Cultivating Science, Harvesting Power

Science and Industrial Agriculture in California

Christopher R. Henke

The MIT Press
Cambridge, Massachusetts
London, England

For information about special quantity discounts, please email special_sales@mitpress.mit.edu

This book was set in Stone Serif and Stone Sans by SNP Best-set Typesetter Ltd., Hong Kong. Printed and bound in the United States of America.

Library of Congress Cataloging-in-Publication Data

Henke, Christopher R., 1969–
Cultivating science, harvesting power : science and industrial agriculture in California / by Christopher R. Henke.
p.cm.—(Inside technology)
Includes bibliographical references and index.
ISBN 978-0-262-08373-7 (hardcover : alk. paper)
1. Agriculture—Research—California—Salinas River Valley 2. Agricultural productivity—California—Salinas River Valley. I. Title.
S541.5.C2H46 2008
630.72′0794—dc22

2008008743

10 9 8 7 6 5 4 3 2 1

1 Introduction: Repairing Industrial Agriculture

A Built (Agricultural) Environment

Driving south of San Francisco on California Highway 101, a driver passes through miles and miles of industrial and suburban sprawl, the result of Silicon Valley's explosive development. The scenery remains the same through Palo Alto and San Jose, until the strip malls and housing developments suddenly fall away and are replaced with soft caramel hills, lonely stands of trees, and the occasional cow. Once this transformation takes place, it is not long before the highway bends west toward the Pacific, and roadside signs begin to promote a series of agricultural "capitals of the world," including Gilroy, the garlic capital; Castroville, the artichoke capital; Watsonville, known for strawberries; and Greenfield, the broccoli capital. At the heart of this region is Salinas and the Salinas Valley—the lettuce capital of the world (fig. 1.1).

For the urban traveler racing south toward a vacation in Big Sur or a meeting in Los Angeles, these signs may look like a self-aggrandizing attempt to make something out of nothing. But field after field of crops do, in fact, add up to a massive center of farm production that supplies most of the United States with fresh vegetables. While the Midwest has been called the United States' breadbasket, these California towns and the coastal valleys surrounding them are collectively named the nation's salad bowl. In 2002, California dominated U.S. vegetable production, producing 99 percent of all the nation's artichokes, 58 percent of asparagus, 92 percent of broccoli, 67 percent of carrots, 83 percent of cauliflower, 94 percent of celery, 86 percent of garlic, 76 percent of head lettuce, and 94 percent of processing tomatoes. Despite its image as the home of Hollywood and Disneyland, surfing and sun bathing, California leads the United States in

Figure 1.1
California's Salinas Valley. Illustration by Lara Scott.

the overall value of its farm production. At a value of $31.7 billion in 2005, California nearly doubled the cash receipts from farm products in Texas ($16.4 billion), the number two state (CDFA 2006, 20, 25).

How did one small valley become the center of vegetable production for the United States? There are some clues, visible even from the road. The valley's Mediterranean climate allows for the production of many kinds of crops that are not viable on the same scale in other areas of the nation. Large crews of field-workers weed lettuce, pick berries, or cut celery; miles of irrigation pipes and furrows deliver water to thirsty plants; and an endless number of refrigerated semitrucks rumble along, carrying produce destined for salad bowls throughout the United States.[1] Beginning in the summer of 1997, I, too, drove through the Salinas Valley, but I stopped and stayed, in order to satisfy my own curiosity with this question. I spent the next several years exploring an institution that is essential for understanding the history and contemporary context of this industry: agricultural science. During my time studying the vegetable industry, I found that farming in the valley was built on land, water, money, and labor, but the work of scientists has shaped, mediated, and stabilized the relationships between these elements. Agricultural science and farm technologies grew up alongside the farm industry, coproducing each other in very literal ways. Science, therefore, is a relatively hidden but essential element for understanding how the vegetable industry—and California's farm industry more broadly—was created and is maintained on such a broad scale. In short, although the view changes on the drive from San Francisco to the Salinas Valley, the landscapes of urban sprawl and pastoral farmland have more similarities than differences: this valley of vegetables was built, and scientists did an important part of the building.[2]

This book is about the work of agricultural scientists employed by the University of California (UC), and I use the case of UC Cooperative Extension farm advisors in the Salinas Valley to illustrate how scientists and growers[3] have cooperated—and struggled—over how to solve problems associated with building the state's farm industry. These farm advisors are employees of the university but do not work on campus; instead, they are stationed in counties throughout California, charged with providing advice and expertise to their local farming communities. When faced with "crises" as diverse as labor shortages, plagues of insects, and environmental regulations, experts from the UC have stepped forward to help California's growers. Through these interventions, agricultural science has served as a mechanism of repair, a means for maintaining the diverse social and material elements required to grow crops on an industrial scale. Behind the production of a head of lettuce are many seemingly mundane technical decisions like how crops are fertilized or how bugs are controlled, but these same details form the basis for an industry: they make a structure that grows crops but also produces power. Thus, I use the story of how the Salinas Valley became the vegetable capital to understand a more fundamental set of questions about practice and power, and the power relationships among science, industry, and the state.

Industrial Agriculture as an Ecology of Power

Americans have a long tradition of romanticizing agriculture. When we envision a farm or the act of farming, we imagine Farmer Brown on a green tractor, a red barn in the background, among rolling fields of crops and livestock. These images make the terms *farm industry* or *industrial agriculture* seem jarring or even derogatory, but I use them in an analytic sense, to convey both the scale of contemporary agriculture in a place like the Salinas Valley and the social structures that support food production.

The origins of industrial agriculture in California date to the late nineteenth century. With profits from the mining industry waning, California investors looked to farming as a way to make money. These early "growers" farmed massive wheat and barley fields, many of which were more appropriately measured in square miles than in acres (Daniel 1982). However, as competition in grain markets, especially wheat, increased through the late nineteenth century, growers shifted production from field crops to fruit and nut crops. From about 1890 until the onset of World War I, growers experimented with a wide variety of these crops, and the largest producers developed complex production, distribution, and marketing systems for orchard crops like peaches, grapes, raisins, almonds, and oranges.[4]

In turn, these systems served as models for the growth of other farming regions in the state, forming niche market industries, commodity markets that, although relatively small compared to the so-called major crops such as corn or wheat, are still large enough to constitute a significant market for large-scale production.[5] Niche industries are formed around intensive crops such as fruit, nut, and vegetable crops that may rely heavily on hand labor for planting and harvesting, require more intensive use of water and other farming inputs, and are often much more expensive to produce than extensive field crops such as corn, wheat, or cotton. The requirements for intensive crops are offset by the potential for much greater profit. For example, in 2003 an average acre of corn in the United States was worth $334, whereas an acre of head lettuce brought $6,370 (USDA 2004a; 2004b). At the same time, this acre of lettuce cost thousands of dollars to produce, creating a situation where the potential risk and profit for the grower are both relatively high. For this reason, farming in California has often been likened to the fortune-seeking, risk-taking ways of the miners who flocked to the state during the Gold Rush. This characterization has often been used in a pejorative sense, as when Carey McWilliams, in his sweeping work of social criticism, *California: The Great Exception* (1949), wrote, "The soil [in California] is really mined, not farmed" (101). But the capital-intensive character of California's niche market industries does encourage a kind of speculator's logic. This logic was emphasized to me in an interview with the owner of a large fertilizer company in the Salinas Valley, who described the attitude growers in niche markets often take toward growing conditions:

> You don't make money in the produce business when everything is right. If the weather is beautiful and you get a good crop, the odds are you're gonna sell it for [little profit]. It's just when something happens—weather events or something like that—that causes a decrease in production and the market goes up.

The ideal for the niche market grower, in this view, is for a catastrophic event to destroy everyone else's crop while leaving the grower's own crop healthy and ready for a seller's market. This "moral economy" of niche market growers places a special emphasis on California growers' interest in controlling their farming environments and helps to explain their attitudes toward and investments in agricultural science.[6] Although agriculture and science may seem like disparate activities, they have some common features and goals. Perhaps the most fundamental of these similarities stems from the unpredictability of farming. Industrial agriculture is a complex built environment, but changes in the weather, shifting pest pressures, and fickle markets all make agriculture an uncertain venture. Farming is organized on a seasonal cycle with the optimistic assumption that conditions will be more or less the same from year to year, but things are almost never the same. For this reason, agriculture has been called "the first empirical science" because it is essentially a seasonal experiment (Busch, Lacy, and Burkhardt 1991). Growers have always experimented with new techniques and technologies to improve yield and quality while at the same time seeking to understand the complex interaction of soil, water, climate, and life to improve conditions of predictability and control.

In this sense, 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. In neither case is this mastery a matter of purely academic concern; instead, the ability to effectively control people and things is a critical source of power.[7] Mundane technical practices like how crops are fertilized or how bugs are controlled may not seem closely related to lofty matters like power, but there is an essential link between them. The fertilizer dealer quoted previously emphasized the local conditions for farming, the influence of commodity markets, and how these factors interact and shape each other. To understand the relationships between growers and agricultural scientists, it makes sense to study the multiple levels of material and social stuff that are the subject of their work. The difficulty with this approach lies in theorizing the connections between these diverse factors; scholarly research on science and agriculture tends to focus more strongly on one or another level of analysis. For example, work in science and technology studies (STS) concentrates most often on the local culture and practice of scientific communities, whereas research in the sociology of agriculture emphasizes the political economy of agricultural markets, industry organization, and state institutions.[8] My goal here is to develop analytic tools that bridge these levels of analysis, to understand the ways that local interactions are connected with institutional structures. I use two interrelated concepts to understand these relationships.

First, I conceptualize the diverse social and material elements behind industrial agriculture as an *ecology of power*, a broad system of social and material production that forms the larger playing field where growers and agricultural scientists work to turn products created from local contexts—food, commodities, data, knowledge—into capital that is transferable to other institutions. These forms of economic and social capital are made valuable through this process of exchange and, in turn, can provide actors with control and influence over the very places and practices that serve as the basis for this capital. Despite actors' best attempts to control the production of capital from this ecology, however, there are numerous sources of disruption that challenge their mastery of the structure; anything from a dry year or a failed experiment to a budget crisis or a war can affect these exchanges. These disruptions create the need to *repair* these flows of production—the second conceptual tool that I use to understand the power relations between science and industrial agriculture. Repair work takes diverse practical forms, shaped by the interests of actors in how an ecology produces capital and power. I argue that agricultural science has often served as a mechanism of this kind of repair for the farm industry, working on nearly every aspect of the ecology in order to maintain the productivity and power of the industry.

Figure 1.2 presents the key elements that compose the ecology of power for science and industrial agriculture. My use of the term *ecology* is borrowed from biology, of course, but also from the field of science and technology studies, where the concept of institutional ecology is used to analyze complex social and material networks of activity.[9] The metaphor is useful because an ecology is a field where elements interact in a hierarchical, interdependent, dynamic system. Figure 1.2 schematically represents the interactions of land, plants, scientists, growers, farmworkers, farming techniques, and social institutions that produce not only food but also wealth, knowledge, and, ultimately, power. Changes to one element in this system affect the others; the management and control of each element provides control over the larger system of production and power. In this sense, power is the ultimate product of this system, but power itself is not a tangible quality or "good" apart from the social and material interactions of this ecology. Power is an effect that is produced through this interactive process, and control of the process is the key to power.

There are three levels of analysis in this model (see fig. 1.2, bottom to top). Although the distinctions between these three levels of analysis are artificial, they help to clarify the interactions and influences between different parts of the ecology, especially those elements that are less visible yet essential parts of this system of production. The first level, the local context, forms the base of the model and represents the local *place* where both agriculture and applied agricultural science happen. The unique interactions of soil, water, climate, and other place-specific factors compel both growers and scientists to account for the local characteristics of a given

Figure 1.2
An ecology of power. Illustration by Lara Scott.

place, adapting their work to local conditions.[10] This engagement with the material world also provides actors with skills that can be formally or informally codified in the form of *practice*, the second level of analysis. Some farming practices are quite old: the use of furrows for irrigated agriculture began thousands of years ago and is still used to this day. Whether new or old, however, these ways of interacting with the contingencies of place represent a kind of investment, and changes to even seemingly simple practices can lead to large-scale disruption of the overall production system. In the same way, scientists themselves have considerable interests in practice, which define their research careers and serve as a kind of structure for their work (Pickering 1980; 1984). One of the most common ways for agricultural scientists to convince growers of the value of a new way of farming is through the use of field trials, experiments that use a plot of land to test and visually demonstrate the efficacy of a new practice or technology (see chapter 5).

These local combinations of land and practice are used to create portable capital that is valuable and transferable to the third level: *institutions outside of a given place* (Bourdieu 1990; 2004). Growers produce crops; those crops are sold on commodity markets and transformed into wealth. Similarly, applied agricultural science combines place and practice when testing new farming techniques to assess their efficacy. These experiments create new knowledge that may be translated to other contexts or used to reshape the very relations of practice and place that produced the knowledge. In each case, farm commodities and knowledge are relatively stable products that may be used as capital and exchanged for other forms of capital as well as to control and reshape the overall ecology itself (Latour 1988; 1990; 1993). This control is the basis of power, but it is a "fragile power," and seeing how capital is produced from the most basic interactions of practice and place makes it easier to understand why actors may be intensely interested in the impact of some form of disruption to production.[11] Saying that "knowledge is power" or "wealth is power" is, in this view, inaccurate; knowledge and wealth are only as powerful as the places and practices on which they are based.

The value of an ecological approach to the analysis of industrial agriculture is that it does not emphasize place, practice, technology, markets, politics, or culture over any of the others but instead seeks to understand the interactive effects of these elements—"ecological determinism" is a contradiction in terms. This approach is in contrast to a long history of social science methods that have emphasized (and even naturalized) the effects of economic and technological change in agriculture, placing normative labels on growers and their adoption rates, or conceiving of change as driven by irresistible treadmills (Rogers 1958; 1983; Cochrane 1993). While profit motives and new innovations certainly have powerful effects on the decisions and interests of both growers and scientists, an ecological view of production highlights actors' attempts to control the very factors that create these results. Capital is not self-generating, and in this way, a control motive is essential for understanding a complex system of production like industrial agriculture (Noble 1977; 1984). When the production of something as simple as a head of lettuce or a stalk of celery can lead to power, control of even small details of production is a key interest for the players in this ecology.

Controlling Agricultural Ecologies: A Theory of Repair

If an ecology of power represents the material, practical, and institutional structure of the relationship between science and industrial agriculture, then repair is the work of maintaining this system in the face of constant change. In everyday usage, "repair" describes a process of fixing things. Sociologists working in the fields of ethnomethodology and symbolic interaction often use the term in a slightly different sense: a process of maintaining social order. In this view, social order is a practical, everyday accomplishment, negotiated over and over again.[12] The canonical example of this negotiated order comes from studies of everyday conversations, where social interaction is like a juggling routine between two actors. In the course of a conversation, actors skillfully toss all kinds of "objects" to each other; in this case, the objects are symbols, meant to be understood and returned. In this metaphor, meaning and understanding are contingent upon the continual exchange of symbols and their proper recognition as such. Just as in a juggling routine, a misthrown symbol requires an adjustment to continue the interaction. We continually adjust to slight variations in the flow of symbols as we communicate with each other. Actors in social interaction work within a basic structure of meaning, but the actual accomplishment of this interaction is highly improvisational. In this way, the ethnomethodological sense of repair provides a rich view of social life, where order, adaptation, and change are structured yet fluid, omnipresent yet delicate.[13]

This way of thinking about social order works well for understanding some aspects of the ecology of power that I have described. We can envision agriculture as a kind of structure that is dynamic and constantly shifting. Changes in the context of farming, whether from new pest pressures, volatile markets, or shifting government policies, can threaten the production of the various forms of capital depicted in figure 1.2, requiring growers and scientists to renegotiate and repair their practices to account for these changes. The analogy of everyday conversation as social order, however, only goes so far in explaining the case I am considering here. Prior work has given little attention to either the material context of social interaction or the power dynamics of structures beyond the level of interpersonal interaction.[14] Built environments like industrial agriculture point to the need for a theory of how the social and the material are brought together in systems of production, and how these systems are maintained through the efforts of interested actors. In addition, a broader theory of repair needs to account for disagreements about repair, particularly over how repair should take place or whether something needs to be repaired at all. In disputes over repair, order may likely be the result not of mutual understanding but rather of power relations.

Figure 1.3 presents my framework for a broader theory of repair, including two types of repair strategies and the repair practices used to work toward these strategies. The first distinction, between the repair strategies of maintenance or transformation, points to the different goals and investments that actors may have in the particular structure of their social and material ecology. Does this structure create capital for an actor? Does the structure limit or create barriers for another actor and his or her interests? These factors help explain why a maintenance or transformation strategy of repair would be preferable to a given actor or group. Repair as maintenance is an attempt to solve problems by making modest adjustments to the elements within an established structure, keeping intact as much of the system as possible while remedying the trouble. Repair as transformation is a more radical set of changes to the actual ecology, in which the relationships between culture, practice, and environment are substantially reordered. In most cases, repair as maintenance is the default strategy, especially for those actors with significant investments in the existing

	Repair Strategies	
Repair Practices	*Maintenance*	*Transformation*
Discursive	—reinforcing and protecting established meanings and boundaries —framing "problems" as threats to established structures of power —downplaying critiques of established structures	—challenging and calling for change to established meanings and boundaries —framing "problems" as endemic to established structures of power —critiquing and proposing substantial change to established structures
Ecological	—responding to problems through established structures —modest change of established structures in order to preserve overall control over production —creation of new structures that ultimately preserve established systems of production and reproduce power	—responding to problems through structural change —large-scale structural change to established systems of production —creation of new structures that disrupt established systems of production and power

Figure 1.3
Repair strategies and practices.

structure of an ecology. At first, this may seem obvious: it will always be more convenient for actors to maintain a system rather than create a new one. But we only really understand why it seems convenient to maintain a system when we uncover its structure and explore the interests at stake in the balance between order and change. In many cases, maintaining the structure of an ecology may take just as much effort or as many resources as transforming it, but maintenance of the status quo is beneficial for a select group. Therefore, transformative repair is much more likely to be proposed and supported by those who are critical of, disenfranchised from, or subject to an established ecology of power. Those who benefit from the ecology are only likely to turn to transformative repair when the structure no longer works in the same way for them or as a last resort.

A second distinction in figure 1.3 emphasizes the sociomaterial approach I am taking here. The two repair practices—discursive and ecological—describe the practical methods that actors may use to repair an ecology as well as the diverse forms that this improvisational work may take. Discursive repair is the form that has been studied most extensively through ethnomethodological conversation analysis, but the focus I take here is on a broader view of discourse, where repair is aimed at the cultural and symbolic frames that shape and legitimate structures.[15] This repair practice is a kind of "boundary work" (Gieryn 1983; 1995; 1999), a way to discursively maintain or transform the frames around an ecology, but it can also cast repair itself as the subject of debate and negotiation. Does a problem exist? What exactly is the nature of that problem? And what is the best way of solving it? The answers to these questions represent practical attempts to shape the discursive frame for meaning and action, which, in turn, lead to ideas about what form a structure can or should take. In contrast, ecological repair is aimed at the institutionalized practices and material structures that shape the production of capital within an ecology. Clearly, these two sets of practices overlap, and, in fact, the case studies that I present in subsequent chapters show that most repair draws on both. The work of rhetorically defining a problem for repair goes hand in hand with institutional forms of repair, providing a continuum from methods of insect control to large-scale legitimation crises of the entire ecology of power.[16] The following section describes how growers and scientists have historically navigated this ecology of power and negotiated its shape through repair.

Science, Industry, and the State: A Brief History of Repair in Agriculture

The ties among agriculture, knowledge, and power have long been understood by the state; without an adequate and affordable supply of food, it is difficult to maintain rule for very long. Archeological evidence suggests a relatively direct link between the stability of food production and the viability of a political elite (Diamond 2005). This relationship is also expressed in the stories we tell about food production and politics. For example, in the Bible's Genesis story, Joseph, sold into slavery in Egypt by his jealous brothers, found favor with Pharaoh by interpreting a set of strange dreams as a prophecy about seven years of bountiful harvests followed by seven years of famine. Pharaoh was so impressed by this advance warning that he put Joseph in charge of a project to hold back grain during the plentiful years, in preparation for the lean ones. Early in U.S. history, Thomas Jefferson believed that the nation's democracy was directly dependent on the strength of its farming and saw the independent family farm as a stabilizing force against class conflict and economic change.[17] Even now, when less than 2 percent of the U.S. workforce is in farming, compared with nearly 50 percent at the beginning of the twentieth century, many lament the demise of the small family farm and the public good it is presumed to provide.

Beginning in the latter half of the nineteenth century and continuing through today, the state and other farming interests have sought to control and protect U.S. agriculture through the use of science. Long before the work of physicists and engineers was seen as essential to national security, agricultural science was proposed and accepted as a state project, intended as an antidote to foreign competition, increasing cost-of-living expenses, and a perceived decline in the quality of American rural life (Rosenberg 1976; 1977; Marcus 1985). The first major step toward a formal system of state-sponsored agricultural science began with the foundation of the land-grant university system following the Morrill Land-Grant College Act of 1862. This federal legislation provided grants of land to states on the condition that they would be sold and the profits used to found a college for training rural citizens in agriculture and other practical crafts, a mandate that came to be known as the land-grant mission. A system of agricultural experiment stations, based on the land-grant university campuses, was also begun in order to provide research on problems important to farming.

Through the first several decades of the land-grant system, however, scientists and farm communities remained relatively isolated: agricultural researchers did not necessarily want to work on problems of immediate practical interest to growers, and growers were often impatient with the promises of long-term basic research (Marcus 1985). Therefore, around the beginning of the twentieth century, a movement formed that called for a system of extension work to be put in place, to bring research from the land-grant schools to local farm communities. Members of the extension movement argued that a system of extension advisors stationed in local farming communities could bring improved methods of agriculture to rural populations, thereby fulfilling the land-grant mission. In 1914 the federal Smith-Lever Act was passed, providing funds for each land-grant university to establish its own system of extension work. The program was named Cooperative Extension because funding for the advisors came from the federal, state, and county levels of government. After a rapid expansion of the program during World War I, most counties in the United States had a Cooperative Extension advisor, affiliated with each state's land-grant university and charged with promoting the latest methods and technologies for making local agriculture more productive. At that time, and likely still today, Cooperative Extension represented the most widespread and pervasive arm of state-based expertise in the United States.

Cooperative Extension work is an ideal case for studying the interface of social and material repair because advisors are supposed to intervene directly in the ecology of place, practice, and power found in their local communities. This aspect of Cooperative Extension work brings to mind Michel Foucault's extensive work on the ties between power, knowledge, and the modern state. In Foucault's conceptualization, the state maintains power and social order through modern institutions of expert knowledge and practice, such as medical clinics and prisons. In this respect, Foucault's view of modern statecraft is defined not so much by an ideology or a historical era but rather by institutionalized practices, a set of techniques that consolidate power.[18] Despite Foucault's emphasis on the power of these practices, however, their efficacy seems quite variable. The techniques of domination he describes in connection with the rise of penology have had a profound effect on the way modern societies treat lawbreakers, but new problems seem to inevitably arise from these systems of power-based order.

This dichotomy between state intentions and outcomes is the subject of James Scott's *Seeing Like a State* (1998), in which he describes several "high-modernist" attempts by the state to control and direct the lives of its populace, including urban planning, agrarian reform, and rural resettlement projects. In each of his examples, Scott writes, the state viewed this intervention in a very linear and simplistic way, assuming that abstract principles of design imposed from above could easily improve and replace the systems of practice already in place on the local level. In addition, state planners believed this reordering of local practices could increase the control and accountability that the state held over its people, "consolidating the power of central institutions and diminishing the autonomy of [subjects] and their communities vis-à-vis those institutions" (286). Scott describes how these grandiose projects turned out quite badly for the state and especially for its people, and he argues that high-modernist projects failed because they did not account for the importance of local knowledge. Overall, the cases presented by Scott argue against the totalizing power of the modern state and its ability, as emphasized in Foucault's work, to intervene in local communities of practice (1998, 101).

The case of Cooperative Extension lies somewhere between these two extremes, where expert-based power is portrayed as either totalizing or bumbling in its control of the local. Unlike the projects described by Scott, Cooperative Extension was intended to intervene on the local level by specifically accounting for the importance of place and practice. Although it has meant different things to different people, Cooperative Extension was designed as a way of influencing farm practices by putting a network of experts directly in contact with farm communities. Given this difference, farm advisors' work at first seems more in line with the kind of knowledge-based techniques of mastery that Foucault describes. But when the state does intervene in a decentralized way, the results are mixed, and do not always resemble the kind of totalizing power that Foucault attributes to the rise of expert systems of control (Mukerji 1997, 321). As a result, my analysis here is aimed in a slightly different direction, toward understanding how these experts themselves—farm advisors in this case—become entangled in existing and ongoing power struggles that tie local places and practices to the state and the wider farm industry.[19] As depicted in figure 1.2, the knowledge and expertise of advisors (and the university) has influence on other state actors and the farm industry, but these same groups also shape the work of advisors through their own sources of influence, including wealth and political regulation. In the face of constant change and crisis from many sources, Cooperative Extension has served to stabilize and reproduce the ecology of power in industrial agriculture, repairing elements on every level of this ecology. At the same time, the story of Cooperative Extension is just as much about how local actors resist and reshape state institutions. As one example, during a series of labor crises brought on by the onset of World War II, the farm industry demanded that Cooperative Extension advisors organize and ration the use of diverse sources of farm labor, essentially acting as a kind of labor contractor (see chapter 4). Farm advisors cross many boundaries in the course of their work, but the common thread among this work is repair; Cooperative Extension is an institution of repair. Its mandate to improve the productivity of agricultural communities has often served to preserve and maintain the power structure of the local social and material ecology.

The Structure of This Book

Science and industrial agriculture are engaged in a long process of historical and cultural coproduction. Because I want to understand and see this process at multiple levels of analysis, I used a combination of methods for this project, including participant-observation fieldwork, semistructured interviews, and analysis of historical documents. My choice of these methods for a study of repair was inspired by Jean Lave's call for a "more inclusive theory of social order" that sees "objects of analysis [as] points of cultural-historical conjuncture [that] should be analyzed in those terms" (1988, 171). Therefore, I see a multimethod approach as essential for a "thick" ethnographic analysis of the relationship between industrial farming and agricultural science (Geertz 1973). See the appendix for details on my data collection methods.

My analysis of Cooperative Extension as an institution of repair draws on both historical and contemporary examples, but the overall structure of the cases is largely chronological. Chapters 2 and 3 each cover the history of Cooperative Extension in the context of the United States, California, and the Salinas Valley. In chapter 2, I describe the history of the agrarian ideal in U.S. agriculture and especially how that ideal changed in the context of industrialization and social change during the nineteenth century. These shifts created a cultural context in which agriculture could be seen as a social problem and in need of repair, leading to the establishment of the land-grant university system. In particular, I trace the ideals and interests of Progressive Era politics, circa 1890–1920, and social movements that called for the use of expert knowledge to address the perceived deficiencies of U.S. farming and rural life. Though Cooperative Extension's mission of service to local farm communities derived from this ethos of expertise, the practical implementation of farm advising was subject to divergent interests and a great deal of uncertainty about the best direction for U.S. agriculture. Using archival materials and oral histories, I trace the formation of UC Cooperative Extension and describe the growing pains it faced when confronted with the rise of niche industry farming in California in the period between the world wars. Chapter 3 continues this story for the case of farm advising and the produce industry in the Salinas Valley. Cooperative Extension's "mission ambiguity" was at least partly resolved for the Salinas Valley farm advisors with the rise of the vegetable industry—an industry hungry for specific technical expertise and armed with the funds to support its production. At the same time, this specialization continued to raise questions about the appropriate relationship between advisors, industrial agriculture, and smaller growers.

Chapter 4 treats the issue of farm labor during World War II and details how growers and advisors tried to respond to a labor crisis during the war years. Although labor was an important problem for growers during this period, I show that the war years were actually part of a long series of labor "crises" in California's farm fields. Both within the farm industry and among experts and intellectuals, this recurring history of labor conflict represented an irrational problem that merited a rational solution, but the definitions of the problem and the proposed solutions were diverse. With these ongoing debates as a larger context, I use the case of the Spreckels Sugar Company to show how the farm industry and the UC worked to resolve the farm labor problem in the years before, during, and after World War II. The case makes a useful example of how labor, technologies, grower practices, experimental knowledge, and the production of commodities are enmeshed in a struggle to maintain control over the larger ecology of power in industrial agriculture.

In chapters 5 and 6, I focus on more contemporary instances of advisor-grower interaction. Chapter 5 describes how farm advisors use field trials to collect data on new farm practices and to convince growers that these new practices are worth adopting. These trials make a useful case for exploring the role of place in the negotiation over what set of practices makes up the best way to farm a given piece of land. Typically, growers are most likely to trust research results that are generated from a trustworthy place—often their own land—and so field trials conducted on a grower's own field can make a powerful demonstration. At the same time, the place-bound character of these trials raises many issues of control for the advisors and their experimental practices. Therefore, field trials are an excellent site for studying in detail how place and practice shape, and are shaped through, the use of experiment.

Chapter 6 also focuses on the balance that advisors strive to maintain between their ideals for new farming practices and the investments that growers may have in existing methods. In this case, the balance concerns environmental problems related to farming in the Salinas Valley. Today's farm advisors spend a significant amount of their time working on environmental issues, trying to minimize the environmental impacts of farming in the county. Growers also see these issues as problems, but not in the same way; they may be primarily interested in deflecting criticism of their industry and preventing further government regulation. These alternative definitions of the situation can lead to conflict, and I analyze advisors' work on environmental problems as a special case of boundary work, where advisors walk a fine line between an established order of practice and the possibility of social change (Gieryn 1983; 1995; 1999). Overall, chapters 5 and 6 provide a detailed look at how repair works at the local level and how this local work is integral to the maintenance of power.

Chapter 7 draws upon the preceding empirical chapters to further elaborate my theoretical interest in the relationship between different kinds of production, especially the interface of commodities, knowledge, and power. I argue that the study of repair is broadly applicable to a range of other cases, especially where the maintenance of power relations is a key concern for actors. In addition, I explore the policy implications of this work and end the chapter with a vision for how expertise could be deployed to encourage more extensive change. I argue that farm advisors have an advantageous position as locally based sources of expertise, but that they are also limited by this position. Advisors need additional support from the state or from other sources of leverage that can make their expertise more widely available and effective at promoting change. Though additional (direct) governmental regulation is one way to give advisors more power to influence change, I suggest that ethnographic accounts like mine also play an important structural role in the process of social change.