DC. <http://www.gao.gov/products/GAO-02-47T>.
- . 2008. “FOOD SAFETY: Improvements Needed in FDA Oversight of Fresh Produce.” GAO-08-1047.
- Garcia Martinez, Marian, Andrew Fearne, Julie A. Caswell, and Spencer Henson. 2007. “Co-Regulation as a Possible Model for Food Safety Governance: Opportunities for Public-private Partnerships.” *Food Policy* 32 (3): 299–314. doi:10.1016/j.foodpol.2006.07.005.
- Gennet, Sasha, Jeanette Howard, Jeff Langholz, Kathryn Andrews, Mark D. Reynolds, and Scott A. Morrison. 2013. “Farm Practices for Food Safety: An Emerging Threat to Floodplain and Riparian Ecosystems.” *Frontiers in Ecology and the Environment* 11 (5): 236–42. doi:10.1890/120243.
- Gerlock, Grant. 2015. “Our Food-Safety System Is A Patchwork With Big Holes, Critics Say.” *NPR: The Salt*. March 30. <http://www.npr.org/sections/thesalt/2015/03/30/396360395/our-food-safety-system-is-a-patchwork-with-big-holes-critics-say>.
- Giammona, Craig, and Leslie Patton. 2015. “Chipotle’s Greatest Strength Now Its Greatest Weakness Too.” *Chicago Tribune*, December 8. <http://www.chicagotribune.com/business/ct-chipotle-fresh-ingredients-e-coli-20151208-story.html>.
- Gieryn, Thomas. 1995. “Boundaries of Science.” In *Handbook of Science and Technology Studies*, edited by Sheila Jasanoff, Gerald Markle, James Petersen, and Trevor Pinch, 1st ed. London: SAGE Publications.
- Gilad, Sharon. 2010. “It Runs in the Family: Meta-Regulation and Its Siblings.” *Regulation & Governance* 4 (4): 485–506.
- Goetz, Gretchen. 2013. “Peanut Corporation of America from Inception to Indictment: A Timeline.” *Food Safety News*, February 22. <http://www.foodsafetynews.com/2013/02/peanut-corporation-of-america-from-inception-to-indictment-a-timeline/>.
- Goodwin, Lorine Swainston. 1999. *The Pure Food, Drink, and Drug Crusaders, 1879-1914*. Jefferson, N.C.: McFarland.
- Gould, L Hannah, Kelly A Walsh, Antonio R Vieira, Karen Herman, Ian T Williams, Aron J Hall, and Dana Cole. 2013. “Surveillance for Foodborne Disease outbreaks—United States, 1998–2008.” *Morbidity and Mortality Weekly Report (MMWR), Surveillance Summaries* 62 (SS02): 1–34.
- Gubernot, Diane, Marianne Fatica, Cerise Robinson, Sheila Merriweather, Tami Cloyd, and Gary Weber. 2016. “A Summary of Foodborne Illness Outbreaks Investigated by FDA’s Coordinated Outbreak Response and Evaluation Network, August 2011 to December 2015.” In . St. Louis, Missouri: Iafp. <https://iafp.confex.com/iafp/2016/webprogram/Paper11553.html>.

- Gunderson, Lance H., and C. S. Holling. 2001. *Panarchy: Understanding Transformations in Human and Natural Systems*. Washington: Island Press.
- Guth, Jacob. 2016. "Compost Tea in the Age of Food Safety." *Farm Food Safety and Conservation Network*. February 28. <http://www.ffscn.net/blog/2016/2/28/compost-tea-in-the-age-of-food-safety>.
- Guzewich, J.J. 1986. "Statewide Implementation of a HACCP Food Service Regulatory Program." *Journal of Environmental Health* 49 (3): 148–52.
- Haas, Peter M. 1992. "Introduction: Epistemic Communities and International Policy Coordination." *International Organization* 46 (1): 1–35.
- Hajer, Maarten, and Wytske Versteeg. 2005. "Performing Governance through Networks." *European Political Science* 4 (3): 340–47.
- Halper, Evan. 2015. "Latest Climate Change Battle May Center on Food Pyramid." *Los Angeles Times*, January 18. <http://www.latimes.com/nation/la-na-climate-food-20150118-story.html>.
- Haraway, Donna. 1988. "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective." *Feminist Studies* 14 (3): 575–99.
- Hardesty, Shermain D, and Yoko Kusunose. 2009. "Growers' Compliance Costs for the Leafy Greens Marketing Agreement and Other Food Safety Programs." *UC Small Farm Program Brief*. Accessed January 20: 2010.
- Hardy, Anne. 1999. "Food, hygiene, and the laboratory: A short history of food poisoning in Britain, circa 1850-1950." *Social History of Medicine* 12: 293–311.
- . 2001. "Methods of Outbreak Investigation in the 'Era of Bacteriology' 1880-1920." *Sozial- Und Präventivmedizin* 46: 355–60.
- Hatanaka, Maki, Carmen Bain, and Lawrence Busch. 2005. "Third-Party Certification in the Global Agrifood System." *Food Policy* 30 (3): 354–69.
- Henao, Olga L., Timothy F. Jones, Duc J. Vugia, and Patricia M. Griffin. 2015. "Foodborne Diseases Active Surveillance Network—2 Decades of Achievements, 1996–2015." *Emerging Infectious Diseases* 21 (9): 1529–36. doi:10.3201/eid2109.150581.
- Henke, Christopher. 2008. *Cultivating Science, Harvesting Power Science and Industrial Agriculture in California*. Cambridge, Mass.: MIT Press.
<http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=237759>.
- Henson, Spencer. 2011. "Private Agrifood Governance: Conclusions, Observations and Provocations." *Agriculture and Human Values* 28 (3): 443–51. doi:10.1007/s10460-011-9309-y.
- Henson, Spencer, and Thomas Reardon. 2005. "Private Agri-Food Standards: Implications for Food Policy and the Agri-Food System." *Food Policy* 30 (3): 241–53.
- Héritiera, Adrienne, and Dirk Lehmkuhl. 2008. "The Shadow of Hierarchy and New Modes of Governance." *Journal of Public Policy* 28: 1–17.
- Hoefler, Dina, Sharon Hurd, Carlota Medus, Alicia Cronquist, Samir Hanna, Julie Hatch, Tameka Hayes, et al. 2010. "Laboratory Practices for the Identification of Shiga Toxin–Producing *Escherichia Coli* in the United States, FoodNet Sites, 2007." *Foodborne Pathogens and Disease* 8 (4): 555–60. doi:10.1089/fpd.2010.0764.

- Holmes, Seth M. 2013. *Fresh Fruit, Broken Bodies: Migrant Farmworkers in the United States*. Berkeley, CA: University of California Press.
- Horsfall, Scott. 2011. “‘Co-Management’ Officially Becomes Part of LGMA Metrics.” *LGMA*. August 22. <http://www.lgma.ca.gov/2011/08/co-management-officially-becomes-part-lgma-metrics/>.
- Hughes, Thomas. 1987. “The Evolution of Large Technological Systems.” In *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, edited by Wiebe Bijker, Thomas Hughes, and Trevor Pinch. Cambridge, Mass: MIT Press.
- Hughes, Thomas P. 1986. “The Seamless Web: Technology, Science, Etcetera, Etcetera.” *Social Studies of Science* 16 (2): 281–92. doi:10.1177/0306312786016002004.
- Hurd, Sharon, Mary Patrick, Julie Hatch, Paula Clogher, Katie Wymore, Alicia B. Cronquist, Suzanne Segler, et al. 2012. “Clinical Laboratory Practices for the Isolation and Identification of *Campylobacter* in Foodborne Diseases Active Surveillance Network (FoodNet) Sites: Baseline Information for Understanding Changes in Surveillance Data.” *Clinical Infectious Diseases* 54 (suppl 5): S440–45. doi:10.1093/cid/cis245.
- [IOM] Institute of Medicine. 1991. *Seafood Safety*. Washington, D.C.: National Academies Press. <http://www.nap.edu/catalog/1612>.
- . 1998. *Ensuring Safe Food: From Production to Consumption*. Washington, DC: National Academies Press. <http://www.nap.edu/catalog/6163/ensuring-safe-food-from-production-to-consumption>.
- . 2012. *Improving Food Safety Through a One Health Approach: Workshop Summary*. Edited by E. R. Choffnes, D. A. Relman, L. Olsen, R. Hutton, and A. Mack. Washington, D.C.: National Academies Press. <http://www.nap.edu/catalog/13423>.
- [IOM] Institute of Medicine, and [NRC] National Research Council. 1998. *Ensuring Safe Food: From Production to Consumption*. The National Academies Press. http://www.nap.edu/openbook.php?record_id=6163.
- Jasanoff, Sheila. 1990. *The Fifth Branch: Science Advisers as Policymakers*. Cambridge, Mass: Harvard University Press.
- . 1999. “The Songlines of Risk.” *Environmental Values*, 135–52.
- . 2003. “Technologies of Humility: Citizen Participation in Governing Science.” *Minerva* 41 (3): 223–44. doi:10.1023/a:1025557512320.
- . 2004. *States of Knowledge: The Co-Production of Science and Social Order*. London; New York: Routledge.
- . 2012. *Science and Public Reason*. London; New York: Routledge.
- Jones, TF, E. Scallan, and FJ Angulo. 2007. “FoodNet: Overview of a Decade of Achievement.” *Foodborne Pathogens and Disease* 4 (1): 60.
- Karp, Daniel S., Patrick Baur, Edward R. Atwill, Kathryn De Master, Sasha Gennet, Alastair Iles, Joanna L. Nelson, Amber R. Sciligo, and Claire Kremen. 2015. “The Unintended Ecological and Social Impacts of Food Safety Regulations in California’s Central Coast Region.” *BioScience* 65 (12): 1173–83. doi:10.1093/biosci/biv152.
- Karp, Daniel S., Sasha Gennet, Christopher Kilonzo, Melissa Partyka, Nicolas Chaumont, Edward R. Atwill, and Claire Kremen. 2015. “Comanaging Fresh Produce for Nature

- Conservation and Food Safety.” *Proceedings of the National Academy of Sciences* 112 (35): 11126–11131. doi:10.1073/pnas.1508435112.
- Karp, Daniel S., Rebekah Moses, Sasha Gennet, Matthew S. Jones, Shimat Joseph, Leithen K. M’Gonigle, Lauren C. Ponisio, William E. Snyder, and Claire Kremen. 2016. “Agricultural Practices for Food Safety Threaten Pest Control Services for Fresh Produce.” *Journal of Applied Ecology*, May, n/a-n/a. doi:10.1111/1365-2664.12707.
- Kauffman, FL. 1974. “How FDA Uses HACCP.” *Food Technology* 28 (9): 51-.
- Klijn, Erik-Hans, and Chris Skelcher. 2007. “DEMOCRACY AND GOVERNANCE NETWORKS: COMPATIBLE OR NOT?” *Public Administration* 85 (3): 587–608. doi:10.1111/j.1467-9299.2007.00662.x.
- Knorr-Cetina, K. 1999. *Epistemic Cultures: How the Sciences Make Knowledge*. Cambridge, Mass.: Harvard University Press.
- Knutson, R, and L.A. Ribera. 2011. “Provisions and Economic Implications of FDA’s Food Safety Modernization Act, AFPC Issue Paper 11-1.” College Station, TX: Agricultural and Food Policy Center, Texas A&M University.
- Kupchik, G, R Elston, K Lewis, and S Hoover. 1971. “Proceedings of the 1971 National Conference on Food Protection.” In . Denver, Colorado: US Department of Health, Education, and Welfare, US Food and Drug Administration, and the US Public Health Service.
- Kupferschmidt, Kai. 2011. “Outbreak Detectives Embrace the Genome Era.” *Science* 333 (6051): 1818–19. doi:10.1126/science.333.6051.1818.
- Latour, Bruno. 1987. *Science in Action : How to Follow Scientists and Engineers through Society*. Cambridge, Mass.: Harvard University Press.
- . 1988. *The pasteurization of France*. Cambridge, Mass.: Harvard University Press.
- . 1993. *We Have Never Been Modern*. Cambridge, Mass.: Harvard University Press.
- . 1999. *Pandora’s Hope : Essays on the Reality of Science Studies*. Cambridge, Mass.: Harvard University Press.
- . 2005. *Reassembling the Social : An Introduction to Actor-Network-Theory*. Oxford; New York: Oxford University Press.
- Law, John. 1992. “Notes on the Theory of the Actor-Network: Ordering, Strategy, and Heterogeneity.” *Systems Practice* 5 (4): 379–93.
- Leavitt, Judith Walzer. 1992. “‘ Typhoid Mary’ Strikes Back Bacteriological Theory and Practice in Early Twentieth-Century Public Health.” *Isis* 83 (4): 608–629.
- Lee, Timothy B. 2015. “Chipotle’s Food Safety Crisis, Explained.” *Vox*, December 21. <http://www.vox.com/business-and-finance/2015/12/9/9882256/chipotle-food-safety-crisis-explained>.
- Leopold, Aldo. 1949. *A Sand County Almanac with Essays on Conservation from Round River*. New York: Ballantine books.
- Levenstein, Harvey A. 2012. *Fear of Food : A History of Why We Worry about What We Eat*. Chicago; London: The University of Chicago Press.
- Levi-Faur, David. 2006. “Regulatory Capitalism: The Dynamics of Change beyond Telecoms and Electricity.” *Governance* 19 (3): 497–525. doi:10.1111/j.1468-0491.2006.00327.x.

- . 2009. “Regulatory Capitalism and the Reassertion of the Public Interest.” *Policy and Society* 27 (3): 181–91. doi:10.1016/j.polsoc.2008.10.002.
- . 2011. “Regulation and Regulatory Governance.” In *Handbook on the Politics of Regulation*, edited by David Levi-Faur, 3–21. Cheltenham, UK: Edward Elgar. <http://books.google.com/books?id=KOKtKzEyQIYC>.
- Lewis, James. 2011. “HACCP Manager Training, Version 4.0.” HACCP Training Series. NSF International.
- Ley, Ruth E. 2010. “Obesity and the Human Microbiome.” *Current Opinion in Gastroenterology* 26 (1). http://journals.lww.com/co-gastroenterology/Fulltext/2010/01000/Obesity_and_the_human_microbiome.3.aspx.
- Lin, Biing-Hwan, and Rosanna Mentzer Morrison. 2016. “A Closer Look at Declining Fruit and Vegetable Consumption Using Linked Data Sources.” *Amber Waves, USDA Economic Research Service*, July 5. <http://www.ers.usda.gov/amber-waves/2016-july/a-closer-look-at-declining-fruit-and-vegetable-consumption-using-linked-data-sources.aspx#.V4-mYriANBc>.
- Little, Tom J, David M Shuker, Nick Colegrave, Troy Day, and Andrea L Graham. 2010. “The Coevolution of Virulence: Tolerance in Perspective.” *PLoS Pathogens* 6 (9): e1001006.
- Loconto, Allison, and Lawrence Busch. 2010. “Standards, Techno-Economic Networks, and Playing Fields: Performing the Global Market Economy.” *Review of International Political Economy* 17 (3): 507–36. doi:10.1080/09692290903319870.
- Loeber, Anne. 2011. “The Food Chain Reforged: Novel Food Risk Arrangements and the Metamorphosis of a Metaphor.” *Science as Culture* 20 (2): 231–53. doi:10.1080/09505431.2011.563571.
- Lowell, K., J. Langholz, and D. Stuart. 2010. “Safe and Sustainable: Co-Managing for Food Safety and Ecological Health in California’s Central Coast Region.” San Francisco, CA, and Washington, D.C.: The Nature Conservancy of California and the Georgetown University Produce Safety Project.
- Manulis-Sasson, Shulamit, and Shlomo Sela (Saldinger). 2015. “What Else Can We Do to Mitigate Contamination of Fresh Produce by Foodborne Pathogens?” *Microbial Biotechnology* 8 (1): 29–31.
- Markland, Sarah M., and Kalmia E. Kniel. 2015. “Chapter Five - Human Pathogen–Plant Interactions: Concerns for Food Safety.” In *Advances in Botanical Research*, edited by Harsh Bais and Janine Sherrier, Volume 75:115–35. Academic Press. <http://www.sciencedirect.com/science/article/pii/S0065229615000579>.
- Marler, Bill. 2008. “Marler Clark Settles Last of Dole Spinach E. Coli Cases | Marler Blog.” *Marler Blog*. October 28. <http://www.marlerblog.com/legal-cases/marler-clark-settles-last-of-dole-spinach-e-coli-cases/#.V5KwS1UrLGg>.
- Marsden, Terry. 2010. *The New Regulation and Governance of Food : Beyond the Food Crisis?* New York: Routledge.
- Marx, Leo. 1964. *The Machine in the Garden: Technology and the Pastoral Ideal in America*. New York: Oxford University Press.
- Mathews, Andrew S. 2011. *Instituting Nature : Authority, Expertise, and Power in Mexican Forests*. Cambridge, Mass.: MIT Press.

- McMahon, Martha. 2013a. "What Food Is to Be Kept Safe and for Whom? Food-Safety Governance in an Unsafe Food System." *Laws* 2 (4): 401–427.
- . 2013b. "What Food Is to Be Kept Safe and for Whom? Food-Safety Governance in an Unsafe Food System." *Laws* 2 (4): 401–427.
- Merchant, Carolyn. 1980. *The Death of Nature: Women, Ecology, and the Scientific Revolution*. ———. 1989. *Ecological Revolutions : Nature, Gender, and Science in New England*. Chapel Hill: University of North Carolina Press.
- . , ed. 2008. *Ecology*. 2nd ed. Key Concepts in Critical Theory. Amherst, NY: Humanity Books.
- . 2013. *Reinventing Eden: The Fate of Nature in Western Culture*. Second. New York: Routledge.
- Minkoff-Zern, Laura-Anne, Nancy Peluso, Jennifer Sowerwine, and Christy Getz. 2011. "Race and Regulation: Asian Immigrants in California Agriculture." In *Cultivating Food Justice: Race, Class, and Sustainability*, edited by Alison Hope Alkon and Julian Agyeman, 65. MIT Press.
- Mitchell, Don. 2012. *They Saved the Crops : Labor, Landscape, and the Struggle over Industrial Farming in Bracero-Era California*. Athens: University of Georgia Press.
- Mol, Annemarie. 2012. "Mind Your Plate! The Ontonorms of Dutch Dieting." *Social Studies of Science* 43 (3): 306312712456948.
- Moorman, Mark, Payton Pruett, and Martin Weidman. 2010. "Value and Methods for Molecular Subtyping of Bacteria." In *Principles of Microbiological Troubleshooting in the Industrial Food Processing Environment*, edited by Jeffrey L. Kornacki, 157–74. Food Microbiology and Food Safety. Springer New York.
http://link.springer.com/chapter/10.1007/978-1-4419-5518-0_10.
- Mossel, D. A. A. 1989. "Listeria Monocytogenes in Foods. Isolation, Characterization and Control." *International Journal of Food Microbiology* 8 (3): 183–95. doi:10.1016/0168-1605(89)90013-5.
- National Research Council. 2010. *Enhancing Food Safety: The Role of the Food and Drug Administration*. The National Academies Press.
http://www.nap.edu/openbook.php?record_id=12892.
- Nestle, Marion. 2003. *Safe Food: Bacteria, Biotechnology, and Bioterrorism*. Berkeley, CA: University of California Press.
- North, Douglass C. 1990. *Institutions, Institutional Change, and Economic Performance*. Cambridge; New York: Cambridge University Press.
- [NSAC] National Sustainable Agriculture Coalition. 2009. "Food Safety on the Farm: Policy Brief and Recommendations." <http://sustainableagriculture.net/wp-content/uploads/2008/08/NSAC-Food-Safety-Policy-Brief-October-20091.pdf>.
- Olaimat, Amin N., and Richard A. Holley. 2012. "Factors Influencing the Microbial Safety of Fresh Produce: A Review." *Food Microbiology* 32 (1): 1–19. doi:10.1016/j.fm.2012.04.016.
- Ortiz, Erik. 2014. "Victims' Families Devastated as Colorado Farmers Avoid Prison after Deadly Melon Outbreak." *NBC News*, January 28.

- http://usnews.nbcnews.com/_news/2014/01/28/22483133-victims-families-devastated-as-colorado-farmers-avoid-prison-after-deadly-melon-outbreak.
- Painter, JA, RM Hoekstra, T Ayers, RV Tauxe, CR Braden, and FJ Angulo. 2013. "Attribution of Foodborne Illnesses, Hospitalizations, and Deaths to Food Commodities by Using Outbreak Data, United States, 1998-2008." *Emerg Infect Dis* 19 (3): 407–15. doi:10.3201/eid1903.111866.
- Parker, Christine. 2002. *The Open Corporation: Effective Self-Regulation and Democracy*. Cambridge University Press.
- . 2006. "Meta-Regulation: Legal Accountability for Corporate Social Responsibility." In *The New Corporate Accountability: Corporate Social Responsibility and the Law*, edited by Doreen McBarnet, Aurora Voiculescu, and Tom Campbell. Cambridge University Press.
- Parker, Jason, Julia DeNiro, Melanie Lewis Ivey, and Doug Doohan. 2016. "Are Small and Medium Scale Produce Farms Inherent Food Safety Risks?" *Journal of Rural Studies* 44 (April): 250–60. doi:10.1016/j.jrurstud.2016.02.005.
- Parker, Jason S., Robyn S. Wilson, Jeffrey T. LeJeune, Louie Rivers III, and Douglas Doohan. 2012. "An Expert Guide to Understanding Grower Decisions Related to Fresh Fruit and Vegetable Contamination Prevention and Control." *Food Control* 26 (1): 107–16. doi:http://dx.doi.org/10.1016/j.foodcont.2011.12.025.
- Pendergrast, Mark. 2010. *Inside the Outbreaks: The Elite Medical Detectives of the Epidemic Intelligence Service*. Houghton Mifflin Harcourt.
- Perrow, Charles. 1999. *Normal Accidents: Living with High-Risk Technologies*. Princeton, NJ: Princeton University Press.
- Peterson, AC, and RE Gunnerson. 1974. "Microbiological Critical Control Points in Frozen Foods." *Food Technology* 28 (9): 37.
- Pillsbury Company, and Research and Development Department. 1973. *Development of a Food Quality Assurance Program and the Training of FDA Personnel in Hazard Analysis Techniques*. Minneapolis, Minn.: The Company. <http://books.google.com/books?id=nJfvAAAAMAAJ>.
- Pinch, Trevor. 1994. "Cold Fusion and the Sociology of Scientific Knowledge." *Technical Communication Quarterly* 3 (1): 85–100.
- Pollan, Michael. 2006. *The Omnivore's Dilemma : A Natural History of Four Meals*. New York: Penguin Press.
- . 2009. *Food Rules: An Eater's Manual*. New York: Penguin Books.
- . 2013. "Some of My Best Friends Are Germs." *The New York Times*, May 15, sec. Magazine. <http://www.nytimes.com/2013/05/19/magazine/say-hello-to-the-100-trillion-bacteria-that-make-up-your-microbiome.html>.
- . 2015. "Why 'Natural' Doesn't Mean Anything Anymore." *The New York Times*, April 28. http://www.nytimes.com/2015/05/03/magazine/why-natural-doesnt-mean-anything-anymore.html?ref=earth&_r=0.
- Power, Michael. 1997. *The Audit Society : Rituals of Verification*. Oxford, [England]; New York: Oxford University Press.

- Power, Michael. 2004. *The Risk Management of Everything : Rethinking the Politics of Uncertainty*. London: Demos.
- Power, Michael, . 2007. "Organized Uncertainty Designing a World of Risk Management." <http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=201112>.
- Rabinow, Paul. 1996. *Making PCR: A Story of Biotechnology*. Chicago: University of Chicago Press.
- Ransom, Elizabeth, Carmen Bain, and Vaughan Higgins. 2013. "Private Agri-Food Standards: Supply Chains and the Governance of Standards." *Int. Jrnl. of Soc. of Agr. & Food* 20 (2): 147–54.
- Renn, Ortwin. 2008. *Risk Governance: Coping with Uncertainty in a Complex World*. Earthscan.
- Rennell, Corey. 2011. "Does 'The Secret To Nutrition' Really Exist?" *The Huffington Post*, September 16. http://www.huffingtonpost.com/corey-rennell/nutrition-principles_b_958327.html.
- Rittel, Horst W J., and Melvin M Webber. 1973. "Dilemmas in a General Theory of Planning." *Policy Sciences* 4 (2): 155–69. doi:10.1007/bf01405730.
- Rose, Nikolas, and Peter Miller. 1992. "Political Power beyond the State: Problematics of Government." *The British Journal of Sociology* 43 (2): 173–205. doi:10.2307/591464.
- Ross-Nazzari, J. 2007. "From Farm to Fork: How Space Food Standards Impacted the Food Industry and Changed Food Safety Standards." In *Societal Impact of Spaceflight*, edited by S. J. Dick and R. D. Launius, 219–36. Washington, DC: NASA. <http://history.nasa.gov/sp4801-part1.pdf>.
- Russell, Edmund. 2003. "Evolutionary History: Prospectus for a New Field." *Environmental History* 8 (2): 204–28. doi:10.2307/3985709.
- Sabel, C.F., and J. Zeitlin. 2012. "Experimentalist Governance." In *The Oxford Handbook of Governance*, edited by David Levi-Faur. Oxford University Press.
- Sady, Wojciech. 2012. "Ludwik Fleck." In *The Stanford Encyclopedia of Philosophy*, edited by Edward N. Zalta, Summer 2012. <http://plato.stanford.edu/archives/sum2012/entries/fleck/>.
- Sanchez, Marc C. 2011. "Understanding the Ancestry of the Food Safety Modernization Act." *Food Safety Magazine*, September. <http://www.foodsafetymagazine.com/magazine-archive1/augustseptember-2011/funderstanding-the-ancestry-of-the-food-safety-modernization-act/>.
- Satin, Morton. 2007. *Death in the Pot: The Impact of Food Poisoning on History*. Prometheus Books.
- Scallan, Elaine, Patricia M Griffin, Frederick J Angulo, Robert V Tauxe, Robert M Hoekstra, and others. 2011. "Foodborne Illness Acquired in the United States—unspecified Agents." *Emerg Infect Dis* 17 (1): 16–22.
- Scallan, Elaine, Robert M Hoekstra, Frederick J Angulo, Robert V Tauxe, Marc-Alain Widdowson, Sharon L Roy, Jeffery L Jones, and Patricia M Griffin. 2011. "Foodborne Illness Acquired in the United States—major Pathogens." *Emerg Infect Dis* 17 (1).
- Scott, James C. 1998. *Seeing like a State : How Certain Schemes to Improve the Human Condition Have Failed*. New Haven: Yale University Press.

- Shapin, Steven, and Simon. Schaffer. (1985) 2011. *Leviathan and the Air-Pump : Hobbes, Boyle, and the Experimental Life*. Princeton, NJ: Princeton University Press.
- Shekhar, Varun. 2010. "Produce Exceptionalism: Examining the Leafy Greens Marketing Agreement and Its Ability to Improve Food Safety." *Journal of Food Law and Policy* 6: 267.
- Siegner, Cathy. 2015. "IAFP 2015: Debating Three Food Safety Perspectives." *Food Safety News*, July 27. <http://www.foodsafetynews.com/2015/07/iafp-2015-debating-three-food-safety-perspectives/>.
- Simonsen, B.a, F.L.b Bryan, J.H.B.c Christian, T.A.d Roberts, R.B.e Tompkin, and J.H.f Silliker. 1987. "Prevention and Control of Food-Borne Salmonellosis through Application of Hazard Analysis Critical Control Point (HACCP)." *International Journal of Food Microbiology* 4 (3): 227–47.
- Smith, Merritt Roe, and Leo Marx. 1994. *Does Technology Drive History? The Dilemma of Technological Determinism*. Cambridge, Mass.: MIT Press.
- Sørensen, Eva. 2002. "Democratic Theory and Network Governance." *Administrative Theory & Praxis* 24 (4): 693–720.
- . 2006. "Metagovernance The Changing Role of Politicians in Processes of Democratic Governance." *The American Review of Public Administration* 36 (1): 98–114.
- Sørensen, Eva, and Jacob Torfing. 2003. "Network Politics, Political Capital, and Democracy." *International Journal of Public Administration* 26 (6): 609–34. doi:10.1081/pad-120019238.
- . 2005. "The Democratic Anchorage of Governance Networks." *Scandinavian Political Studies* 28 (3): 195–218.
- . 2009. "Making Governance Networks Effective and Democratic through Metagovernance." *Public Administration* 87 (2): 234–58.
- Sparrow, Malcolm K. 2008. *The Character of Harms : Operational Challenges in Control*. Cambridge; New York: Cambridge University Press.
- Sperber, William H, and Richard F Stier. 2009. "Happy 50th Birthday to HACCP: Retrospective and Prospective." *FoodSafety Magazine*. December, 42–44.
- Starmer, Elanor, and Marie Kulick. 2009. "Bridging the GAPS: Strategies to Improve Produce Safety, Preserve Farm Diversity and Strengthen Local Food Systems." Food & Water Watch and Institute for Agriculture and Trade Policy.
- Stearns, Denis. 2014. "A Continuing Plague: Faceless Transactions and the Coincident Rise of Food Adulteration and Legal Regulation of Quality." *Wisconsin Law Review* 101. <http://papers.ssrn.com/abstract=2469331>.
- Stokstad, Erik. 2011. "Food Safety Law Will Likely Strain FDA Science." *Science* 331 (6015): 270. doi:10.1126/science.331.6015.270.
- Strauss, Debra. 2011. "An Analysis of the FDA Food Safety Modernization Act: Protection for Consumers and Boon for Business." *Food and Drug Law Journal* 66 (3): 353–76.
- Stuart, Diana. 2008. "The Illusion of Control: Industrialized Agriculture, Nature, and Food Safety." *Agriculture and Human Values* 25 (2): 177–81. doi:10.1007/s10460-008-9130-4.

- . 2009. “Constrained Choice and Ethical Dilemmas in Land Management: Environmental Quality and Food Safety in California Agriculture.” *Journal of Agricultural and Environmental Ethics* 22 (1): 53–71. doi:10.1007/s10806-008-9129-2.
- . 2010. “Science, Standards, and Power: New Food Safety Governance in California.” *Journal of Rural Social Sciences* 25 (3): 111–40.
- . 2011. “‘Nature’ Is Not Guilty: Foodborne Illness and the Industrial Bagged Salad.” *Sociologia Ruralis* 51 (2): 158–74. doi:10.1111/j.1467-9523.2010.00528.x.
- Stuart, Diana, and Michelle Worosz. 2012. “Risk, Anti-Reflexivity, and Ethical Neutralization in Industrial Food Processing.” *Agriculture and Human Values* 29 (3): 287–301. doi:10.1007/s10460-011-9337-7.
- Sturdy, S., and R. Cooter. 1998. “Science, Scientific Management, and the Transformation of Medicine in Britain C. 1870-1950.” *History of Science* 36: 421–66.
- Susser, M. 1985. “Epidemiology in the United States after World War II: The Evolution of Technique.” *Epidemiologic Reviews* 7: 147.
- Swain, Steven. 2013. “Compost Tea.” *UC IPM Green Bulletin* 3 (4): 4.
- Swaminathan, B., T. J. Barrett, S. B. Hunter, and R. V. Tauxe. 2001. “PulseNet: The Molecular Subtyping Network for Foodborne Bacterial Disease Surveillance, United States.” *Emerging Infectious Diseases* 7 (3): 382–89.
- Szasz, Andrew. 2007. *Shopping Our Way to Safety : How We Changed from Protecting the Environment to Protecting Ourselves*. Minneapolis: University of Minnesota Press.
- The Human Microbiome Project Consortium. 2012. “Structure, Function and Diversity of the Healthy Human Microbiome.” *Nature* 486 (7402): 207–14. doi:10.1038/nature11234.
- The National Advisory Committee on Microbiological Criteria for Foods. 1997. “HACCP Principles & Application Guidelines.” US Department of Agriculture. <http://www.fda.gov/Food/GuidanceRegulation/HACCP/ucm2006801.htm>.
- Thomas, Courtney Irene Powell. 2014. *In Food We Trust : The Politics of Purity in American Food Regulation*. Lincoln, Nebraska: University of Nebraska Press.
- Timmermans, Stefan, and Steven Epstein. 2010. “A World of Standards but Not a Standard World: Toward a Sociology of Standards and Standardization*.” *Annual Review of Sociology* 36: 69–89.
- Tomes, N. 1999. *The Gospel of Germs: Men, Women, and the Microbe in American Life*. Harvard University Press. <http://books.google.com/books?id=3Yk2ylBmmtsC>.
- Tompkin, R. B. 1990. “The Use of HACCP in the Production of Meat and Poultry Products.” *Journal of Food Protection* 53 (9): 795–803.
- Tout, Thomas Frederick. 1920. *Chapters in the Administrative History of Mediaeval England: The Wardrobe, the Chamber and the Small Seals*. University Press.
- Tsing, Anna Lowenhaupt. 2005. *Friction: An Ethnography of Global Connection*. Princeton, N.J.: Princeton University Press.
- [UCCE] University of California Cooperative Extension. n.d. “Balancing Food Safety and Sustainability: Opportunities for Co-Management.” <http://ucfoodsafety.ucdavis.edu/files/198482.pdf>.
- USA v. Jensen et al. 2013 Docket No. 1:13-mj-01138 (D. Colo. Sept 24, 2013), Court Docket.

- [USDA] U.S. Department of Agriculture, and [HHS] U.S. Department of Health and Human Services. 2010. "Dietary Guidelines for Americans 2010, 7th Edition." Washington, D.C.: U.S. Government Printing Office.
<http://health.gov/dietaryguidelines/dga2010/DietaryGuidelines2010.pdf>.
- [USDA-FSIS] United States Department of Agriculture - Food Safety and Inspection Service. 2014. "Food Safety Information: Chicken from Farm to Table."
http://www.fsis.usda.gov/wps/wcm/connect/ad74bb8d-1dab-49c1-b05e-390a74ba7471/Chicken_from_Farm_to_Table.pdf?MOD=AJPERES.
- Voetsch, Andrew C., Frederick J. Angulo, Terry Rabatsky-Ehr, Sue Shallow, Maureen Cassidy, Stephanie M. Thomas, Ellen Swanson, et al. 2004. "Laboratory Practices for Stool-Specimen Culture for Bacterial Pathogens, Including Escherichia Coli O157:H7, in the FoodNet Sites, 1995–2000." *Clinical Infectious Diseases* 38 (Supplement 3): S190–97. doi:10.1086/381586.
- Wagner, Michael M., Fu-Chiang Tsui, Jeremy U. Espino, Virginia M. Dato, Dean F. Sitting, Richard A. Caruana, Laura F. McGinnis, David W. Deerfield, Marek J. Druzdzal, and Douglas B. Fridsma. 2001. "The Emerging Science of Very Early Detection of Disease Outbreaks." *Journal of Public Health Management and Practice* 7 (6).
http://journals.lww.com/jphmp/Fulltext/2001/07060/The_Emerging_Science_of_Very_Early_Detection_of.6.aspx.
- Walker, Richard. 2004. *The Conquest of Bread: 150 Years of Agribusiness in California*. New York: New Press : Distributed by Norton.
- Waltner-Toews, David. 1996. "An Agroecosystem Perspective on Foodborne Illnesses." *Ecosystem Health* 2 (3): 177–185.
- Wang, Siyun, Daniel Weller, Justin Falardeau, Laura K. Strawn, Fernando O. Mardones, Aiko D. Adell, and Andrea I. Moreno Switt. 2016. "Food Safety Trends: From Globalization of Whole Genome Sequencing to Application of New Tools to Prevent Foodborne Diseases." *Trends in Food Science & Technology* 57, Part A (November): 188–98. doi:10.1016/j.tifs.2016.09.016.
- Warner, Keith Douglass. 2006. "Extending Agroecology: Grower Participation in Partnerships Is Key to Social Learning." *Renewable Agriculture and Food Systems* 21 (2): 84–94. doi:10.1079/RAF2005131.
- . 2007. *Agroecology in Action: Extending Alternative Agriculture Through Social Networks*. MIT Press.
- . 2008. "Agroecology as Participatory Science Emerging Alternatives to Technology Transfer Extension Practice." *Science, Technology & Human Values* 33 (6): 754–77. doi:10.1177/0162243907309851.
- Weise, Elizabeth, and Julie Schmit. 2007. "Spinach Recall: 5 Faces. 5 Agonizing Deaths. 1 Year Later." *USA Today*.
- Wengle, Susanne. 2015. "When Experimentalist Governance Meets Science-Based Regulations; the Case of Food Safety Regulations." *Regulation & Governance*, n/a–n/a. doi:10.1111/rego.12067.
- West, P.A. 1986. "Hazard Analysis Critical Control Point (HACCP) Concept: Application to Bivalve Shellfish Purification Systems." *Journal of the Royal Society of Health* 106 (4): 133–40.

- White, Richard. 1995. *The Organic Machine: The Remaking of the Columbia River*. New York: Hill and Wang.
- [WHO] World Health Organization. 2016. "Sentinel Surveillance." *WHO*. http://www.who.int/immunization/monitoring_surveillance/burden/vpd/surveillance_type/sentinel/en/.
- Wilson, George, and Samuel Shpall. 2012. "Action." In *The Stanford Encyclopedia of Philosophy*, edited by Edward N. Zalta, Summer 2012. <http://plato.stanford.edu/archives/sum2012/entries/action/>.
- Wilson, Norbert L.W., and Michelle R. Worosz. 2014. "Zero Tolerance Rules in Food Safety and Quality." *Food Policy* 45 (April): 112–15. doi:10.1016/j.foodpol.2013.11.004.
- Winters, Diana R. H. 2011. "Not Sick Yet: Food-Safety-Impact Litigation and Barriers to Justiciability." *Brooklyn Law Review* 77: 905.
- Wood, G. Burton. 1961. "MARKETING AGREEMENTS AND ORDERS - WITHOUT PRODUCTION CONTROLS." *Increasing Understanding of Public Problems and Policies*. <http://econpapers.repec.org/article/agsiuppap/17627.htm>.
- Woodhouse, E.J., and S.E. Cozzens. 1995. "Science, Government, and the Politics of Knowledge." In *Handbook of Science and Technology Studies*, edited by S. Jasanoff, Gerald Markle, James Petersen, and Trevor Pinch, 533–53. Thousand Oaks, Calif.: SAGE Publications.
- Worster, Donald, . 1994. *Nature's Economy : A History of Ecological Ideas*. Cambridge; New York, NY, USA: Cambridge University Press.
- Yazdanbakhsh, Maria, Peter G. Kremsner, and Ronald van Ree. 2002. "Allergy, Parasites, and the Hygiene Hypothesis." *Science* 296 (5567): 490–94. doi:10.1126/science.296.5567.490.
- Yeni, F., S. Acar, Y. Soyer, and H. Alpas. 2016. "How Can We Improve Foodborne Disease Surveillance Systems: A Comparison through EU and US Systems." *Food Reviews International* 0 (0): 1–18. doi:10.1080/87559129.2016.1175018.
- Yiannas, Frank. 2009. *Food Safety Culture : Creating a Behavior-Based Food Safety Management System*. New York: Springer.

Appendix A

Projects Funded by the Center for Produce Safety, Coded by Theme.

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
2016	Characterization and mitigation of bacteriological risks associated with packing fresh-market citrus	\$166,437	Laboratory Simulation	Unspecified	Tree Fruit	Listeria; Salmonella	Wash Water	Control	Food Science
2016	Control of Listeria monocytogenes on apple through spray manifold-applied antimicrobial intervention	\$290,000	Laboratory Simulation	Washington; California	Tree Fruit	Listeria	Wash Water	Control	Microbiology
2016	Cyclospora: Potential Reservoirs and Occurrence in Irrigation Waters	\$305,641	Environmental Observation	Arizona; Texas	Unspecified	Parasites	Agricultural Water	Characterization	Environmental Science; Microbiology
2016	Detection, validation, and assessment of risks implied by the viable but non-culturable (VBNC) state of enteric bacterial pathogens in fresh produce	\$200,000	Laboratory Simulation; Field Trial	Unspecified	Leafy Greens	E. coli; Salmonella	Produce	Detection	Food Science

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
2016	Developing Cross-Assembly Phage as a Viral Indicator for Irrigation Waters	\$143,236	Environmental Observation	Pennsylvania; California; Arizona	Unspecified	Viruses	Agricultural Water	Detection	Engineering
2016	Establishment of operating standards for produce wash systems through the identification of specific metrics and test methods	\$225,725	Laboratory Simulation	Unspecified	Vegetables and Melons	Unspecified	Wash Water	Control	Microbiology
2016	Listeria monocytogenes growth and survival on peaches and nectarines as influenced by stone fruit packing house operations, storage and transportation conditions.	\$94,410	Laboratory Simulation	Unspecified	Tree Fruit	Listeria	Facilities and Equipment	Characterization	Food Science
2016	Remotely-sensed and field-collected hydrological, landscape and weather data can predict the quality of surface water used for produce production	\$349,998	Environmental Observation	California; Arizona	Unspecified	E. coli; Listeria; Salmonella	Agricultural Water	Characterization	Microbiology
2016	Resolving postharvest harborage sites of Listeria protects Zone 1 surfaces	\$358,132	Field Trial	California	Tree Fruit	Listeria	Facilities and Equipment	Characterization	Microbiology

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
2016	Significance of the dormant state in the persistence, interaction with growing plants and virulence of Shiga Toxin producing Escherichia coli	\$72,140	Laboratory Simulation	Unspecified	Unspecified	E. coli	Soil	Characterization	Microbiology
2015	Comparative genomics analysis and physiological assessment of the avirulent Salmonella surrogate relevant to produce safety	\$110,494	Laboratory Analysis	Unspecified	Unspecified	Salmonella	Genome	Characterization	Microbiology
2015	Control of Cross-Contamination during Field-pack and Retail Handling of Cantaloupe	\$217,066	Laboratory Analysis	Unspecified	Vegetables and Melons	Listeria; Salmonella	Facilities and Equipment	Control	Food Science
2015	Establishing Die-off Rates of Surrogate and Virulent EHEC-STEC Strains from Strawberry and Cilantro Surfaces: Time, Inoculum Dose and Chemical Intervention - Proof of Concept	\$50,000	Laboratory Simulation	Eastern US	Vegetables and Melons; Berries	E. coli	Agricultural Water	Characterization	Microbiology; Plant Science
2015	Evaluation of sanitizing treatments for sizer	\$100,062	Laboratory Simulation	Unspecified	Tree Fruit	Listeria; Salmonella	Facilities and Equipment	Control	Food Science

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/ Source	Goal	Discipline
	carriers in stone fruit packinghouses								
2015	Evaluation of the efficacy of antimicrobial agents to prevent the transfer of <i>Listeria monocytogenes</i> from existing biofilms to produce or processing surfaces	\$107,048	Laboratory Simulation	Unspecified	Unspecified	Listeria	Produce; Facilities and Equipment	Control	Microbiology
2015	Factors that influence the introduction, fate and mitigation of foodborne pathogens on mangoes throughout the production chain	\$135,218	Laboratory Simulation	Unspecified	Tree Fruit	Salmonella	Produce	Characterization	Food Science
2015	Identification of novel indicator organisms to determine the risks of fecal contamination of irrigation waters	\$234,921	Environmental Observation	Arizona	Unspecified	Unspecified	Agricultural Water	Detection	Microbiology
2015	Methods for the detection of diverse parasites on packaged salads based on (viable) oocysts	\$223,907	Laboratory Analysis	Unspecified	Leafy Greens	Parasites	Produce	Detection	Engineering

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
2015	Microbial food safety risks of reusing tail water for leafy green production	\$162,695	Environmental Observation; Laboratory Simulation	California	Vegetables and Melons	Unspecified	Agricultural Water	Characterization	Agronomy; Microbiology
2015	Pathogen physiological state has a greater effect on outcomes of challenge and validation studies than strain diversity	\$274,750	Laboratory Analysis	Unspecified	Unspecified	E. coli; Listeria; Salmonella	Genome	Characterization	Microbiology
2015	Validating a physically heat-treated process for poultry litter in industry settings using the avirulent Salmonella surrogates or indicator microorganisms	\$193,921	Laboratory Simulation	Unspecified	Unspecified	Salmonella	Soil Amendment	Control	Microbiology
2014	Contamination of leafy green crops with foodborne pathogens: Are wildlife a problem?	\$197,429	Environmental Observation	Indiana	Unspecified	Unspecified	Soil	Control	Food Science
2014	Demonstration of practical, effective and environmentally sustainable agricultural water treatments to achieve compliance	\$260,675	Laboratory Simulation; Field Trial	Unspecified	Unspecified	E. coli	Agricultural Water	Control	Microbiology

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
	with microbiological criteria								
2014	Enteric viruses as new indicators of human and cattle fecal contamination of irrigation waters	\$219,879	Environmental Observation	Arizona; California; Georgia; Wisconsin	Unspecified	Unspecified	Agricultural Water	Detection	Environmental Science; Microbiology
2014	Evaluation of an alternative irrigation water quality indicator	\$334,252	Environmental Observation	California; Arizona	Unspecified	E. coli; Salmonella	Agricultural Water	Detection	Microbiology
2014	Evaluation of falconry as an economically viable co-management strategy to deter nuisance birds in leafy green fields	\$49,336	Field Trial	California; Arizona	Leafy Greens	Unspecified	Wildlife	Control	Animal Science
2014	Impact of wash water disinfectants on Salmonella enterica transfer and survival in mango packing facility water tank operations	\$142,166	Laboratory Simulation	Unspecified	Tree Fruit	Salmonella	Wash Water	Control	Food Science
2014	Improved sampling and analytical methods for testing agricultural water for pathogens, surrogates and	\$298,462	Environmental Observation	Georgia	Unspecified	E. coli; Salmonella; Other Bacteria	Agricultural Water	Detection	Engineering; Microbiology

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
	source tracking indicators								
2014	Improving pasteurization validation methods for pistachio processing	\$279,859	Laboratory Simulation	Unspecified	Nuts	Salmonella	Produce	Control	Engineering; Microbiology
2014	Investigation of risk criteria and foodborne pathogen reduction practices for irrigation water	\$152,344	Environmental Observation; Laboratory Simulation	Virginia	Unspecified	E. coli; Listeria; Salmonella	Agricultural Water	Detection	Plant Science; Food Science
2014	Optimal strategies for monitoring irrigation water quality and the development of guidelines for the irrigation of food crops	\$117,202	Environmental Observation	Arizona	Unspecified	E. coli	Agricultural Water	Detection	Microbiology
2014	Rapid bacterial testing for on-farm sampling	\$272,208	Laboratory Analysis	Unspecified	Unspecified	Salmonella	Agricultural Water	Detection	Food Science
2014	Rapid tests to specifically differentiate clinically significant from environmental STEC towards reducing	\$329,481	Laboratory Analysis	Unspecified	Leafy Greens	E. coli	Produce	Detection	Microbiology

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/ Source	Goal	Discipline
	unnecessary crop destruction								
2014	Towards preventing internalization and persistence of human bacterial pathogens in fresh produce	\$40,025	Laboratory Simulation	Unspecified	Leafy Greens	E. coli; Salmonella	Produce	Characterization	Plant Microbiology
2014	Validation of chlorine level in sanitization system to avoid cross-contamination	\$161,947	Laboratory Simulation	Unspecified	Unspecified	E. coli; Salmonella	Wash Water	Control	Food Science
2013	Assessing postharvest food safety risks and identifying mitigation strategies for foodborne pathogens in pistachios	\$230,185	Laboratory Simulation	Unspecified	Nuts	E. coli; Salmonella	Facilities and Equipment	Characterization	Food Science
2013	Does Salmonella move through the irrigation systems of mixed produce farms of the southeastern United States?	\$371,782	Environmental Observation	Georgia	Vegetables and Melons	Salmonella	Agricultural Water	Characterization	Engineering

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
2013	Effect of physiochemical and biological parameters on survival, persistence and transmission of norovirus in water and on produce	\$324,403	Laboratory Analysis	Unspecified	Vegetables and Melons	Viruses	Agricultural Water; Produce	Characterization	Microbiology
2013	Enhancement of forced-air cooling to reduce Listeria monocytogenes, Salmonella and/or total surface microbiota on cantaloupes	\$49,740	Laboratory Simulation	Unspecified	Vegetables and Melons	Listeria; Salmonella	Produce	Control	Food Science
2013	Evaluation of multiple disinfection methods to mitigate the risk of produce contamination by irrigation water	\$280,483	Field Trial	Tennessee	Vegetables and Melons; Berries	E. coli	Agricultural Water	Control	Engineering
2013	Evaluation of pathogen survival in fresh water sediments and potential impact on irrigation water quality sampling programs	\$50,000	Environmental Observation	Arkansas	Unspecified	E. coli; Listeria; Salmonella	Agricultural Water	Detection	Food Science
2013	Evaluation of risk-based water quality sampling strategies	\$150,745	Environmental Observation	California; Arizona	Unspecified	E. coli	Agricultural Water	Detection	Engineering

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/ Source	Goal	Discipline
	for the fresh produce industry								
2013	Feasibility of using nitric oxide donors to disperse biofilms of industrial significance to strengthen the efficacy of current industrial disinfectants	\$49,951	Laboratory Simulation	Unspecified	Unspecified	E. coli; Listeria; Salmonella	Facilities and Equipment	Control	Microbiology
2013	Food safety risks at the fresh produce-animal interface: identifying pathogen sources and their movement on diversified farms	\$274,693	Field Trial	North Carolina	Unspecified	E. coli; Salmonella	Livestock	Characterization	Animal Science
2013	Remediation and recovery measures to expedite planting or replanting of vegetables following soil contamination by Salmonella enterica	\$376,225	Field Trial	Australia; California	Leafy Greens	Salmonella	Soil	Control	Microbiology
2013	Selection of E. coli surrogates with attachment and survival patterns similar to those of human pathogens	\$236,330	Laboratory Analysis	Unspecified	Unspecified	E. coli; Listeria; Salmonella	Soil; Agricultural Water; Produce	Characterization	Microbiology

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
	associated with produce								
2013	Validation of geospatial algorithms to predict the prevalence and persistence of pathogens in produce fields to improve GAPs	\$291,023	Field Trial	New York	Unspecified	Listeria	Livestock; Soil; Wildlife	Characterization	Microbiology
2013	Effectiveness of a batch ozonated retail wash system for iceberg lettuce.	\$10,000	Laboratory Simulation	Unspecified	Leafy Greens	E. coli; Listeria; Salmonella	Wash Water	Control	Microbiology
2013	Does splash from overhead sprinkler irrigation systems contaminate produce with Salmonella in the southeastern United States?	\$81,864	Environmental Observation	Georgia	Vegetables and Melons	E. coli; Salmonella	Agricultural Water	Characterization	Engineering
2013	Survival of generic E. coli and Salmonella during the growth, curing, and storage of dry bulb onions produced with contaminated irrigation water	\$68,460	Laboratory Simulation	Oregon	Vegetables and Melons	E. coli; Salmonella	Agricultural Water	Characterization	Food Science

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
2013	Transfer and survival of organisms to produce from surface irrigation water	\$72,589	Field Trial	Tennessee	Vegetables and Melons	E. coli	Agricultural Water	Characterization	Food Science
2013	Use of zero valent iron (ZVI) in irrigation of tomatoes with manure-contaminated water at varying E. coli levels	\$68,777	Laboratory Simulation	Unspecified	Vegetables and Melons	E. coli; Salmonella	Agricultural Water	Control	Microbiology
2012	Assessment of sanitation techniques for tree fruit storage bins	\$171,313	Laboratory Simulation; Field Trial	Pacific Northwest	Tree Fruit	Unspecified	Facilities and Equipment	Control	Animal Science
2012	Avirulent Salmonella strains and their use to model behavior of the pathogen in water, composts, in and on vegetables	\$217,273	Laboratory Analysis	Unspecified	Unspecified	Salmonella	Genome	Characterization	Microbiology
2012	Die-off rates of human pathogens in manure amended soil under natural climatic conditions using novel sentinel chamber system	\$128,491	Field Trial	Canada	Unspecified	Unspecified	Soil Amendment	Characterization	Food Science

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
2012	Evaluation of the level of white-tailed deer fecal colonization by E. coli O157:H7 and the ecological role of dung beetles with the pathogen in produce farms	\$50,000	Environmental Observation; Laboratory Simulation	Maine	Berries	E. coli	Wildlife	Characterization	Microbiology
2012	Genomic elucidation of the physiological state of enteric pathogens on pre-harvest lettuce	\$280,071	Laboratory Simulation	Unspecified	Leafy Greens	E. coli; Salmonella	Genome	Characterization	Microbiology
2012	Novel coating systems with sustained release of food antimicrobials to improve safety of cantaloupe	\$231,485	Laboratory Analysis	Unspecified	Vegetables and Melons	Unspecified	Produce	Control	Food Science
2012	Practical validation of surface pasteurization of netted melons	\$244,770	Field Trial	California; Arizona	Vegetables and Melons	Unspecified	Produce	Control	Microbiology
2012	Rapid assessment of oxidative stress induced in microbes to evaluate efficacy of sanitizers in wash water	\$128,758	Laboratory Analysis	Unspecified	Unspecified	E. coli; Salmonella	Wash Water	Detection	Food Science

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
2012	Reducing the risk for transfer of zoonotic foodborne pathogens from domestic and wild animal to vegetable crops in the southwest desert	\$252,777	Environmental Observation	California; Arizona; Mexico	Vegetables and Melons	E. coli; Salmonella	Wildlife; Livestock	Characterization	Animal Science
2012	Science-based evaluation of risks associated with wildlife exposure for contamination of irrigation water by Salmonella	\$99,323	Environmental Observation	Southeastern US	Unspecified	Salmonella	Wildlife; Agricultural Water	Characterization	Microbiology
2011	Identifying causative factors contributing to positive leafy green samples. (rapid response)	\$25,000	Environmental Observation	California	Leafy Greens	Unspecified	People	Detection	Business Management
2011	On-farm evaluation of the prevalence of human enteric bacterial pathogens during the production of melons in California	\$7,500	Environmental Observation	California	Vegetables and Melons	Unspecified	Produce	Characterization	Microbiology

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
2011	Apple growing and packing microbial risk factors and their potential to lead to foodborne disease outbreaks.	\$133,614	Environmental Observation	Unspecified	Tree Fruit	Unspecified	Produce	Characterization	Toxicology
2011	Assessment of E. coli as an indicator of microbial quality of irrigation waters use for produce.	\$84,580	Laboratory Simulation	Unspecified	Unspecified	E. coli	Agricultural Water	Detection	Engineering
2011	Comparative assessment of field survival of Salmonella enterica and E. coli O157:H7 on cilantro (Coriandrum sativum) in relation to sequential cutting and re-growth.	\$96,729	Field Trial	California	Vegetables and Melons	E. coli; Salmonella	Produce	Characterization	Microbiology
2011	Distribution of Salmonella in pistachios and development of effective sampling strategies.	\$192,984	Environmental Observation	Unspecified	Nuts	Salmonella	Produce	Detection	Food Science
2011	DNA-based identification of foliar microbiota with potential to predict or preclude pathogen establishment on	\$96,973	Laboratory Simulation; Field Trial	Unspecified	Unspecified	E. coli; Salmonella	Soil	Control	Microbiology

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
	field-grown leafy greens								
2011	Evaluation of sampling protocol to provide science-based metrics for use in identification of Salmonella in irrigation water testing programs in mixed produce farms in the Suwannee River watershed.	\$254,888	Environmental Observation	Unspecified	Unspecified	Unspecified	Agricultural Water	Detection	Engineering
2011	Glucosinolate-derived compounds as a green manure for controlling E. coli O157:H7 and Salmonella in soil	\$175,229	Field Trial	Unspecified	Unspecified	E. coli; Salmonella	Soil	Control	
2011	Sanitization of soft fruits with ultraviolet (UV-C) light.	\$78,470	Laboratory Simulation	Unspecified	Tree Fruit	Unspecified	Produce	Control	Microbiology
2011	Sources and mechanisms of transfer of Salmonella in the production and postharvest tree nut environment.	\$317,320	Environmental Observation	California	Nuts	Salmonella	Livestock; Facilities and Equipment	Characterization	Food Science

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
2011	The role of riparian zones in bacteria dispersal to produce farms.	\$319,316	Environmental Observation	Unspecified	Unspecified	Unspecified	Wildlife	Characterization	Microbiology
2011	Toward a rapid and reliable pathogen detection system in produce.	\$152,591	Laboratory Analysis	Unspecified	Unspecified	E. coli; Salmonella	Produce	Detection	Microbiology
2011	Validating Salmonella inactivation during thermal processing of the physically heat-treated chicken litter as soil amendment and organic fertilizer.	\$147,344	Laboratory Simulation	Unspecified	Unspecified	Salmonella	Soil Amendment	Control	Microbiology
2011	Validation of testing methods for the detection and quantification of E. coli O157:H7, Salmonella spp., fecal coliforms and non-pathogenic E. coli in compost.	\$121,015	Laboratory Analysis	Unspecified	Unspecified	E. coli; Salmonella	Soil Amendment	Detection	Microbiology
2011	Microbial food safety on-farm risk assessment. (rapid response)	\$10,000	Environmental Observation	California	Vegetables and Melons	Unspecified	Livestock	Characterization	Microbiology
2010	Developing and validating practical strategies to improve microbial safety in	\$296,368	Field Trial	Unspecified	Unspecified	E. coli; Salmonella	Soil Amendment	Control	Microbiology

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
	composting process control and handling practices.								
2010	Developing a program to educate the walnut supply chain as it pertains to product handling and safety.	\$95,454	Field Trial	California	Nuts	Salmonella	People	Control	Business Management
2010	Developing buffer zone distances between sheep grazing operations and vegetable crops to maximize food safety.	\$169,575	Environmental Observation	Western US	Vegetables and Melons	E. coli	Livestock	Characterization	Animal Science
2010	Enhancing the efficacy of fresh produce washing operations through establishing monitoring methods and water disinfection technologies based on a combination of filtration and UV.	\$101,325	Laboratory Simulation	Unspecified	Unspecified	Unspecified	Wash Water	Control	Food Science
2010	Evaluation of amphibians and reptiles as potential reservoirs of foodborne pathogens and risk reduction to protect	\$142,523	Environmental Observation	California	Leafy Greens	E. coli; Salmonella	Wildlife	Characterization	Animal Science

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/ Source	Goal	Discipline
	fresh produce and the environment.								
2010	Evaluation of the baseline levels of microbial pathogens on Washington state fresh market apples and mitigation measures used to eliminate contamination.	\$58,885	Environmental Observation	Washington	Tree Fruit	Unspecified	Produce	Characterization	Microbiology
2010	Escherichia coli O157:H7 in bioaerosols from cattle production areas: evaluation of proximity and airborne transport on leafy green crop contamination.	\$296,360	Field Trial	Unspecified	Leafy Greens	E. coli	Livestock	Characterization	Microbiology
2010	Influence of the pre-harvest environment on the physiological state of Salmonella and its impact on increased survival capability.	\$96,935	Laboratory Analysis	Unspecified	Unspecified	Salmonella	Genome	Characterization	Food Science

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
2010	Investigation of E.coli survival on contaminated crop residue.	\$118,000	Field Trial	California	Leafy Greens	E. coli	Soil	Characterization	Plant Science
2010	Irrigation regime, fruit water congestion and produce safety: parameter optimization to reduce susceptibility of tomatoes and peppers to post-harvest contamination, pathogen transfer and proliferation of Salmonella.	\$188,271	Field Trial	Florida	Vegetables and Melons	Salmonella	Produce	Characterization	Microbiology
2010	Non invasive imaging approaches to evaluate potential infusion of pathogens during vacuum cooling of lettuce leaves and real time dynamics of microbes on leaf tissues as a function of moisture content.	\$45,008	Laboratory Simulation	Unspecified	Leafy Greens	Unspecified	Produce	Characterization	Food Science
2010	Pathogen transfer risks associated with specific	\$117,445	Environmental Observation	Florida	Vegetables and Melons	Unspecified	Facilities and Equipment	Characterization	Food Science

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
	tomato harvest and packing operations.								
2010	Rapid testing of flume water organic load to better assess the efficacy of free chlorine against Escherichia coli O157:H7 during commercial lettuce processing.	\$70,104	Laboratory Simulation	Unspecified	Leafy Greens	E. coli	Wash Water	Control	Food Science
2010	Risk assessment of Salmonella preharvest internalization in relation to irrigation water quality standards for melons and other cucurbits.	\$92,285	Field Trial	Unspecified	Vegetables and Melons	Salmonella	Agricultural Water	Characterization	Microbiology
2010	Survival, transfer, and inactivation of Salmonella on plastic materials used in tomato harvest.	\$235,787	Laboratory Simulation	Unspecified	Vegetables and Melons	Salmonella	Facilities and Equipment	Characterization	Food Science
2010	The likelihood of cross-contamination of head lettuce by E. coli O157:H7, Salmonella and norovirus during	\$330,541	Laboratory Simulation; Field Trial	Unspecified	Leafy Greens	E. coli; Salmonella; Viruses	People	Control	Food Science

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
	hand harvest and recommendations for glove sanitizing and use.								
2010	Investigation of potential reservoirs of shiga toxin-producing E. coli and Salmonella in produce production areas of Arizona and Mexico. (rapid response)	\$70,567	Environmental Observation	Arizona; Mexico	Leafy Greens	E. coli; Salmonella	Wildlife	Characterization	Animal Science
2010	Science-based evaluation of regional risks for Salmonella contamination of irrigation water at mixed produce farms in the Suwannee River watershed.	\$313,513	Environmental Observation	Georgia; Florida	Unspecified	Salmonella	Agricultural Water	Characterization	Microbiology
2009	Science-based monitoring for produce safety: Comparing indicators and pathogens in water, soil and crops.	\$178,700	Laboratory Simulation; Field Trial	Unspecified	Unspecified	Unspecified	Agricultural Water; Soil; Produce	Detection	Microbiology; Plant Science
2009	Persistence and detection of norovirus, Salmonella, and pathogenic	\$125,000	Laboratory Simulation	Unspecified	Leafy Greens	E. coli; Salmonella; Viruses	Produce	Characterization	Food Science

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
	Escherichia coli on basil and leafy greens.								
2009	Using Leafy Green Marketing Agreement audit data to determine non-compliance areas and preparation of training and recommendations for improvements in future growing seasons.	\$133,540	Environmental Observation	California	Leafy Greens	Unspecified	People	Evaluation	Business Management
2009	Assessing postharvest risks for Salmonella in pistachios.	\$244,805	Laboratory Analysis	Unspecified	Nuts	Salmonella	Produce	Characterization	Food Science
2009	Differential susceptibility of spinach grown under slow- and fast-growth conditions to enteric bacterial contamination.	\$84,063	Laboratory Simulation; Field Trial	Unspecified	Leafy Greens	E. coli	Produce	Characterization	Plant Science
2009	Epidemiologic analysis and risk management practices for reducing E. coli in irrigation source water supplies and	\$300,000	Environmental Observation	California; Arizona	Leafy Greens	E. coli	Agricultural Water	Characterization	Animal Science

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
	distribution systems.								
2009	Establishment of critical operating standards for chlorine dioxide in disinfection of dump tank and flume water for fresh tomatoes.	\$48,747	Environmental Observation; Laboratory Simulation	California; Florida	Vegetables and Melons	Salmonella	Wash Water	Control	Microbiology
2009	Evaluation and optimization of postharvest intervention strategies for the reduction of bacterial contamination on tomatoes	\$293,240	Laboratory Simulation	Florida	Vegetables and Melons	Unspecified	Wash Water	Control	Food Science
2009	Impact of almond moisture, almond cultivar and Salmonella Serovar on the desiccation, persistence and heat resistance of Salmonella in almonds.	\$82,401	Laboratory Simulation	Unspecified	Nuts	Salmonella	Produce	Characterization	Food Science
2009	Improving produce safety by stabilizing chlorine in washing solutions with high organic loads.	\$243,909	Laboratory Simulation	Unspecified	Vegetables and Melons	E. coli; Listeria; Salmonella	Wash Water	Control	Food Science

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
2009	Mitigation of irrigation water using zero-valent iron treatment.	\$236,790	Laboratory Simulation	Unspecified	Unspecified	E. coli; Salmonella	Agricultural Water	Control	Microbiology
2009	Reducing tomato contamination with Salmonella through cultivar selection and maturity at harvest.	\$60,771	Environmental Observation	Virginia	Vegetables and Melons	Salmonella	Produce	Characterization	Microbiology
2009	Survival of E. coli on soil amendments and irrigation water in leafy green field environments.	\$112,100	Field Trial	California	Leafy Greens	E. coli	Soil Amendment; Agricultural Water	Characterization	Plant Science
2009	Wildlife survey for E. coli O157:H7 in the central coastal counties of California	\$300,000	Environmental Observation	California	Leafy Greens	E. coli	Wildlife	Characterization	Animal Science
2009	A high-throughput, culture-independent approach to identify index and indicator species for E. coli O157:H7 contamination.	\$182,205	Laboratory Analysis	California; Arizona	Leafy Greens	E. coli	Produce	Detection	Plant Science
2009	Comparison of surrogate E. coli survival and epidemiology in the phyllosphere of diverse leafy green crops.	\$125,000	Field Trial	Unspecified	Leafy Greens	E. coli	Produce	Characterization	Microbiology

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/ Source	Goal	Discipline
2009	Contribution of phyllosphere microbiota to the persistence of Escherichia coli O157:H7 ATCC 700728 on field-grown lettuce.	\$50,800	Laboratory Simulation	Unspecified	Leafy Greens	E. coli	Produce	Characterization	Food Science
2009	Fly reservoirs of E. Coli O157:H7 and their role in contamination of leafy greens.	\$50,800	Environmental Observation	California; Oklahoma	Leafy Greens	E. coli	Wildlife	Characterization	Plant Science
2009	Food safety risks associated with sheep grazing in vegetable stubble fields.	\$83,000	Environmental Observation	California	Leafy Greens	E. coli; Salmonella	Livestock	Characterization	Animal Science
2009	Minimizing pathogen transference during lettuce harvesting by optimizing the design of the harvesting device and operation practices.	\$103,125	Laboratory Simulation	California	Leafy Greens	E. coli	Facilities and Equipment	Control	Food Science

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
2009	Survival of attenuated Escherichia coli O157:H7 ATCC 700728 in field inoculated lettuce.	\$49,151	Field Trial	California	Leafy Greens	E. coli	Produce	Characterization	Food Science
2008	A sensitive and specific molecular testing method for live Salmonella in produce.	\$46,500	Laboratory Analysis	Unspecified	Unspecified	Salmonella	Produce	Detection	Food Science
2008	Enhancing the effectiveness of human pathogen testing systems for the advancement of practical produce safety research and commercial management.	\$148,023	Laboratory Analysis	Unspecified	Unspecified	E. coli; Salmonella	Produce	Detection	Food Science
2008	Environmental effects on the growth or survival of stress-adapted Escherichia coli O157:H7 and Salmonella spp. in compost.	\$222,098	Laboratory Simulation	Unspecified	Unspecified	Unspecified	Soil Amendment	Detection	Microbiology
2008	Examination of the survival and internalization of E.coli on spinach under field	\$142,790	Field Trial	California	Leafy Greens	E. coli	Produce	Characterization	Plant Science

RFP Year	Title	Grant Amount	Research Type	Location	Crop	Pathogen	Target/Source	Goal	Discipline
	production environments.								

Appendix B

Industry News Articles Discussing Co-Management, with Selected Comments

Article Title	Date	Selected Comments on Co-Management
<i>The Packer</i>		
Wegmans: small growers can implement food safety standards	May 17, 2011	“Wegmans recommends that while co-management of food safety and sustainability may be considered, ultimately food safety has to be the top priority. In other words, sustainability is nice, food safety is a necessity.”
United Fresh to FDA: Few, if any, metrics are applicable to all commodities	May 17, 2011	“Food safety must always be FDA’s priority, as it is the industry’s, and any regulation should not become overly distracted with co-management objectives. However, with proper planning, food safety performance standards need not be in conflict with successful and safe agricultural and environmental practices.”
PMA to FDA: Define content of food safety standard	May 17, 2011	“At the end of the day, food safety has to be the dominant priority, but it does not have to be mutually exclusive of environmental sustainability... The subject of food safety and sustainability co-management may be an area where specific rules may be premature... At this juncture, it is PMA’s position that we do not have enough science for FDA to create specific rules or quantifiable metrics around the interface of food safety and environmental sustainability.” “Additional research is needed. Absent scientifically valid data, the issue becomes a political and emotional issue with both producers and consumers trapped in the middle of confusing dialogue... Today we see a shift in momentum in research funding toward produce food safety... regarding pathogen survival in the production environment, vectors for pathogen transfer and methods to kill pathogens. PMA would suggest that research also needs to be directed to the co-management of food safety and environmental sustainability.”
UPDATED: Cleared buffer zones not helpful for food safety, study says	August 11, 2015	““The LGMA encourages growers to engage in co-management practices, and this study adds important new information for consideration,” Horsfall [CEO of CA LGMA] said.”
Food safety, environmental stewardship can co-exist	May 23, 2016	“[T]o frame a discussion on the challenges of co-managing food safety and environmental measures at a conference in 2009... [Tim York, CEO of the Markon Cooperative in Salinas, told a group of stakeholders], ‘For food safety to win, the environment doesn’t have to lose.’”
<i>The Produce News</i>		
Center for Produce Safety awards \$3 million to 16 projects	October 08, 2013	“The research awards are directed at answering critical questions in specific areas of food-safety practices for fruit, vegetable and tree nut production; pre-harvest, harvest and post-harvest handling; and co-management of food safety and the environment.”
CPS awards \$2.8 million to 14 projects	October 8, 2014	<i>Same text as 2013 announcement</i>
<i>Food Safety News</i>		

FDA, USDA, Cornell in Alliance for Produce Safety	November 5, 2010	“According to the FDA’s announcement Thursday, the [Produce Safety Alliance’s] key efforts will include... Creating an information bank of up-to-date scientific and technical information related to on-farm and packinghouse produce safety, environmental co-management, and eventually the FDA’s proposed produce safety rule.”
Can Marketing Orders Improve Leafy Greens Safety?	April 27, 2011	“[USDA] has proposed a program to establish a voluntary, national marketing agreement to set safety standards and regulate the handling of leafy green vegetables... As for those worried about the environment, [a USDA official] said, ‘There were a lot of concerns over co-management with food safety practices and conservation practices, so the proposal includes the NRCS having a seat on the Technical Review Committee.’”
Feral in the Fields: Food Safety Risks from Wildlife	September 19, 2011	<p>“This summer, the [LGMA] announced approval of the addition of co-management to their accepted food safety practices. Co-management is defined by the LGMA as ‘an approach to conserving soil, water, air, wildlife and other natural resources while simultaneously minimizing microbiological hazards associated with food production.’</p> <p>While protecting the public health must always remain the first priority in fresh produce production, the co-management approach represents a proactive and positive step forward in managing food safety risks from wildlife.”</p>
Produce Farming on the Brink	March 5, 2012	<p>“Our process of framing and regulating produce food safety is upside down and backwards. Human pathogens constantly flow from urban environments and animal production into farm environments, contaminating water and soil, and finding a home in wildlife. Then we ask farmers to deliver pathogen-free fruits and vegetables...”</p> <p>One can imagine a consensus on a set of national priorities focused on fixing the worst hazards first, an FDA that puts more emphasis on causal analysis of outbreaks..., and co-management of food safety and the preservation of habitats and the farm environment... Overall food safety would be greatly improved. That is not where we are, right now.”</p>
IAFP 2015: Debating Three Food Safety Perspectives	July 27, 2015	<p>“The second debate question, ‘Is sustainability trading on food safety?’, featured Kathy Gombas of FDA’s CFSAN addressing the ‘yes’ side. She told the audience that she had referred the question to industry, academic, and other sources in preparing her argument and found that ‘there is no consensus on sustainability.’</p> <p>More information is needed about what sustainability is and how it can be managed in industry, Gombas said, because efforts to reduce waste and compost, for example, can end up inadvertently creating food safety problems. However, she noted, potential co-management opportunities exist throughout the supply chain which could combine food safety and sustainability programs.</p> <p>Taking the ‘no’ side of the argument, Brent Kobielush, manager of toxicology for General Mills, said the issue wasn’t just about food safety and that ‘we cannot silo off sustainability’ from the discussion. ‘If how you produce food isn’t safe, you will not have sustainability,’ he said.”</p>
Small plus local doesn’t equal a free pass on food safety	April 15, 2016	“[Food safety trainer Atina] Diffley said food safety requirements and conservation practices are not mutually exclusive. She pointed out that the Produce Rule does not require farms to exclude wildlife from outdoor growing areas, to destroy wildlife habitat, or to clear borders around growing or drainage areas.

		Even so, because wild life could create food safety risks, measures should be taken to minimize wildlife incursions into growing fields. However, removing conservation habitat can be not only environmentally damaging, it can increase food safety risks. ‘There can be many food safety benefits to co-management,’ she said.”
Tech+intellect = 100% consumers at CPS Research Symposium	July 6, 2016	“Lightning rounds and poster briefs [at the 2016 Center for Produce Safety annual symposium] ranged from an evaluation of using falcons as an economically viable co-management strategy to deter nuisance birds in leafy green fields to methods of detecting diverse parasites on packaged salads.”