Science, Soil, and the State:

Eugene Hilgard and the Elusive Promise of the Land-Grant Complex

By

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Abstract

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The Jeffersonian vision underlying government support for American agriculture involved both scientifically-based productivity and an educated, democratic citizenry. The Morrill Acts of 1862 and 1890 supported the establishment of land-grant colleges in the United States, and the Hatch Act of 1887 provided federal subsidies for a nationwide system of agricultural experiment stations. The eminent soil scientist Eugene Hilgard (1833-1916) devoted his career to the project of agricultural education and research that the Morrill and Hatch Acts promoted. As professor of agriculture and director of the agricultural experiment station at the University of California, he engaged in critical investigations that supported the state's development. Hilgard had firm ideas about agricultural education and the role of agricultural science in relation to farmers and the government, ideas that he forcefully promoted. At the same time, he failed to engage issues of justice and equality critical to the nation that, arguably, were also part of the land grant vision. As an analysis of Hilgard's career indicates, the development of land-grant institutions has embodied tensions between economic production and social and economic equity. Despite the success of publicly funded science in boosting agricultural productivity, the benefits of government support of agriculture have been unequally distributed, often in favor of powerful private interests, and dissenting views about socially or environmentally optimal outcomes for rural communities and the nation have often been muted.

Contents

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Chapter 1
Introduction:
America's Land-Grant Institutions

> This bill proposes to establish at least one college in every State upon a secure and perpetual foundation, accessible to all, but especially to the sons of toil, where all the needful science for the practical avocations of life shall be taught . . . and where agriculture, the foundation of all present and future prosperity, may look for troops of earnest friends, studying its familiar and recondite economies, at last elevating it to that higher level where it may fearlessly invoke comparison with the most advanced standards of the world.
>
> -Justin Smith Morrill[1]

For a century and a half American land-grant institutions have provided education, research support, and outreach for farming and rural populations. Beginning in 1862 with the passage of the first Morrill Act, the land-grant system has come to include over time not only universities but agricultural experiment stations, supported by the Hatch Act of 1887, and extension services, subsidized by the Smith-Lever Act of 1914. Although these federal laws have had a significant impact, they also serve as signposts to what was already happening on the ground. Americans were debating agricultural improvement and education well before the passage of the Morrill Act, and scientists and farmers had been conducting agricultural research for many decades before the Hatch Act became law. Similarly, experts and educators had endeavored to reach out to change the practices of farmers and to build rural communities for years prior to the enactment of the Smith-Lever bill. Working in coordination with state and local efforts, these federal laws mobilized the resources of the national government to support agricultural education and research and 'improve' rural America.

The project of improvement was one that the protagonist of this thesis embraced. Internationally renowned as a soil scientist, Eugene Hilgard devoted his career to the work that the Morrill, Hatch, and Smith-Lever Acts endeavored to promote. Hilgard's first job in the 1850s was to map the natural resources of the state of Mississippi. After the Civil War, when his efforts failed to get an agricultural college off the ground at the University of Mississippi, he moved, first briefly to the University of Michigan, and finally, in 1875, to the new university in Berkeley. As Professor of Agriculture at the University of California for three decades, Hilgard laid a firm foundation for public agricultural education and research. As director of the experiment station, he consulted with farmers and engaged in critical investigations that supported the state's agricultural development. As will be shown in the chapters to follow, Hilgard had firm ideas about agricultural education and the role of agricultural science in relation to farmers, the state, and the nation, ideas that he forcefully promoted. At the same time, he failed to engage some issues critical to the nation, issues of justice and equality that, arguably, were also part of the land grant vision.

From its inception the land-grant system sought to realize a vision involving both

[1]As quoted in Edward D. Danforth, *Colleges for our Land and Time* (New York: Harper & Bros., 1956), 34.

scientifically-based agricultural productivity and an educated, democratic citizenry, a vision that honors the idea of a common good beyond individual self-interest. The land-grant system has broadened access to higher education for many, though not all. Through furthering agricultural science it has played a major role in increasing American agricultural production. It has also helped to reduce labor requirements in many farm sectors, freeing food producers to work elsewhere (if they can), and in that way it has contributed to the depopulation of the countryside. Despite or perhaps because of the tensions it embodies between economic production and social and economic equity, the land-grant vision persists in the national imagination, even as the underlying political economy has changed.

The Morrill Act, the Homestead Act, and the law establishing the U.S. Department of Agriculture all passed Congress within a few months in 1862, a feat made possible by the absence of the seceded Southern states. Southerners in Congress had previously blocked similar legislation, fearing the expansion of the federal government and the territorial extension of farming not dependent on enslaved labor. The Morrill Act granted federal lands as an endowment for states to establish public colleges to teach 'agriculture and the mechanical arts,'[2] while the Homestead Act provided allotments of 160 acres of federal land to settlers if they occupied and worked it. The Department of Agriculture was created to improve farming through research and to "procure, propagate, and distribute among the people new and valuable seeds and plants."[3] Together these laws were intended to put federal support behind building a more reliable and productive commercial agriculture in the nation, one that generated enough to supply growing cities without requiring the extensive and oppressive labor of the slave system. The combined effect, many hoped, would support an educated, dispersed rural population, owning and operating the means of production in a relatively egalitarian way, a system essentially extending the conditions of agriculture prevalent in the northeastern states and the old Northwest Territory. Taken together, the three 1862 laws reflected beliefs in the importance of family-scale farming, private property, scientific innovation, and the productive use of natural resources. (Another law passed in 1862, the Pacific Railroad Act, later bolstered by additional Congressional actions, provided loan guarantees and land grants to encourage private capital to build transcontinental railroads,[4] a critical if problematic element in the development of the West.) Of course, the Morrill Act embodied an additional political ideal: that publicly funded and useful higher education in 'agriculture and the mechanical arts' should be broadly available in every state.

A Jeffersonian Project

This project of government support for agricultural education carried forward the Jeffersonian idea that a virtuous citizenry consisting mainly of independent land-owning white farmers was the proper foundation for a republic, as well as the Jeffersonian vision of innovative,

[2]Although this thesis focuses on the agricultural component of land-grant institutions, the land-grant mission also includes the teaching of 'mechanical' science and engineering.

[3]Act of May 15, 1862, ch. 72, 12 Stat. 387, sec.520. See also Jack Ralph Kloppenburg, Jr., *First the Seed: The Political Economy of Plant Biotechnology*, 2nd ed. *(*Madison: University of Wisconsin Press, 2004), 59.

[4]See Richard White, *Railroaded: The Transcontinentals and the Making of Modern America* (New York: W.W. Norton, 2011), 17.

scientific farming. As historian Drew McCoy has shown, Jefferson did not favor a nation of subsistence or tenant farming; rather, he believed that a rural population involved in commercial agriculture, independent, landed, educated and internationally connected, would constitute the ideal, virtuous citizenry of the new nation. Fearing the political and social consequences of American progression through stages of societal development, assumed to be inevitable, from agriculture to manufacturing, with its attendant urban crowding, wage labor, dependency, and poverty, Jefferson hoped that the nation could forestall this progression by the ongoing westward expansion of agriculture and the marketing abroad of agricultural surpluses. He saw this "vision of expansion across space—the American continent—as a necessary alternative to the development through time that was generally thought to bring with it both political corruption and social decay"[5] that could undermine the republic. The Land Ordinance of 1785, co-authored by Jefferson, established a system for surveying the nation's western lands, a system intended to foster the methodical extension of white settlement that included provision of land for public schools. The education of the rural population was an essential part of Jefferson's vision to promote "progressive agricultural development"[6] and support republican government while encouraging individual liberty.

The Jeffersonian vision was supported by the particular material circumstances of the late eighteenth and early nineteenth centuries, especially the rising demand for a diversity of food imports in Europe and the West Indies due to population increases and a supply reduced by the French Revolution and Napoleonic wars, a demand that the relatively small-scale farmers of the mid-Atlantic states were well-situated to meet: As historian Joyce Appleby comments:

> By isolating in time and space the golden era of grain growing in the early national period, one can see more clearly the material base upon which Jefferson built his vision of America, a vision that was both democratic and capitalistic, agrarian and commercial. It is especially the commercial component of Jefferson's program that sinks periodically from scholarly view, a submersion that can be traced to the failure to connect Jefferson's interpretation of economic developments to his political goals. Agriculture did not figure in his plans as a venerable form of production giving shelter to a traditional way of life; rather, he was responsive to every possible change in cultivation, processing, and marketing that would enhance its profitability.[7]

At the same time, Jefferson also thought that commercial success would inculcate 'virtue,' as long as the ownership of land remained in the hands of many farmers. 'Virtue' referred to a material independency that would allow the educated land-holding class (which was the voting class) to see beyond their immediate material interest to promote the common good. The Jeffersonian complex of ideas about creating a democratic citizenry both through the nationwide provision of public education and through support of scientific agriculture to bolster commercial production found institutional expression in the 1862 statutes.

Much has been made of the Jeffersonian tradition of agrarian republicanism. But there is a grimmer side to agriculture, embodied in Jefferson's role as a slaveholding planter, that has

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[5]Drew McCoy, *The Elusive Republic* (Chapel Hill: University of North Carolina Press,1996), 9-10.
[6]Joyce Appleby, "Commercial Farming and the 'Agrarian Myth' in the Early Republic," *Journal of American History* 68, no.4 (1982): 844.
[7]Appleby, "Commercial Farming," 844.

shadowed American farming, labor, and land policies and practices. Agricultural fieldwork has had a long and harsh history in America, dating back to the colonial period and involving the exploitation of enslaved, noncitizen, and immigrant labor. White Southerners justified slavery, which was protected by the U.S. Constitution for nearly eight decades, as the means to expand liberty and equality for whites. Moreover, federal land policy has proved less than egalitarian. As historian Adam Rothman explains, whatever the intent of the Land Ordinance of 1785, the "Jeffersonian land system did not create a yeoman's paradise in the Deep South" in the early nineteenth century. Not only were Indian people dispossessed of their land but 'civilized' agriculture in the territory was enabled by enslaved labor. Because at that time Congress insisted on selling federal land to settlers, rather than granting the land as Jefferson had wished, rich planters were better able to acquire land. This advantage "facilitated the spread of the plantation system in the Deep South" and established the "cotton frontier" that Eugene Hilgard, as recounted in chapter 2, would encounter in the1850s.[8]

In the eighteenth and early nineteenth centuries, the improvement of land and agricultural innovation were preoccupations of ordinary farmers as well as those with privilege and wealth, such as Washington and Jefferson. In *Notes on the State of Virginia* (1787), Jefferson presented a detailed survey of his home state, identifying its natural resources and their potential use. (A critical component in the nation's expansion, such surveys would prove to be a focus for American scientists, including Hilgard, over the following century and more.) Farmers and planters also worked individually and collectively to improve long-settled lands on the Eastern seaboard that were showing signs of depleted fertility. In the 1840s, German chemist Justus von Liebig set forth the theory that soil fertility depended on maintaining the correct proportion of nitrogen, phosphorous, and potassium. Engaged, however, in adapting their own practices based on experience and belief in the moral value of agriculture, American farmers did not accept unquestioningly the work of Liebig and other 'men of science.'[9] In the South, slaveholders shared experimental findings among themselves, hoping to reform agricultural production in order to preserve the slave system.[10] Yet, despite resistance, scientific approaches to agricultural improvement came to dominate the discourse of agricultural improvement by the mid-nineteenth century.[11] Numerous local and state agricultural societies sought to educate farmers through agricultural fairs and exhibitions, and also pressed for other kinds of reform.

Land-Grant Colleges

The United States Agricultural Society, formed in 1851, exerted considerable influence on Congress, especially in the passage in 1862 of the first Morrill Act and the bill establishing the Department of Agriculture.[12] Sponsored by Vermont Congressman Justin Morrill, the

[8]Adam Rothman, *Slave Country: American Expansion and the Origins of the Deep South* (Cambridge: Harvard University Press, 2005), 45.
[9]See generally Benjamin Cohen, *Notes from the Ground: Science, Soil, and Society in the American Countryside* (New Haven: Yale University Press, 2009).
[10]Cohen, *Notes from the Ground,* 132.
[11]See Cohen, *Notes from the Ground,* 5-7.
[12]Roy V. Scott, *The Reluctant Farmer: The Rise of Agricultural Extension to 1914* (Urbana: University of Illinois Press, 1970), 14. An earlier bill proposed by Morrill had been passed by Congress but vetoed by

Morrill Act of 1862 authorized a grant from federal land (or equivalent land scrip) to each state (30,000 acres per member of Congress) on the condition that the state use the interest from the proceeds of the land for the "endowment, support, and maintenance of at least one college where the leading object shall be … to teach such branches of learning as are related to agriculture and the mechanic arts."[13] States in "rebellion or insurrection" were initially excluded, but following the Civil War the benefits of the Act were extended to the former Confederate states as well as to states admitted to the Union after 1862.

Both the 1862 Morrill Act, and the 1890 Morrill Act that followed, gave federal land grants to all states that accepted the conditions. For states that contained no federal land, scrip was granted for land from the newer states, including California, and territories, sweetening the deal for the Eastern and more established states, but perhaps unfairly burdening the western regions. In fact, the late-nineteenth century socialist reformer Henry George claimed that the Morrill Act "agricultural scrip" was one of the causes of the monopolization of land ownership in California.[14] However, the Morrill Act land grants should be seen in the context of other federal land grants, by which they pale in comparison. While 17 million acres were allocated for higher education under the 1862 Morrill Act, federal land grants to railroads totaled over 130 million acres, covering an area bigger than that of any state except Alaska or Texas.[15] Whether the government owned the land it granted was another question, but, as historian Richard White for one has pointed out, "Indian ownership had never proved much of an obstacle to congressional schemes."[16]

Some states had already established agricultural colleges which benefited from the land grant (the Michigan college had served as a model for the Morrill Act), but the provision of significant federal support led to the proliferation of land-grant colleges.[17] However, as will be discussed further in chapter 2, the form that agricultural education should take remained a matter of dispute. While many of the Act's supporters were concerned about improving the poor condition of American farming in the mid-nineteenth century, Morrill himself emphasized the Act's extension of educational opportunities, including in the classics, to working people and deplored the addition of 'agriculture' to the Act's formal title.[18] Regardless of the diverse reasons for its passage, the Act joined public higher education with scientifically-based agricultural improvement; together with independent land ownership, this would, in Jefferson's terms, create the virtuous citizenry working for the common good.

President Buchanan because of Southerners' 'states' rights' objections to federal aid. After the Southern states had seceded, the bill passed again and was signed into law by President Lincoln.

[13]First Morrill Act, Act of July 2, 1862, ch. 130, 12 Stat. 504 (1862).

[14]Henry George, *The Complete Works of Henry George: Our Land and Land Policy: Speeches, Lectures and Miscellaneous Writings*, 1904 ed. (New York: Doubleday Page, 1871), 17-18.

[15]See White, *Railroaded*, 24-25. For an additional point of comparison, 234 million acres were opened to settlers under the Homestead Act. David Madsen, "The Land-Grant University: Myth and Reality," in G. Lester Anderson, ed., *Land-Grant Universities and Their Continuing Challenge* (Lansing: Michigan State University Press,1976), 32.

[16]White, *Railroaded*, 25.

[17]In 1994, Congress included Native American colleges in the land-grant system.

[18]Earl F. Cheit, *The Useful Arts and the Liberal Tradition* (New York: McGraw Hill, 1975), 35-36.

The Morrill Act of 1890, or the second Morrill Act, provided additional funds for new agricultural colleges, which were given the same legal standing as 1862 land-grant institutions, and was aimed at former Confederate states. It required that race not be used as a criterion for admission to a land-grant college, or else that the state establish a separate land-grant college for African-American students, as long as the proceeds were shared "in a just and equitable division" between the white "college" and the "institution for colored students,"[19] a requirement that was generally not met. The so-called "1890 land-grant institutions" include many historically black colleges. Mississippi, as will be described in chapter 2, as well as sixteen other states established these "separate and unequal" colleges.

American laws and policies have greatly benefited agricultural interests, in part with the increased productivity to which land-grant institutions have contributed significantly. However, an often overlooked corollary is that these benefits have been unequally distributed: over time many people have been denied the full range of access to this largesse due to their race, ethnicity, immigrant status, or poverty. The underfunding of 1890 land-grant colleges is but one example of this inequity.

Despite the hopes of some of the supporters of the 1862 Morrill Act, initially the agricultural colleges either failed to teach "practical agriculture," or, to address this shortcoming, had students perform farm labor, which proved unpopular. Faculty with practical experience and academic training were in short supply, and student enrollments were low.[20] Related difficulties included "[t]he lack of a body of scientific information to teach and the need to solve problems faced by ordinary farmers."[21] To serve farmers' needs and develop a base of knowledge in scientific agriculture, some land grant colleges had set up experiment stations and model farms soon after establishment. As will be discussed in chapter 3, the well-respected soil scientist Eugene Hilgard, soon after his arrival in 1875 at the University of California as the (sole) Professor of Agriculture, began research and experimentation. Although the College of Agriculture lacked any students at the time,[22] Hilgard and his staff were soon barraged with questions from growers; this "pressure for diversified knowledge"[23] made it hard for Hilgard to develop a focused plan for research. Because financial support for agricultural research was insufficient and unreliable in California and other states, by the 1880s demand was growing for federal funding for stations for agricultural experimentation. Researchers "desperately wanted an institutional buffer between the university and the insistent demands of a farm clientele who expected them, in the words of one farmer, to 'bring science down out of the sky and hitch it to a plough.'"[24]

Agricultural Experiment Stations: The Hatch Act of 1887

The Hatch Act of 1887 established federal subsidies for agricultural research either at

[19]Act of August 30, 1890, ch. 841, sec. 1, 26 Stat. 417 (1890).
[20]See Scott, *Reluctant Farmer*, 30-32.
[21]Scott, *Reluctant Farmer*, 32.
[22]Ann Foley Scheuring, *Science and Service: A History of the Land-Grant University and Agriculture in California* (Oakland, CA: University of California ANR Publications, 1995), 29-30.
[23]Edward Wickson, as quoted in Scheuring, *Science and Service*, 36.
[24]Kloppenburg, *First the Seed*, 358, quoting Carstensen.

experiment stations affiliated with land-grant colleges or at an independent station established by a state. The purpose of the Act was to "aid in acquiring and diffusing … useful and practical information" on agricultural topics and to "promote scientific investigation and experiment respecting the principles and applications of agricultural science."[25] According to the Act, experiment stations should "conduct original researches or verify experiments" on a range of topics including the "physiology of plants and animals," "diseases" and "their remedies," "the comparative advantages of rotative cropping," and "the capacity of new plants and trees for acclimation." Additional topics included "the analysis of soils and water" and "the chemical composition of manures, natural or artificial."[26] As will be seen in chapter 3, many if not all of these topics had already been the focus of investigation by Hilgard at the California experiment station. The Act acknowledged "the varying conditions and needs" of different states and regions; the issue of regional differences was a matter of some significance to Hilgard, to be discussed in chapter 4.

Although farmers' problems and needs differed regionally and even locally, given the place-based nature of agriculture, the work of the decentralized experiment station network ultimately contributed to much increased agricultural productivity. Before the passage of the Hatch Act, some American farmers had resisted scientific (and laboratory-based) approaches, as they debated the place of 'book-learning' and outside authority in reforming farming practices. Historian Alan Marcus describes disagreements, in the second half of the century, between farmers who favored a more business-oriented "systematic farming," involving the reorganization of agricultural practices, and those farmers who aspired to become professional scientists, developing "scientific farming" themselves through on-farm investigations. In both of these approaches to reform, farmers maintained their independence, either individually or collectively. In contrast to these farmer-led reforms, agricultural science entailed improvements developed by government experts, scientists not farmers. According to Marcus, the passage of the Hatch Act "signified the legitimization of agricultural science as an integral part of the agricultural enterprise" and the "ascendancy of agricultural colleges as research institutions."[27]

In this brave new world, farmers were "businessmen, not scientific professionals,"[28] relying on non-farmers such as Eugene Hilgard for research-based expertise. As the following chapters will reveal, Hilgard developed his expertise through university and laboratory training in the sciences as well as through extensive fieldwork conducting geological and agricultural surveys. He was well-qualified to advise farmers and to forward the educational and research goals of the Morrill and the Hatch Acts.

[25]Act of March 2, 1887, ch. 314, 24 Stat. 440 (1887).
[26]Act of March 2, 1887, ch. 314, 24 Stat. 440 Sec. 2 (1887).
[27]Alan Marcus, *Agricultural Science and the Quest for Legitimacy: Farmers, Agricultural Colleges, and Experiment Stations, 1870-1890* (Ames: Iowa State University Press, 1985), 217.
[28]Marcus, *Agricultural Science*, 219.

Chapter 2
Hilgard Before California

Eugene Hilgard's eminence as a soil scientist, promoter of California agriculture, and fierce advocate for agricultural education and research at the University of California has been recounted and celebrated.[29] The current project aims to do something different: to contextualize Hilgard's life and work and to understand what was ordinary about him as well as what was extraordinary in order to understand the nature and meaning of agriculture in California and nationwide. Agriculture has had a contested political and social significance in the United States. Agrarian republicanism and its celebration of yeoman farming and diversified provisioning has been shadowed by commodity production, with its heritage of plantation agriculture and exploitative labor practices. Agricultural science has played a role both in assisting farmers and in organizing nature for commodification and the nation's commercial expansion.

Within the trajectory of Hilgard's career, the second half of the nineteenth century can be seen in terms of several overlapping processes crucial to the path taken by American agriculture, and to the relationship between science, the cultivation of the land, and the role of the state. First, as Hilgard's antebellum work exemplifies, government scientists in the slaveholding South as well as in the free-labor North mapped the mineral and agricultural resources of an expanding nation to develop the potential for economic and social "progress." After the Civil War, agricultural science developed as a public enterprise (though always connected with private interests), that became embedded in the land-grant universities and agricultural experiment stations like those Hilgard developed in California, as well as in the federal Department of Agriculture. The rise of agricultural science shifted the relationship between knowledge and labor, as reflected in the charged debates about education under the Morrill Act, in some ways reinscribing class and racial distinctions in the changing agricultural landscape. In the concern for maximizing or maintaining the materially productive potential of land, American farmers with the aid of agricultural science increasingly relied on external inputs, including fertilizers and germplasm, while disregarding the "economy of nature." Finally, around the turn of the twentieth century agricultural science and practices accompanied the expansion of American power and control beyond the continent, in a process that Hilgard promoted from California, for the global circulation, albeit uneven, of knowledge and germplasm was considered to be all to the good.

Upbringing and Education

The man who was to play a major role in the development of California's agriculture had

[29]See, e.g., Hans Jenny, *E.W. Hilgard and the Birth of Modern Soil Science* (Pisa: Collana della Rivista "Agrochimica," 1961); Scheuring, *Science and Service*; Ronald Amundson and Dan Yaalon, "E.W. Hilgard and John Wesley Powell: Efforts for a Joint Agricultural and Geological Survey," *Soil Science Society of America Journal* 59 (January-February 1995): 4-13; Ronald Amundson, "Philosophical Developments in Pedology in the United States: Eugene Hilgard and Milton Whitney," in Benno P. Warkentin, ed., *Footprints in the Soil: People and Ideas in Soil History* (Amsterdam: Elsevier, 2006), 149-165.

never visited the state until invited to lecture at Berkeley in 1874. Eugene Woldemar Hilgard had been brought up and educated in several cultures. He was born in 1833 in the mostly agricultural and wine-producing Palatinate region of Rhineland Germany, the ninth and youngest child of a judge of the Court of Appeals. Hilgard's father was a well-educated man of liberal political views who decided to emigrate to America in 1835, presumably in order to escape political repression and heavy taxation. Bringing an extensive library and a grand piano, the family followed relatives and other German immigrants in traveling by boat from New Orleans up the Mississippi to St. Louis. The Hilgards bought a farm across the river from St. Louis in Belleville, a southern Illinois settlement where "a number of cultured German families, largely political fugitives, were already established." While the Germans in the area tended to be well-educated, the Americans, according to Eugene's reminiscences, lacked refinement. The Hilgards found that servants were unexpectedly hard to get and to keep, and were as prone to illness as family members were. The elder Hilgard decided not to practice law; he would have been versed in civil law, and the common law was "unsuited to his taste." When he became concerned about dwindling resources, he opened a lumber yard on the farm, sold off some lots, and speculated a bit in real estate. However, he focused on intellectual and cultural pursuits, and when he was not translating Ovid into German, he gave his children a rigorous education that included the classics, French, and mathematics.[30] He also wanted the boys to work with tools and in the garden, work that they would not have been allowed to do in Germany because of their social position. In addition to farm work, the boys were in charge of baking bread.[31]

When they were free of studies and a "substratum of farm, garden and housework," Eugene and his brother educated themselves in natural history as they explored the surrounding "woodlands and prairie."[32] In this endeavor they were encouraged by their immigrant cousin, George Engelmann, a physician in nearby St. Louis. Engelmann was also a naturalist and botanist who through his work came to know Asa Gray of Harvard, the preeminent American botanist of the century, and other prominent figures in American natural history, especially as scientific and collecting expeditions to the West often passed through St. Louis.[33] Eugene's brother Julius, eight years older and gifted in mathematics, studied civil engineering and began work at the United States Coast Survey (later the Coast and Geodetic Survey), where he remained for his entire career.[34] The Coast Survey, established in 1807 at President Jefferson's initiative, was the preeminent scientific agency of the U.S. in the mid-nineteenth century. It was charged with the immense and taxing mission of charting the nation's coastlines and determining elevations on land in order to further navigation, determine national boundaries, and aid in defense. Its superintendent, Alexander Dallas Bache, asserted that "[t]he life of anyone on the Coast Survey is essentially and necessarily one of sacrifice for the public service, and not of

[30]Eugene Hilgard, "Autobiography," unpublished manuscript, Hilgard Family Papers, Bancroft Library, University of California, Berkeley (hereafter HFP). See also Frederick Slate, *Biographical Memoir of Eugene Woldemar Hilgard, 1833-1916* (Washington, D.C.: National Academy of Sciences, 1919). Slate's memoir closely follows and makes liberal use of Hilgard's autobiography.
[31]Eugene Hilgard, "Autobiography," HFP.
[32]Eugene Hilgard, "Autobiography," HFP.
[33]"Obituary of George Engelmann," *The Universe* (St. Louis), Vol. V No 5 (May 1885), HFP.
[34]"Sketch of Professor Hilgard," *Popular Science Monthly* 7 (September 1875): 617.

ease."[35] The Survey provided a common framework for the mapping of the growing nation,[36] which aided the state surveys such as those that later occupied Eugene Hilgard. Thus the young Eugene, despite his remote origins, had connections to major American nationalist scientific endeavors of the day as well as to European intellectual culture and politics.

Living an otherwise insulated existence, his family's engagement in and opinions about American political conflicts are less clear. Although Illinois did not permit slavery, Missouri, just across the Mississippi from Belleville, was a slave state. During Hilgard's childhood, the slave Dred Scott was brought by his St. Louis master for an extended stay across the river into Illinois; this stay became the basis for Scott's freedom suit, resulting in the infamous Supreme Court decision that slaves of African descent and their defendants were not protected by the Constitution. Also during Hilgard's childhood, Abraham Lincoln was beginning a political career inextricably entangled with the issue of slavery just over a hundred miles away. The politics of slavery was an inescapable element of antebellum life in southern Illinois.

Malaria and other illnesses flourished in the mosquito-plagued Mississippi Valley of Hilgard's youth. Eugene contracted typhoid fever at age six, in an epidemic that killed an older sister. His mother died when he was nine. He suffered recurrent bouts of illness throughout his life, and particularly was troubled by the damage to his eyesight. In order to improve his health and further his education, he joined his brother Julius in Washington when he was fifteen. After Eugene studied in Philadelphia, it was decided that he should continue his training in Europe, where his brother Theodore had already returned to study medicine.[37] In April, 1849, as the ultimately unsuccessful revolutionary efforts to unify Germany headed into their final months, sixteen-year-old Eugene took a steamer from New York with a trunk and, notably in view of his later support for the California citrus industry, "three dozen oranges."[38] He joked that he hoped "to aid in suppressing a few dukes, kings, and emperors," but as he witnessed conflicts or dodged his way around them, he "saw the hopelessness of the revolution" and the "absence of any intelligent management."[39] Politically, then, his time in Europe may have left him disenchanted with social movements and conflict.

Hilgard studied "the natural sciences—Chemistry, Physics, Botany, Geology—all in their widest sense" at various universities in Germany and in Zurich, as well as metallurgy and mining. He experimented with extracting gold with "chlorine water" and rejoiced at the discovery of new mercury deposits in California as useful for gold mining, although he was not ready to join the rush: "as yet I have not the slightest desire to go to California so quick." His brother Julius offered guidance from afar. However, Eugene resisted Julius's suggestion that he become a

[35]As quoted in H. R. Slotten, *Patronage, Practice, and the Culture of American Science: Alexander Dallas Bache and the U.S. Coast Survey* (Cambridge: Cambridge University Press, 1994), 147. See "The Field Work," NOAA Central Library, National Oceanographic Data Center, accessed March 18, 2012, http://www.lib.noaa.gov/noaainfo/heritage/coastsurveyvol1/BACHE4.html.
[36]See "History of Coast Survey," NOAA Office of Coast Survey, accessed March 18, 2012, http://www.nauticalcharts.noaa.gov/staff/hist.html.
[37]Hilgard, "Autobiography," HFP.
[38]Eugene Hilgard to Frank Hudson, 19 April 1849, HFP.
[39]Hilgard, "Autobiography," 12-13, HFP.

mining engineer. He considered getting a doctoral degree and asked his brother "whether the seal of such a title might be of essential use to me in the dominion of Uncle Sam," especially if he were "to hold any government employ," although "if I went to smelting lead & copper on my own score in the west, it might be pretty much all the same to me whether or not I am Dr. Phil."[40]

Even as a student in Germany Hilgard defined himself as "the man of science and practice both," [41] and his career was to follow these intertwined paths. He was occupied with discoveries, for example developing a "new, cheap solvent for Caoutchouc & Gutta [percha]," natural sources of latex.[42] In addition to studying mining and metallurgy, he attended to the relationship between local conditions and the global circulation of technologies, noting, for example, that the newly-developed Welsh methods for copper smelting, although the best in the world, might not be transferable elsewhere. In a foreshadowing of his later work developing California agriculture, he noted that: "the method of smelting must be so greatly adapted to local circumstances, fuel etc., that there is no telling whether the Wales processes would be at all applicable in the [American] West."[43]

Hilgard's recurrent health problems were compounded by several instances of poisoning caused by his studies. During "arduous work" in a "Practical Course" at a smelting works near Freiberg, "the fumes of sulfur, arsenic and lead from the furnaces that I had to feed, affected my throat . . . ." On one occasion, he was given a dosage of iodine after he "inhale[d] the fumes of mercury."[44] After leaving the smelting course, he worked in a "laboratory where I am from morn till night, so ill ventilated, that two hours after its occupation there is always a dense mist of white fumes enveloping us all . . . . I have, by this time, contracted a strong dislike to poisoning, or, rather, to being poisoned."[45] The doctors, including his brother Theo, whom he consulted after these experiences, told him that "the out-of-door life of a geologist or botanist would be by far the best for me."[46] He continued to regret the necessity of giving up smelting.

Hilgard decided against studying under Justus von Liebig, the influential figure in agricultural chemistry, because he did not "relish overmuch" the prospect of "initiat[ing]" himself in "all Liebig's theories."[47] He ended up getting his doctorate *summa cum laude* in 1853 at age twenty under the chemist Robert Bunsen in Heidelberg with research on the different parts of the candle flame. Afterward, because of illness (assumed by some to be incurable tuberculosis), Hilgard moved for a couple of years to Malaga, Spain, where he met his future wife, finished writing up his dissertation, went on collecting expeditions and studied the geology of the region. Here he first encountered arid landscapes and irrigation,[48] later to be a major focus of his work in California. As he prepared to return to America, he was decided against private

[40]Eugene Hilgard to Julius Hilgard, 9 February 1852, HFP.
[41]Eugene Hilgard to Julius Hilgard, 9 February 1852, HFP.
[42]Eugene Hilgard to Julius Hilgard, 9 February 1852, HFP.
[43]Eugene Hilgard to Julius Hilgard, 9 February 1852, HFP.
[44]Hilgard, "Autobiography," HFP.
[45]Eugene Hilgard to Alice, 19 December 1852, HFP.
[46]Hilgard, "Autobiography," HFP.
[47]Eugene Hilgard to Julius Hilgard, 9 February 1852, HFP.
[48]Hilgard, "Autobiography," HFP.

enterprise –"going into a manufacturing business is not exactly my plan"— because "I should better like to 'do something for science,' though not to 'live at ease.'" In particular, "[t]o enter a professorship of chemistry is w[hat] I feel myself the most perfectly 'up to,' as far as knowledge is concerned, " but first, "for hea[lth]," he hoped to join a "geognostical survey or exploring expedition," perhaps as a botanist.[49] Fortuitously, his next steps were to hew quite closely to this plan, and were to lead him to a career in agricultural science, as yet unanticipated.

Hilgard returned from Europe in 1855 with a large collection of fossils and plants that stumped the customs officer[50] but also with important elements of his later thinking and experience mapped out. He was wary of populist political movements and perhaps of political commitments. He was not devoted to rural life, describing how the "littleness and petty politics" of German villages "parches us with mental thirst," but was drawn to places where "intellect not money reigns."[51] He was familiar with mining and metallurgy, although leery of the risks of toxicity. A highly trained scientist in chemistry, geology, and botany and at the cutting edge of European research, he saw a position as a state-sponsored researcher as most appropriate for someone with his skills. Curious about climatic variation, he was also interested in practical innovation and production for global markets.

The Mississippi Survey

On returning to Washington, Hilgard was given space at the Smithsonian to continue his work in chemistry, but soon was asked by Frederick Barnard, Professor of Physics at the University of Mississippi in Oxford, to become the assistant state geologist entrusted with continuing that state's geological survey. En route to Oxford, at his brother Julius's suggestion, Hilgard stopped in New Harmony, in southern Indiana, to meet with David Dale Owen, who was then completing similar surveys of Kentucky and Arkansas. David Dale Owen was the son of Robert Owen, the Welsh-born industrialist, social reformer, and socialist, who had sought to establish a utopian community in New Harmony in the 1820s together with Scotsman William Maclure, a geologist who published the first geological history of the United States.[52] Because of Maclure's interest in natural history, New Harmony had become a destination for scientists. Hilgard, "being then much interested in Socialism," was told by the younger Owen that the utopian colony had collapsed because of the subsequent generations' "ambitions to strike out for themselves."

Hilgard described the encounter with Owen as a "most fruitful and interesting visit" which "gave direction to much of my future work." Owen encouraged Hilgard to pay "close attention to the agricultural features and soils, upon which both the practical utility and the popularity of these surveys depended, the more as Mississippi was not likely to be a mineral-producing state."[53] As Hilgard later recounted, Owen believed "in the advantages that a closer and more rational knowledge of the peculiarities of their soils would give those desiring to

[49]Eugene Hilgard to Julius Hilgard, 12 February 1854, HFP.
[50]Eugene Hilgard, "Autobiography," HFP.
[51]Eugene Hilgard to Julius Hilgard, 12 February 1854, HFP.
[52]For Maclure's influence on American geology and education, see generally *Indiana Magazine of History*, June 1998.
[53]Eugene Hilgard, "Autobiography," 33, HFP.

cultivate them rationally." His method included "gather[ing] from the mouths of the inhabitants all information" regarding their soils and also collecting samples, "noting all details as to depth, subsoil, drainage, 'lay,' natural vegetation, etc." [54] After the visit, Owen responded in detail to Hilgard's questions from Mississippi about analytical techniques.

Hilgard's meeting with David Dale Owen illustrates a turning point in American and European reform movements. While the elder Owen's endeavors exemplified the utopian socialist efforts of the early to mid nineteenth century, efforts ranging from the failed German revolutions of 1848 to the Shakers, Brook Farm, and the Oneida community in the United States, scientists such as the younger Owen and Hilgard put their energies into a different kind of reform, reflecting a scientific, even technocratic, version of a progressive, if not utopian, vision.

While the U. S. Coast Survey studied the nation's margins, state surveys filled in information about the expanding interior. In his survey of cotton for the 1880 census, Hilgard explained that surveys provided a "full and accurate knowledge of the agricultural features and other industrial resources of a state . . . wanted by the immigrant or settler seeking a new home suitable to his tastes and resources." With a telling choice of words, Hilgard noted that this knowledge is also sought "by the larger farmer and capitalist desiring to locate and invest to the best possible advantage." The publications provided by private interests to meet the "demand for this kind of information" were often biased or inaccurate.[55] It was the responsibility of the state, therefore, to step in to provide objective data.

If the goal of the Mississippi survey was to inform and attract immigrants and capital, it came as a late chapter in the history of Mississippi as a slaveholding state. As historian Adam Rothman has shown, the federal government from the start of the early national period onward had aided the expansion of slavery into the territory that became the states of Alabama, Louisiana, and Mississippi by surveying and selling public lands, violently dispossessing the Creek, Choctaw, and Chickasaw nations of vast regions, and acquiescing in the burgeoning domestic slave trade.[56] By 1855, when Hilgard arrived in Mississippi, the project of attracting immigration and capital, which would have been heavily invested in enslaved labor, would also have had a further goal: to try to counter the far faster growth in the population— and political power – of free states to the north,[57] as the political opposition to slavery grew ever more powerful.

While Hilgard in his public reports emphasized the utilitarian value of surveys, they also served to reveal the state's bounty and, as his work would show, to expand the realm of what was known about nature. As he complained to his brother soon after arriving, the avowed scope of the survey authorized by the Mississippi legislature was broad: "'a general geological and agricultural survey of the state comprising a full and scientific investigation of its botanical and zoological productions.' Furthermore, there is desired 'analyses of the different kinds of soil

[54]Eugene Hilgard, "Soil Investigation," in Eugene Hilgard, *General Discussion of the Cotton Production of the United States* (Washington: U.S. Census Office,1883), 55.
[55]Hilgard, Eugene, "Soil Investigation," in *General Discussion of Cotton Production*, 67
[56]Rothman, *Slave Country*, 219-221.
[57]Rothman, *Slave Country*, 222.

found in the state, and of the various materials which might be used as mineral manures.' (marls, gypsum, etc.), also of the ashes of the chief plants etc. etc." From the small sum of $3000, the legislature "expected to squeeze out the survey & numerous & valuable collections etc. etc. for the state cabinet & university museum."[58]

As the chief geologist was incompetent, even a charlatan, the work of the survey fell to Hilgard. While the nation's sectional conflicts deepened, he spent much of his time traveling by cart around Mississippi, the home state of wealthy planter and future Confederate president Jefferson Davis, making observations and collecting materials. For the remainder of his time, he compiled his results at the university in Oxford while negotiating issues about legislative funding and dodging academic conflicts.

According to his biographer Hans Jenny, Hilgard's childhood love of "Mother Earth" was reawakened as he explored Mississippi, and he was horrified by the ravages inflicted on the landscape by farming practices that had depleted the soil and contributed to erosion.[59] What Jenny does not discuss was that much of the state's agricultural economy centered on the cotton plantations in the Mississippi-Yazoo Delta, which were as heavily reliant on enslaved labor as any region in the South. (The density of the slave population in the Delta and elsewhere in the South was illustrated by an 1861 map prepared by a cartographer with the United States Coast Survey in order to muster political support for the Union efforts. [60]) The expansion in short-staple cotton production made possible by enslaved labor in the first half of the nineteenth century had caused much of the devastation that Hilgard witnessed, with profits accruing to the rich planter class. As he went forth on his survey, cotton production was at its highest level ever.[61]

Hilgard examined not only cotton-growing areas, but also the primarily wooded remainder of the state, making important observations about the relationship between native vegetation and soils.[62]

> I made a point of paying close attention to and recording the surface features, vegetation, soils, the quality and supply of water, and especially the marls…. I also made a collection of plants, which … I perceived was essential toward the characterization of soils …. The close connection between the surface vegetation and the underlying formation became so striking, that I soon largely availed myself of the former in tracing the limits of adjacent formations, in searching for outcrops, etc.

[58]Eugene Hilgard to Julius Hilgard, 5 October 1855, HFP.
[59]Jenny, *E.W. Hilgard*, 8.
[60]See *Map Showing the Distribution of the Slave Population of the Southern States of the United States Compiled from the Census of 1860* (Washington, D.C, 1861), in "Mapping Slavery in the Nineteenth Century," NOAA Office of Coast Survey, accessed March 10, 2012, http://www.nauticalcharts.noaa.gov/history/CivilWar/docs/Slave_Density_Map.pdf.
[61]Gene Dattel, "When Cotton Was King," *Opinionator* (blog), *New York Times*, March 26, 2011, http://opinionator.blogs.nytimes.com/2011/03/26/when-cotton-was-king/ .
[62]See Jenny, *E.W. Hilgard*, 28 ff.

> I also, by current inquiry among the inhabitants, ascertained all that was known regarding the peculiarities, merits and demerits of the several regions or soils, from an agricultural point of view, and studied their practice and its results on the several soils and crops.[63]

After some difficulties and interruptions due to issues with the legislature and the university, he submitted his report in 1860, an impressive 391 pages detailing, as his Mississippi student Loughridge recounted, "his observations on the geological formations and agricultural features with many chemical analyses of the important soils," illustrated by a map.[64]

During the 1850s Frederick Law Olmsted, the Northern surveyor and farmer later turned landscape architect, also traveled through Mississippi and other parts of the South, on assignment from a New York newspaper. Signing his reports as "Yeoman," he, like Hilgard, recognized the devastation to the land wrought by cotton-planting, but Olmsted also saw the grim social consequences— not just for enslaved people— of the slave- and cotton-based economy, in which Southerners depended on imports and capital was invested, not in public goods such as schools and transportation, but rather in more slaves and more cotton production.[65] He recognized slavery as "a system of colonization"[66] with dynamic and damaging effects.

Olmsted's articles were gathered and published in three volumes, which were then abridged in 1861 as *The Cotton Kingdom.* In a new introductory chapter, Olmsted reflected on the difference between the landscape, and the social patterns it shapes, and the superimposed map: "The mountain ranges, the valleys and the great waters of America, all trend north and south….An arbitrary political line may divide the north part from the south part, but there is no such line in nature: there can be none socially."[67] To demonstrate his point that the slavery-based agriculture was economically inefficient as well as morally abhorrent, Olmsted and his co-editor developed a map using census data on slave populations that showed how the highest productivity of cotton was not necessarily found in regions with the densest slave populations.[68] (Mississippi's Delta, however, was both dense in slaves and high in production.) Unlike Hilgard in his 1860 report, although referring in part to travels through the same landscape, Olmsted examined the interaction of coercion, labor, and agricultural productivity. Writing for a different audience and with a different assignment, Hilgard's focus was on the natural features of the landscape.

Civil War Years

[63]Hilgard, "Autobiography," 38, HFP.
[64]R.H. Loughridge, "The Life-Work of Professor Hilgard*,"* in *In Memorium: Eugene Woldemar Hilgard* (Berkeley: University of California Press, 1916), 25.
[65]See Louis P. Masur, "Frederick Law Olmsted's Writing about the South," *Opinionator* (blog), *New York Times*, July 9, 2011, http://opinionator.blogs.nytimes.com/2011/07/09/olmsteds-southern-landscapes/ .
[66]Frederick Law Olmsted, *A Journey in the Back Country* (New York: Mason Brothers, 1861), 291.
[67]Frederick Law Olmsted, *The Cotton Kingdom: A Traveller's Observations on Cotton and Slavery in the American Slave States* (New York: Mason Brothers, 1862), 1.
[68]Susan Schulten, "Mapping the Cotton Kingdom," *Opinionator* (blog), *New York Times*, September 28, 2011, http://opinionator.blogs.nytimes.com/2011/09/28.

Although at least at one point Hilgard considered leaving,[69] he stayed on in Oxford during the Civil War. The legislature continued to fund his position as State Geologist. His mentor, Frederick Barnard, who had become the University chancellor, initially remained as well, but when the Confederate Army sent him to take charge of the Niter and Mining Division in Virginia, Barnard and his wife escaped across the Potomac to the North.[70] In his autobiography, Hilgard explained his own rather different decision:

> I considered it but decent to stay and share in the fate of the South, however little I believed in its final success. I did this the more willingly as I had personally become aware of the gross exaggeration of the cruelties toward the slaves alleged by the abolitionists of the North to be of common occurrence, and of the inability of the negroes to become anything but a servile race, even if set free….[71]

In minimizing slavery's evils, denying its violence, and 'naturalizing' racial distinctions, Hilgard adopted the racist ideology developed by Southern pro-slavery apologists that he no doubt encountered in his contacts with Mississippi politicians and planters, some of whom were University trustees. He was likely influenced by the views of Lucius Quintus Cincinnatus Lamar, a defender of slavery and states' rights, whom he first knew as a professor of mathematics and son-in-law of the University president. In 1861 Lamar resigned his seat as a U.S. Representative in order to draft Mississippi's secession ordinance and was active both in Confederate military and diplomatic affairs.[72] Following the war, Lamar wrote to Hilgard, then in California, to lament the "thralldom" suffered by his wife and daughter at the hands of "rude expensive and unintelligent labor." Evoking the tension between labor and mechanization that would later also intensify in agriculture, Lamar begged Hilgard, as a "Southern patriot," to return to Mississippi and turn his scientific talents to inventing "labor-saving machines" in order to minimize the need for domestic labor.[73]

As war engulfed the state, Hilgard was charged with protecting university facilities, and, as an agent of the "Niter Bureau" was "ordered to erect 'calcium lights' on the bluffs" above Vicksburg "for the illumination of the federal gunboats… attempting to run the gauntlet of the batteries," a task he was unable to complete in time.[74] His brother Julius, meanwhile, was serving as Chief of the Bureau of the Coast Survey at its Washington headquarters, as the Coast Service, known to be committed to the abolitionist cause, mobilized its resources and essential expertise in mapping and surveying for the Union cause.[75]

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[69]See Frederick Barnard to Eugene Hilgard, 21 September 1861 and 5 November 1861. Barnard later became president of Columbia University.

[70]Hilgard, "Autobiography," HFP.

[71]Hilgard, "Autobiography," 78, HFP.

[72]Of all the states in the Confederacy, Mississippi's secession ordinance identified its cause to be completely at one with the maintenance of slavery as a fundamental social institution. After Reconstruction and Mississippi's readmission to the union, Lamar was reelected to the U.S. House, then to the Senate. After serving as Secretary of the Interior, he was appointed to the Supreme Court. See William "Brother" Rogers, "Lucius Quintus Cincinnatus Lamar," *Mississippi History Now*, accessed March 15, 2012, http://mshistory.k12.ms.us/articles/173/lucius-quintus-cincinnatus-lamar.

[73]L.Q.C. Lamar to Eugene Hilgard, 20 April 1876, HFP.

[74]Hilgard, "Autobiography," HFP.

[75]See "Sketch of Professor Hilgard," *Popular Science Monthly*, 7 (September 1875), 617; see also John Cloud, "The U.S. Coast Survey in the Civil War*,"* National Atmospheric and Oceanic Administration,

Did Eugene Hilgard have qualms about supporting, or at least not rejecting, the pro-slavery cause? His work on Mississippi agriculture seemed unperturbed by the role of slaves as "capital." Although he might have believed, contrary to Lamar and most other Mississippi leaders, that the end of slavery was inevitable, his beliefs did not compel him to abandon his work for the state of Mississippi. His trans-Atlantic background may have disconnected him from political allegiances while forming him as an 'objective' researcher. He may well have defined himself both as a detached scientist who pursued knowledge for the "public good" and as a civil servant who sought to conserve and to promote the state's agricultural resources. Moreover, his position afforded him the opportunity to pursue his vocation. Whatever the cause, these experiences allowed or impelled Hilgard to dissociate his scientific, scholarly, and even practical interests in agriculture from the conflicted social conditions and political circumstances of labor, land, and production that agricultural systems entail. Later, at Berkeley, Hilgard became the colleague and friend of the geologist Joseph Leconte, a Georgian who had also retained an academic position in the Confederacy during the war but, disgruntled with Reconstruction, left the South in 1869 for the University of California.[76]

Agricultural Education

After the war, Hilgard remained at the University of Mississippi as Professor of Chemistry. While continuing geological research and the supervision of the survey, he undertook to develop agricultural education. Before secession, Mississippi senator Jefferson Davis, along with other Southern congressional representatives and senators, had voted against the Morrill Act, and Mississippi had been in secession when the Act was finally passed by the U.S. Congress. After readmission to the union, Mississippi became eligible for support under the Morrill Act, but there was disagreement about whether the University of Mississippi at Oxford would become a land-grant institution or whether a separate institution would be established. Hilgard had strong opinions about agricultural education, and even asked Vermont Congressman Justin Smith Morrill himself about the intent of the law, to which Morrill responded that he had intended considerable latitude for states to develop land-grant institutions as they saw fit.[77]

The conflict that emerged about the curriculum of agricultural colleges should be understood as concerning not just the relative importance of science and practical training but also labor, class and racial distinctions. The debate evoked images of the white sons of yeoman farmers either working on a model farm or having the chance to learn scientific principles— or to study the classics if they pleased. But a more theoretically oriented education in agricultural science carried class implications—it required more academic preparation and could also be useful for farm owners and managers not expected to work with their hands. Any discussion of land-grant education in the South was likely based on the assumption of segregated institutions. At a deeper level, land-grant education may also have been about sharpening the distinction

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2011, accessed March 17, 2012, http://www.nauticalcharts.noaa.gov/history/CivilWar/docs/The_U_S_Coast_Survey_in_the_Civil_War_report.pdf.

[76]See Eugene Hilgard, *Biographical Memoir of Joseph LeConte, 1823-1901* (Washington, D.C.: Judd and Detweiler, 1907).

[77]Eugene Hilgard, "Autobiography," HFP.

between ownership (or management) and labor, and laying the groundwork for the separation of knowledge from labor in agriculture, even as the population deemed capable of or eligible for social elevation was enlarged.

In 1871, after attending the meeting of the American Academy for the Advancement of Science in Indianapolis, Hilgard proceeded to Chicago for the first meeting of the Association of Agricultural Colleges, composed of professors and college presidents. At the university's behest, he was to learn more about "the organization, practical working, and success" of land-grant colleges in order to put forth a plan for agricultural and mechanical education at the University of Mississippi. In his report to the Chancellor, Hilgard noted that the initiators of the meeting had intended to focus on "the establishment of uniformity in the agricultural experiments conducted" at the colleges. [78] A Michigan professor delivered the first paper, "a treatise on Pig Feeding." As he later recounted, Hilgard "rose to a point of order" and stated that he and others had come to "discuss the education of men, not of animals."[79] An "embarrassing silence" followed, broken by the voicing of support for Hilgard's position by Daniel Coit Gilman,[80] then of Yale's Sheffield Scientific School, but shortly to become president of the University of California.

Gilman's support for Hilgard's position should have come as no surprise. Several years before, in a journal article called "Our National Schools of Science,"[81] Gilman had argued against pigeonholing land-grant colleges as "agricultural" and rejected farmers' efforts to claim them exclusively. After noting the growth of national institutions, both public and private, in the postwar period, he reiterated that the Morrill Act provided for "the mechanic arts" as well as agriculture, and should properly be applied to "industrial" or scientific education, broadly conceived. With the Morrill Act, "the national government lends its co-operation to the development of the national wealth."[82] He maintained that these 'national schools of science,' though they would vary according to each state's needs, were not "to train young men to go back and labor with the hoe or the anvil" but "to train men by scientific courses of study for the higher avocations of life, and especially to take charge" of industrial endeavors and the "conduct of … scientific surveys."[83]

As the exchange involving Hilgard and Gilman suggested, a topic of great interest to the attendees was how best and for whom to provide agricultural and mechanical education.[84] On

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[78]Eugene Hilgard, "Report on Organization of the Department of Agriculture and the Mechanic Arts," in *Minutes of the Board of Trustees of the University of Mississippi, with an Appendix Containing Documents in reference to the Organization of the College of Agriculture and the Mechanic Arts in Connection with the University* (Oxford, MS, 1871), 1.

[79]It might be relevant to note here that Hilgard's family decided not to keep pigs on the Belleville farm because of their unpleasantness. See Hilgard, "Autobiography," HFP.

[80]Hilgard, "Autobiography," HFP.

[81]Daniel C. Gilman, *Our National Schools of Science* (Boston: Ticknor & Fields, 1867), reprinted from *The North American Review*, October, 1867. In the University of California, Berkeley, library, it is bound in a compilation entitled *Pamphlets on Agricultural and Technical Education.*

[82]Gilman, *National Schools*, 16.

[83]Gilman, *National Schools*, 27.

[84]Land-grant institutions were charged with providing both agricultural and mechanical education, as well as military training. However, in part because Mississippi was an agricultural state, Hilgard focused on

one extreme, according to Hilgard's report, was the approach exemplified by Yale's Sheffield Scientific School, in which students were taught the "theory and practice of agriculture and mechanical arts" solely by lecture and laboratory work. At the other extreme was the "practical" or "handicraft" approach, which as implemented initially at Pennsylvania's Agricultural College, involved students working—as Hilgard saw it, performing routine and repetitive tasks—without pay on the college's model farm. This approach was intended to "secure popular support and patronage to the institution," but when it failed to do so, the required hours of labor were reduced. Hilgard saw the Midwestern[85] land-grant colleges as closer to striking the "golden mean" between theory and practice and also cited approvingly similar developments in European and British agricultural education, as had been recently described in the Commissioner of Agriculture's 1868 report.[86]

Instruction in scientific principles would enable students to see beyond local conditions. Hilgard feared that the purely "practical approach" would produce farmers familiar with practices appropriate only to "one particular locality or set of circumstances" who would "fail utterly" as conditions or location changed. "The truly practical man," stated Hilgard, "by combining the knowledge of principles *and* practice, is enabled to adapt the latter to any change of circumstances and external conditions."[87] Given the mobility of the nation's population and the changes in agriculture, farmers needed to be prepared to adapt. This would prove to be a key issue in California.

However, this "golden mean" of education would not be available to all, at least not yet. Despite the Morrill Act's purpose of making public education more broadly available, Hilgard argued that the goal of educating "every farmer's son in the country" was misguided, given the currently poor state of primary education, especially with regard to science. "[A]t present, and for some time to come," then, higher education would likely be the "privilege of comparatively few" who had the "fortune, early opportunities, or talent" to acquire the necessary preparation and to set aside the time for a college education— and money as well, if scholarships were lacking.[88] Hilgard quotes approvingly a report from the Illinois Industrial University that the "thorough mastery" of agriculture and the mechanical arts, and the relevant sciences, "requires an education different in kind, but as systematic and complete, as that required for the comprehension of the learned professions." Higher education of the standard favored by Hilgard and those who shared his view would help to raise the social and cultural status of agricultural students to that of students being trained for the professions such as law and medicine. Hilgard calls the alternative approach--to "lower the standard on pretense of benefiting a larger circle"—demagogic and bound to fail.[89]

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agriculture. The participants at the AAC meeting expressed the wish that Congress strike the military provision from the Morrill Act or else provide military personnel to conduct the training.

[85]In this and other writings of this period, Hilgard uses the term "Western" to refer to what would later be called the Midwest.

[86]See Joseph McChesney, "Report on Agricultural Education in Europe," in *Report of the Commissioner of Agriculture for the Year 1868* (Washington: Government Printing Office, 1868).

[87]Hilgard, "Report on Organization," 3.

[88]Hilgard, "Report on Organization," 3.

[89]Hilgard, "Report on Organization," 4.

Even if the time was not right for universal higher education, educated leaders could enlighten those around them. Referring to an eighteenth-century Scottish author of an agricultural treatise,[90] Hilgard argues that "[a] Dickson in every county of the state would do far more toward the popularization of rational methods of agriculture, than any amount of diluted knowledge diffused among the population could do in an equal amount of time."[91] Arrayed against Hilgard's position, as historian Alan Marcus has shown, were reformer-farmers who wanted broadly available practical training in subjects such as accounting in order to prepare for the business of farming.[92]

In his report to the university, Hilgard acknowledged regional differences in gender and class at land-grant colleges. In the Midwest, women had been admitted to the same course of study as men and were able to "hold their own," though Hilgard thought it would be preferable for women to replace some courses with "a special course in *housekeeping,* in all its branches." The Northeastern agricultural students had to contend with the disdain of "the literary corps of Yale, Harvard, and Amherst." [93] Hilgard attributed this disdain to the association of "agriculture and the mechanic arts" with "manual labor," but argues that "this prejudice … is directed at the … uneducated laborer who works by rote only, like a machine. It is this connection which has *engendered* the prejudice on the part of the educated classes." Such a prejudice would, of course, be unwarranted for "physical labor… connected with high mental culture." In order to dispel the old prejudice, it became all the more important for agricultural colleges to eliminate the "compulsory labor system" on their farms.[94] Given that Hilgard was addressing a Mississippi audience, there was clearly a racial as well as a class subtext to this discussion,[95] for, as Olmsted had commented in his report on his antebellum travels in the South, the association of "manual agricultural labor" with slaves made poor white Southerners, as well as planters, look on farm work with "contempt" or "pity."[96]

According to Hilgard's report, a "truly 'model' farm" would teach students "not only *to know how things should be done, but to do them themselves*." It would have also another purpose, "a delicate and most difficult duty, if properly performed": "that of carrying on agricultural experiments." (Hilgard understood this to be a legal requirement of the Morrill Act[97] and would devote much of his subsequent career to furthering this goal.) Finally, he asserted in the report

[90]See Adam Dickson, *A Treatise on Agriculture*, Edinburgh, 1762.
[91]Hilgard, "Report on Organization," 4.
[92]See Marcus, *Agricultural Science*.
[93]Hilgard, "Report on Organization," 5-6.
[94]Hilgard, "Report on Organization," 6.
[95]This debate about the role of manual labor in agricultural education foreshadows aspects of the debate, decades later, between Booker T. Washington and W.E.B. DuBois about African-American education. At the Tuskegee Institute, headed by Washington from 1881 until his death, paid practical work, in a variety of trades and occupations, constituted an important part of the educational program, which was initially intended to train educators for African-American communities. Although initially supportive of Washington's approach, W.E.B. DuBois later argued against Washington's emphasis on "industrial" education as accommodating white supremacy and, instead, insisted on the importance of liberal arts education for African-Americans.
[96]Olmsted, *Journey in the Back Country*, 299-300.
[97]Hilgard, "Report on Organization," 4.

that agricultural colleges, and the associated model farms, provide a public good and therefore deserve public support, for "neither experimenting nor instruction are lucrative in their nature."[98] Unsurprisingly, his subsequent career would also be devoted to securing public support and funding for agricultural research.

The Mississippi legislature allocated the initial land-grant appropriation to the University of Mississippi and to Alcorn University, established in 1871 as a land-grant institution by the legislature for the "training" of African-Americans.[99] In August, 1871, the Board of Trustees favorably reviewed Hilgard's report and plan for agricultural and mechanical education at the University of Mississippi, although lack of funds prevented immediate implementation. Hilgard was asked to deliver a course on the "special Geology and Agriculture of the State." When funds allowed, a farm was to be established but, the Board took pains to note, no "obligatory labor" was to be "imposed" on the students, and voluntary labor was to be compensated.[100] Around the time, Hilgard later recalled, "Southern extremists" sought to insist that the University deny admission to any African-American applicant, even though, apparently, none had applied.[101]

Hilgard gave a public address to drum up support for his plan from the public and the agricultural societies, who were often antagonistic to college-based education and agricultural science. Describing Mississippi as an "agricultural commonwealth" where soil fertility must be maintained or restored in order to prevent "depopulation," he deplored "the gullied commons waving with broom-sedge, that surround most of our older towns."[102] If soils were allowed to become exhausted, farmers would move on to virgin territory and would fail to invest in their homes and domestic life. It was "high time" for the state to be developing more sustainable practices that would discourage out-migration and provide the basis for farmers' acquisition of civilized manners and high culture.[103] (Recall his family's move from Europe to the frontier with an extensive library and a grand piano.) Referring to Indians' land management practices that would have "lasted forever" (had they not been stripped of their land), he cautions: "Well might the Chickasaws and the Choctaws question the moral right of the act by which their beautiful, park-like hunting grounds were turned over to another race," given that the white settlers had damaged rather than improved the soils.[104] He recommended crop rotation and "green-cropping,"[105] and argued for retention of wastes on the farm; to that end, he supported

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[98]Hilgard, "Report on Organization," 5.

[99]In 1871 its name changed to Alcorn Agricultural and Mechanical College. It calls itself the "oldest public historically black land-grant institution in the United States." See http://www.alcorn.edu/about/default.aspx?id=559.

[100]*Minutes of the Board of Trustees of the University of Mississippi, with an Appendix Containing Documents in reference to the Organization of the College of Agriculture and the Mechanic Arts in Connection with the University* (Oxford, MS, 1871), 16-17.

[101]Hilgard, "Autobiography," HFP.

[102]Eugene Hilgard, *Address on Progressive Agriculture and Industrial Education, Delivered Before the Mississippi Agricultural and Mechanical Fair Association, at Jackson, November 14, 1872* (Jackson, MS: Clarion Book and Job Office, 1873), 3-4.

[103]Hilgard, *Address on Progressive Agriculture*, 5-6.

[104]Hilgard, *Address on Progressive Agriculture*, 9.

[105]Hilgard, *Address on Progressive Agriculture*, 16-18.

fence laws, controversial because they sought to end common grazing,[106] so as to keep animal waste on the farm rather than scattered about in the woods. He also noted the sources of natural 'manures' or fertilizers in the state in the limestones and marls,[107] and emphasized the need for state inspection of commercial fertilizers. Pointing out the risks of social and environmental decline, he offered specific, practical solutions for agricultural improvement.

In a separate article, Hilgard proposed that individual families could take it upon themselves to mitigate the corrosive effects of cotton culture. In a submission to the *Rural Carolinian* entitled "All Cotton and No Comfort," Hilgard distinguished between "*Planting* (i.e., producing a single or a few crops only, for sale) as contra-distinguished from *farming* (in which the greater part, or the whole, of the family subsistence is produced at home, the surplus only being sold)." He deplored the dependence of small-scale farmers on cotton as their one crop, while they purchased their food. He instead advocated diversified production by farm families for home consumption as a way of "home-making." "I honor the cotton plant, as a benefactor to the human race at large," Hilgard wrote, "[b]ut we have allowed ourselves to be enslaved by it, and we have gambled with it, and … we have been demoralized from it, to the detriment of our intellectual and home life, and lasting injury to our soils."[108]

In any event, his pleas to the agricultural societies failed to produce the funding he desired for agricultural education. When the University of Michigan offered him a position in 1873 as Professor of Geology and Natural History, an exasperated Hilgard accepted. However, his stay in Michigan was short. The cold weather exacerbated his health problems, and Gilman, then President of the University of California, prevailed on him to come to Berkeley, first in 1874 as a special lecturer and then the next year as Professor of Agriculture.[109] Hilgard was later interested to hear the news of the establishment of the Mississippi Agricultural and Mechanical College in 1878 as the state's land-grant institution for white students. As he wrote to the secretary of the new college: "I shall greatly rejoice to see a strong agr. college set up in my old state--- I gave the matter up in despair after my experience in '72 and '3, as there seemed to be neither adequate means nor popular interest in agr. education."[110] The University of Mississippi itself was not desegregated until James Meredith enrolled, despite violent opposition, nearly a century later, in 1962, under armed federal protection.

During his eighteen years in Mississippi, Hilgard's focus had shifted from geology and chemistry to include soils and agriculture. In addition to agricultural education, he had taken on as a cause the depletion of soils and the waste of fertility. He advocated sustainable practices of agricultural production and suggested that sustained fertility would promote future cultural advancement, although he shied away from addressing crucial and relevant questions about who

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[106]See Steven Hahn, *The Roots of Southern Populism: Yeoman Farmers and the Transformation of the Georgia Upcountry, 1850-1890* (Oxford, UK: Oxford University Press, 1983).
[107]Hilgard, *Address on Progressive Agriculture*, 14-15.
[108]Eugene Hilgard, "All Cotton and No Comfort," *Rural Carolinian* (no date), Carton 1, HFP.
[109]Interestingly enough, Frederick Law Olmsted had earlier been employed to make an assessment of the proposed location of the new College of Agriculture in Berkeley. His *Report upon a Projected Improvement of the Estate of the College of California at Berkeley, near Oakland* was published in 1866.
[110]Eugene Hilgard to Frank Burkitt, 3 May 1878.

owned, controlled, and worked the land. These questions were and would continue to be crucial and relevant in California, although they were not the main focus of concern in the Berkeley's new land-grant college.

Chapter 3
Hilgard in California

Hilgard's career at the University of California's College of Agriculture and the Agricultural Experiment Station provides a view of a critical phase in the development of the interactions among government, science, and farming in the state and nationwide. He fought hard for, and won, political and financial support for public agricultural education and research and in many ways helped to lay the groundwork for the state's agricultural and scientific future. In addition to teaching college students and leading numerous Farmers' Institutes, Hilgard produced and supervised a steady stream of scientific research, attaining national and international renown. He also responded with care to many thousands of letters from Californians, seeking his advice on topics ranging from marketing possibilities for limes to the efficacy of fertilizer made from human "night-soil."[111] He made relentless efforts to build the store of public knowledge at scales ranging from the local to the global and to disseminate information in language accessible to farmers and nonscientists as well as to scientists. Faced with numerous challenges, Hilgard sometimes longed for Mississippi, but, in a letter to an acquaintance, deplored the difficulty of "active progress" in the South: "This is the reason why, despite repeated solicitations and my own preference for my old field of labor, I have determined not to return so long as I can get along here, where progress is so rapid" that he finds it "almost a little overwhelming sometimes."[112] In California, Hilgard encountered ample opportunity to put his significant intelligence, experience, and skills to work.

Hilgard's multifaceted career in California spanned over three decades. He arrived for good as Professor of Agriculture in 1875, and is reported to have almost immediately begun research and experimentation on the effect of plowing depth on wheat production and on fertilization in the growing of wheat and oats.[113] The development of the agricultural experiment station included the establishment of Hilgard's Garden of Economic Plants in 1879, where plant varieties were tested and seeds and stock were distributed.[114] The irregularity of funding for staff, facilities, and equipment complicated his research efforts, but the passage of the Hatch Act in 1887 ensured federal support for the experiment station and enabled the construction of a new building with labs.[115] In the same year, the state legislature passed the Wright Irrigation Act, which enabled the formation of public irrigation districts, leading to a vast increase in the amount of irrigated farmland. The number of full-time students in the College of Agriculture remained small during Hilgard's tenure, rising from fewer than twenty by the mid-1890s to 101 students, including degree- and non-degree-seeking, in 1904.[116] However, many more California residents received agricultural advice and instruction from outreach efforts ranging from

[111]Eugene Hilgard to Mr. Ashburner, 21 March 1878; Eugene Hilgard to A. Haas, 16 October 1882, HFP.
[112]Eugene Hilgard to Prof. P. Lane, 11 March 1879, HFP.
[113]See Scheuring, *Science and Service*, 30.
[114]See Scheuring, *Science and Service*, 36.
[115]Unfortunately, Budd Hall, which housed the experimental station, burned down in 1897, resulting in the loss of important collections and data, although the building was rebuilt and the work of the experiment station continued. See Scheuring, *Science and Service*, 40.

personal letters (Hilgard himself wrote thousands) to bulletins to extension and institute courses. He retired as Dean in 1905.

In addition to his university work, Hilgard was chosen to supervise the study of cotton production for the 1880 Census of the United States, and used the opportunity to collect considerable information, including data about soils, on the cotton-growing states, in which he included California. For several summers from 1881-1883 he undertook an agricultural survey as part of the Northern Transcontinental Survey. In 1882, as will be detailed below, he co-authored a USDA report on arid areas of the Pacific slope, and he continued to research and write on the problem of alkali soils and irrigation. During the 1880s he unsuccessfully lobbied the newly established U.S. Geological Survey, headed by John Wesley Powell, to undertake an agricultural survey as part of its work.[117] Ten years after the initial arid lands report he published a monograph on "the relation of soil to climate" that described how climatic factors, especially temperature and rainfall, helped to form and change soils. In 1906, after he retired from the university and experiment station, he published *Soils*, a summary of his life's work in soil science. Several times during his California career Hilgard returned to Europe, where he was much honored and played a significant role in international conferences as late as 1909.[118] He co-authored a grade school textbook on agriculture that was published in 1911. After several years of decline, he died in 1916.

This chapter presents several interlocking themes in Hilgard's California career. First, the development of the agricultural economy, with its emphasis on commodity production rather than equal access to land, conflicted in important ways with possibilities for democratic citizenship. Second, projects for farm and horticultural improvement and diversification were marred by racial exclusion, the invisibility of hired labor, and environmental costs. Finally, university scientists produced public knowledge but may at times have served the interests of the economically powerful at the expense of the common good.

Farmers, Laborers, and Reformers

California's admission as a state had been accelerated in order to maintain a balance between 'free soil' states and those in which slavery was legal, as part of the Compromise of 1850. Thus, the state from its birth was enmeshed in a conflict over the status and rights of labor, especially farm labor. California's development of agriculture had taken a distinctive course. Hilgard himself commented that "unlike the great agricultural states of the Mississippi valley, California has not undergone the slow and regular process of settlement by pioneer farmers who … keep selling out and moving west as part of their normal existence."[119] Instead,

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[116]See Scheuring, *Science and Service*, 43.

[117]Amundson, "Philosophical Developments in Pedology," in Benno P. Warkentin, ed., *Footprints in the Soil*, 150.

[118]For a summary of Hilgard's tenure at the University of California, see Scheuring, *Science and Service*, chapter 2. See also *In Memorium: Eugene Woldemar Hilgard* (Berkeley: University of California Press, 1916); Jenny, *E.W. Hilgard*; and James Malin, *The Grassland of North America: Prolegomena to Its History with Addenda and Postscript* (Gloucester: Peter Smith, 1967), 212-219.

[119]Eugene Hilgard, 1878, as quoted in Malin, *Grassland of North America*, 212.

farming had expanded rapidly after 1849 to provide food for the booming population of immigrants who were seeking gold.

Initially, the newly-arrived farmers discovered that the practices of the East and Midwest did not work in a climate of wet and dry seasons. But farmers adjusted their practices and were successfully producing fruits and vegetables in the Sacramento Valley in the 1850s.[120] In the following decade, wheat farming, often on huge estates, became more extensive, and fruit production increased as well.[121] However, many immigrants had difficulty gaining access to land. The journalist and political economist Henry George, known for his advocacy of the single tax on land, was among the first to comment on the state's pattern of farm ownership and farm labor. George railed that the "blight" of land monopolization had "fallen upon California, stunting her growth and mocking her golden promise, offsetting to the immigrant the richness of her soil and the beneficence of her climate," even before "we have commenced to manure our lands or to more than prospect the treasures of our hills." Stressing the importance of labor and ownership regimes to "the character of our agriculture," as Olmsted had done regarding the South a decade or so earlier, George described California agriculture as "more shiftless, perhaps, than that of any State in the Union where slavery has not reigned. For California is not a country of farms," he concluded, "but a country of plantations and estates."[122] Even if poorer Anglo immigrants gained access to land, they lacked the capital to wait several years for vines and orchards to produce fruit.[123] If irrigation was required, the costs were even higher.[124]

The development of private irrigation fostered the expansion of the growing of fruits, vegetables, and nuts, as did the large number of immigrant Chinese farm laborers, displaced from their work on railroad construction, which enabled "many bonanza wheat growers to make the transition to large-scale specialty crop production." According to historian Lawrence Jelinek, the availability of this cheap labor force "greatly accelerated the pace of the transition to intensive agriculture" by making it more profitable for large landholders to retain much of their holdings, although they did sell some acreage to "specialty crop settlers." Chinese workers likely made up more than half of all farm laborers in California by 1882. Jelinek notes that growers often learned how to grow fruits and vegetables from their Chinese employees and tenants. On the islands of the Sacramento-San Joaquin Delta, chiefly reclaimed by Chinese labor, "race and ethnic rotation was practiced with crop rotation," according to Jelinek, as Chinese workers growing fruit, potatoes, onions, or, later, asparagus, transferred to different islands, to be replaced by Italian bean and barley growers, who made way for Portuguese vegetable farmers. White rural reformers "saw Chinese labor as the single most important roadblock to the end of land monopoly," and supported the Chinese exclusion acts of 1882, 1892,

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[120]Gilbert C. Fite, *The Farmers' Frontier, 1865-1900* (New York: Holt, Rinehart and Winston, 1966), 158-159.
[121]Fite, *Farmers' Frontier,* 161.
[122]Henry George, "Our Land and Land Policy," in *The Complete Works of Henry George: Our Land and Land Policy: Speeches, Lectures and Miscellaneous Writings* (New York: Doubleday Page & Co., 1871, repr.1904), 68,
http://archive.org/stream/completeworksofh08georiala/completeworksofh08georiala_djvu.txt.
[123]Fite, *Farmers' Frontier*, 163.
[124]Fite, *Farmers' Frontier*, 167.

and 1902 that effectively eliminated Chinese workers from California agriculture by the beginning of the twentieth century.[125]

Although access to land and water were particularly contested in California, the issue of monopolies and concentration of ownership was at the front and center of American political life in the late nineteenth century. In his account of the transcontinental railroads and the anti-monopolist revolt against them, historian Richard White argues that in the nineteenth century most Americans believed the Jeffersonian idea that the development of an economy should serve the purpose of a democratic citizenry.[126] The democratic intention to broaden access to higher education embodied in the Morrill Act is consistent with that belief, as was the Homestead Act that provided access to land for small producers. As historian Charles Postel has argued, populist farmers were committed not only to greater egalitarianism but also to modernizing their business practices and to challenging the obstacles that kept them from engaging more fully in global markets.[127] Ironically, however, the practices of agricultural science fostered by the Morrill and Hatch Acts, with their emphasis on increased productivity and efficiency decoupled from concerns about labor and ownership, may have served to erode republican values and economic democracy in the rural landscape by making it easier for large-scale producers to dominate. Despite the initial democratic intent of the Homestead, Morrill, and Hatch Acts, the implementation of these laws was wracked by the tension between agricultural science and socio-political constituencies with a stake in farming, a tension embodied in the conflict over corporate power.

Shadowing the rise in corporate power, reform movements flourished in the late nineteenth century, as "the majority of North Americans embraced an ideal of the greater public good and undertook collective measures to achieve it."[128] The Grangers became the most prominent organization of American farmers in the 1870s. Their push for railroad regulation was part of a developing populist and antimonopolist reaction to "special privileges," including land grants, given by the state to "private entities," particularly corporations.[129] The Grangers' wariness about Morrill Act institutions, for example about the University of California, concerned the degree to which this form of federal support was leveling the economic playing field in favor of farmers (for the Grangers and other white reformers of the era, this generally meant white farmers), especially small, independent producers, and farmers' cooperatives, rather than tilting in favor of elites and monopolistic corporate interests. As indicated by their support of Chinese exclusion, the Grangers and other reform movements, as White and others have pointed out, were "tragically flawed by racial exclusiveness that framed that greater good in terms of white manhood,"[130] even as they sought a more democratic economic system, modern and capitalistic but also more egalitarian.[131]

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[125]Lawrence J. Jelinek, *Harvest Empire: A History of California Agriculture* 2nd ed. (San Francisco: Boyd & Fraser, 1982), 52-53.
[126]See White, *Railroaded*, 513.
[127]See Charles Postel, *The Populist Vision* (Oxford: Oxford University Press, 2007).
[128]White, *Railroaded*, 510.
[129]See White, *Railroaded*, 110-111.
[130]White, *Railroaded*, 510.
[131]See Postel, *Populist Vision*, vii and 4-5.

Hilgard may have believed that the purpose of a thriving agricultural economy was to support a democratic citizenry. However, his focus was on using science to improve the technical practice of farming. His support for agricultural modernization using the latest and best-informed scientific techniques may have put to the side questions about the relationship between economy and democracy, as well as efforts by farmers to organize themselves to improve agriculture. In setting the stage for his celebratory account of Hilgard's career, Edward Wickson, Hilgard's collaborator and successor, characterized the "historical, social, and political aspects" as irrelevant to the "fundamental needs of farming" even though they were "dear to the farmers of half a century ago because they seemed to minister directly to the advancing social dignity and political power of their occupation." According to Wickson's narrative, modern or "far-seeing men" like Hilgard understood, though it was "not widely recognized by farmers themselves," that these "fundamental needs" lay in "increasing and improving production and the greater prosperity … through better understanding of farming materials and methods of their economic relations." He described this epiphany with a metaphor from mechanical engineering: "It was revealed to many at that time … that science could do more for farming than tradition; that the way to improve farming was to put more force into the mainspring."[132] In California and in the plantation South, however, a critical issue was the economic inequality associated with the *absence* of a "farm tradition" of yeoman small-farm owners. By constructing a national narrative of the triumph of agricultural science over the "historical, social, and political aspects of farming," Wickson marginalizes those, such as the antimonopolists and the populists, who sought agricultural progress through modernization *and* greater economic democracy. In other words, in his celebratory account of Hilgard as a leading figure in the bright future of agricultural progress, Wickson dismissed the real opportunities for engagement with critical social issues in agriculture that his mentor had overlooked.

Hilgard's Initial Agenda

In California Hilgard encountered familiar conflicts regarding agricultural education and the organization of Morrill Act institutions. As in Mississippi and elsewhere across the country, controversy raged over whether the land-grant college should be in a separate institution from classical, liberal education. In 1874 the State Grange, along with various mechanics' groups, had vehemently protested the firing of Hilgard's predecessor. In a formal resolution, they complained that, despite the provisions of the Morrill Act, "the Board of Regents has totally ignored the mechanical department of the University of California, and appointed but one Professor of Agriculture," while the Board had appointed nineteen professors and assistants for the College of Letters. Finally, the resolution demanded "in the name of the farmers and mechanics of the State, that the agricultural and mechanical departments … each receive as much money and as much attention as the College of Letters."[133] In response, the Board, disputing the Grange's interpretation of the Morrill Act, claimed that the College "only needs a competent Agricultural Professor to be worthy of the State and the University, and to satisfy all

[132]E. J. Wickson, "Address," in *In Memorium: Eugene Hilgard*, 8.

[133]"Preamble and Resolutions of the Joint Committee from the State Grange, Mechanics' State Council, and Mechanics' Deliberative Assembly," San Francisco, August 8, 1874. In the University of California, Berkeley library, it is bound in a compilation entitled *Pamphlets on Agricultural and Technical Education.*

requirements of the Agricultural community."[134] This was the context for President Gilman's 1874 invitation for Hilgard to deliver short courses on soils and on "household chemistry for women."[135] The Regents' subsequent appointment of Hilgard as professor was in part intended to demonstrate to agricultural interests that the College had something to offer, while at the same time reassuring the existing faculty about the intellectual credentials of the professor of agriculture, for Hilgard "could not be impugned for lack of knowledge of classical point of view and materials."[136]

In Hilgard's early overtures to a "stormy assembly" of "men of some prominence in farming and hostile to the University," he made plain his awareness of California's uniqueness. According to his admiring colleague, Wickson, who was present at the meeting, Hilgard "proposed to use all that he had learned in other lands merely as a help to begin to know California, which he had already perceived was different from any other land in which he had lived and worked." Welcoming the farmers' "help and support" in knowing the land, he claimed that he "wished to work from California outward, not to try to fit old theories to a new state." He told them that "since boyhood he had been studying the rocks, the soils, the plants, to see what was in the soil and in the plant in the hope of matching them up, to get the best crops and the most money in farming."[137] Thus, in plain language, he reassured these "prominent" farmers that, as a scientist, he would be collaborating with them in understanding local conditions to improve production and profits. At the same time, he did not propose to examine the arrangements of land ownership and labor that make for successful agricultural society, even though this was a much-debated issue at the time.

Hilgard told the assembled farmers that "[h]e had always been interested in differences and wanted to see what they were and how they worked in farming."[138] With the move Hilgard encountered agricultural landscapes that differed radically in some respects from what he had earlier experienced. Although he had lived in an arid area of Spain, the summer-dry and low rainfall regions of California were to give impetus both to important scientific investigations and to his recognition of the regional biases of previous work in soils and agricultural science. Moreover, Californians in the 1870s were becoming increasingly interested in exploiting the amenability of the state's climate to the cultivation of crops and fruits difficult or impossible to grow in other parts of the country; Hilgard was to become very involved in helping to foster agricultural industries as varied as viticulture, sugar beets, and persimmons.

Hilgard presented his agenda in a letter to the University President in 1878 about how to spend the appropriation for agriculture. He was eager to develop the potential of the college and the state. He planned courses in "special cultures" covering a range of activities from dairy farming to fruit growing, to be "taught by specialists, fully acquainted with the actual local practice." Consistent with his prior work in Mississippi, he also intended to continue the

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[134]"Reply of the Board of Regents," September 21, 1874. In the University of California, Berkeley, library, it is bound in a compilation entitled *Pamphlets on Agricultural and Technical Education.*
[135]Scheuring, *Science and Service*, 27.
[136]E.J. Wickson, "Address" in *In Memorium: Eugene Hilgard,* 13 .
[137]E.J. Wickson, "Address" in *In Memorium: Eugene Hilgard,* 11.
[138]E.J. Wickson, "Address" in *In Memorium: Eugene Hilgard,* 11.

'agricultural survey' shown to be "so effectual in conciliating the good will of the agricultural population, and interesting them in the maintenance of the agricultural department of the university." Hilgard credited the survey with "quieting down the Grange opposition to the University." However, this support came at a cost: "The interest excited among the farmers promises to keep us fully occupied with the investigation of special questions of immediate importance."[139]

Hilgard's department, according to his letter, had assembled a collection of "a number of the most widely spread soils of the state."[140] Without the funds or personnel for fieldwork, he solicited "specimens from all over the state, selected by intelligent persons, and accompanied by remarks descriptive of the region of occurrence, &c." as "part of a more comprehensive and systematic examination of the agricultural resources of the state, which we propose to carry on slowly while we must, rapidly and energetically whenever we can." As he explained to one farmer, samples needed to be "carefully taken in strict accordance with the directions given in the pamphlet I mail with this, and accompanied by all the data called for in the same."[141] He preferred samples from uncultivated and undisturbed soils, not from "squirrel holes" or "cattle paths."[142] Growers' failure to provide contextual information for soil samples frustrated Hilgard, as seen in his response to the land developer (and irrigation promoter) James De Barth Shorb.[143] Although "the golden apples of your section are a long ways ahead of any others in this market" and were much enjoyed by his family, Hilgard wrote, the failure to send the "explanatory remarks" with the soils left him "at a loss as regards the quod est demonstrandum. Is there among them the remarkable soil that seems to need no irrigation?"[144] If a soil sample was "representative" of the state, it would be analyzed for free as a matter of public interest.[145]

Another objective, according to Hilgard's letter, was to create a "means of demonstration" with the "establishment of a garden of general and economic botany." In developing a botanical garden at the Berkeley campus, Hilgard was engaging in an important scientific endeavor of the nineteenth century. The University of Pennsylvania and the Michigan Agricultural College also established small botanical gardens. Several decades earlier the "world's first museum of economic botany" had been founded at Kew in London, and the New York Botanical Garden, created in the 1890s, became a center for botanical and ecological research.[146] Before Hilgard's arrival, the Regents had adopted a garden plan for the newly-established campus[147] that, according to Hilgard, mostly lacked "any real usefulness" while providing chiefly "an ornamental park" with multiple specimens of the same species.

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[139]Eugene Hilgard to President, University of California, May 1878, HFP.
[140]Eugene Hilgard to President, University of California, May 1878, HFP
[141]Eugene Hilgard to H.J. Rudisill, 24 May 1878, HFP.
[142]Hilgard, "Soil Investigation," in *General Discussion of Cotton Production*, 57.
[143]On Shorb as developer, see Ian Tyrrell, *True Gardens of the Gods: Californian-Australian Environmental Reform, 1860-1930* (Berkeley: University of California Press, 1999), 106.
[144]Eugene Hilgard to J. de Barth-Shorb, 11 June 1878, HFP.
[145]Eugene Hilgard to E.A. Thomason, 6 June 1878, HFP.
[146]Sharon Kingsland, *The Evolution of American Ecology 1890-2000* (Baltimore: Johns Hopkins University Press, 2005), 62-63.
[147]The University of California did not move to the Berkeley campus until 1873.

Hilgard, by contrast, sought "utility for instruction and experiment as an essential feature" which could be "combined with ornamental features whenever practicable." To accomplish his goals, he demanded "direct control" over the grounds be transferred to him and away from the current gardener. In addition to "a garden of systematic botany … laid out in the form of a five-rayed star," Hilgard planned the development of "a tract devoted to the culture of economically or otherwise interesting plants." Such a garden in this climate would have great potential: "Our climate gives us the opportunity of exhibiting in actual growth, without the expense of plant houses, a wider range of plants from all climates than in any other locality where a botanical garden now exists." Given the campus's "variety of soils and locations," "the reputation of the institution demands that these peculiar advantages should be improved to the greatest extent possible." A final section of the botanical garden would contain "crops or other economically useful plants" with bigger plots that could be used for "culture experiments" and areas for "the plants yielding textile fibers; the root crops; the hay and forage plants generally; the cereals, &c." that would be "instructive, and interesting to visitors." In order to accomplish this grand plan, seeds would "largely have to be procured from their native countries," although he also sought "as full a representation as possible, of the trees and shrubs of California itself."[148]

Under Hilgard's supervision, different varieties of trees, both native and foreign, were planted all around the Berkeley campus. Fruit trees that required hot summers for ripening did not flourish, but many commercially useful plants were tested and propagated in the Garden of Economic Plants, for over two decades a destination for visitors as well as growers and gardeners in search of experimental varieties.[149]

A trained botanist and devoted gardener, Hilgard clearly had great enthusiasm for this project. He was advised on the garden by several distinguished visitors, the Harvard botanist Asa Gray, and Sir Joseph Hooker, Charles Darwin's closest friend and director of the Royal Botanical Gardens at Kew. Gray and Hooker stopped in Berkeley on a botanical expedition through the western United States and may have looked a bit unkempt. As Hilgard described the visit in a letter to his cousin, George Engelmann, "my wife took them for a couple of Grangers when they rang the bell, and told them rather tartly I wasn't there, whereupon Gray, in his courtly manner, handed his and the bar't's [baronet's] card" to her.[150] Not surprisingly, eminent scientists were more welcome, but less expected, at Hilgard's house than California farmers, who demanded so much of his attention.

Hilgard's botanical garden would have had a specific meaning and intent. The gardens at Kew reflected the reach of the British Empire, and the later-founded New York Botanical Garden, funded primarily by wealthy New York industrialists, was intended to establish the independence of American botany.[151] However, the University of California garden, as Hilgard planned it, would not only have illuminated the plant kingdom for students and visitors and

[148]Eugene Hilgard to President, University of California, May 1878, HFP.
[149]Presumably the Berkeley Garden of Economic Plants became less essential after the founding of the University Farm at Davis in 1905; the garden became a building site in 1918. See Scheuring, *Science and Service*, 36-37.
[150]Eugene Hilgard to George Engelmann, 5 May 1878, HFP.
[151]See Kingsland, *Evolution of American Ecology*, 59-60.

provided opportunities for research, but also would have had the purpose of demonstrating the wide range of potential plants, from all over the world, that could diversify the state's agricultural landscape and strengthen the farm economy. Having witnessed, in Mississippi, the environmental and social costs of an extractive cotton-based economy, Hilgard had embraced the notion of an 'agricultural commonwealth' that conserved the fertility of its soils. In the welcoming climate of California, he saw the opportunity to improve the richness of its resources and develop a multitude of farm products to ensure the resilience and stability of the state. Thus the diversity of crops and plants, displayed in the gardens of the public university and enhancing the "reputation of the institution," may have embodied democratic hopes.

Irrigated Lands and Diversification

Access to water was an acute issue in Hilgard's California, but the scale and organizational structure that irrigation would take was not a foregone conclusion at the time of his arrival. By the end of the 1880s, private companies, established mostly by big growers, may have irrigated as many as a million acres. After the Wright Irrigation Act of 1887 authorized the establishment of public irrigation districts, the amount of irrigated acreage increased further as new infrastructure was built.[152] Hilgard saw irrigation of otherwise uncultivable land as a means, though not without problems, to "defer for a long time the unpleasant forecasts made by Malthus" regarding the limits to food production.[153] As a scientist Hilgard was actively engaged in researching the agricultural potential of irrigated soils, and he seemed to retain the hope that irrigation, despite its capital requirements, could support small-scale family farming.

In 1882 Hilgard and two out-of-state experts from Nebraska and Ohio produced a report on the agriculture of the "arid regions of the Pacific slope" commissioned by Congress and completed for the U.S. Commissioner of Agriculture. In the introduction Hilgard noted that the focus on California rather than other regions of the Southwest was justified by how California "realized within the smallest space" the varieties of arid conditions, which "have been longest subject to experiment and experience on the part of an intelligent and enterprising population." The intent was to provide more specific information than had John Wesley Powell's report on Western arid lands four years earlier.[154] Hilgard acknowledged that large-scale irrigation of the sort he and Powell suggested demanded "large capital and co-operative action."[155] But he did not anticipate the degree to which such an undertaking would eventually involve remaking social relations and natural systems.

Deploring the current unsettled state of water rights in California, Hilgard acknowledged the "recent" realization that "water alone is wanting" to make the American deserts produce "whatever crops their climatic position will permit."[156] Noting the great and lasting fertility,

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[152]Jelinek, *Harvest Empire*, 56-57.

[153]Eugene Hilgard, "The Causes of the Development of Ancient Civilizations in Arid Countries," *North American Review* 175 (September 1902): 309-315, 315.

[154]Hilgard, E.W., Jones, T.C., and Furnas, R.W., *Report on the Climatic and Agricultural Features and the Agricultural Practice and Needs of the Arid Regions of the Pacific Slope with Notes on Arizona and New Mexico* (Washington: Government Printing Office, 1882), 4.

[155]Hilgard, "Irrigation of the Arid Region," in Hilgard, Jones, and Furnas, *Report on Arid Regions*, 24.

[156]Hilgard, "Irrigation of Arid Region," in Hilgard, Jones, and Furnas, *Report on Arid Regions*, 29.

with proper management, of irrigated soils, Hilgard recommended an eighty-acre unit for farms in irrigation districts, half the size advocated by Powell, on the grounds that "the more complete and systematic utilization of the soil's powers" would allow "a smaller area to subserve the needs of a family."[157] In irrigated lands, he argued, "farming becomes a much more safe, satisfactory, and paying occupation,"[158] implicitly imagining that commercial agriculture in California could be conducted by family farms. After this endorsement he turned to alkali soils, recommending practices such as flooding and draining to manage and mitigate the problem of mineral efflorescence. Cotton, root crops, and fruits would do well in alkali soils, the latter two profitable especially if they could be dried for shipping. Cereals would not flourish, and this would be a good thing for soils and rural society. "[T]he necessity imposed by nature, of more varied and careful farming than has heretofore obtained, may . . . prove a blessing in disguise," as it would divorce farmers from reliance on soil-depleting wheat. Distinguishing between "planting" and "farming," he notes that "[t]he planting system enriches a few individuals, almost always at the cost of the soil's permanent productiveness." By contrast, scientifically informed farmers could sustain the agricultural commonwealth: "It is small farms and intelligent culture that constitute the prosperity of an agricultural community."[159] Small farms, one of Hilgard's co-authors of the *Arid Lands* report argued, could be worked by a family, aided by a few hired men or women "not regarded as inferiors." Thus the establishment of "diversified agriculture" on small farms, where hired labor was subsumed in the household, would eliminate the "distinct classes of proprietors and laborers" characteristic of areas with large landholdings.[160]

Clearly Hilgard believed that diversified, small-scale farming was better for soils and society than single-crop plantation agriculture, as did many of his contemporaries. But while he celebrated the former and disparaged the latter, his scientific work helped farmer and planter alike. In his report on California for the cotton census of 1880, he reiterated "the general rule that the greater variety of crops and industries of a country the more independent and the less liable it is to crop failures of a general character." Specifically, he argued for "the partial substitution of cotton for wheat" as less "exhaustive of the soil," in part because of its suitability for irrigated, alkali soils and also because "its own seed regularly returned to the soil" would constitute adequate "manure." In the short term, labor for cotton-picking would be a problem because "white men will not pick, and not many Chinamen were found that could." However, cotton's year-round need for tillage would "serve to secure steady employment, and therefore a steady laboring class."[161] His supervision of the cotton census garnered him well-deserved admiration for its comprehensiveness, but it also facilitated the geographical extension of cotton production, and plantation-style labor practices, to California and the Southwest.

In his "hydraulic" history of the West, Donald Worster describes Hilgard as an

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[157]Hilgard, "Irrigation of Arid Region," in Hilgard, Jones, and Furnas, *Report on Arid Regions*, 25.
[158]Hilgard, "Irrigation of Arid Region," in Hilgard, Jones, and Furnas, *Report on Arid Regions*, 26.
[159]Hilgard, "Irrigation of Arid Region," in Hilgard, Jones, and Furnas, *Report on Arid Regions*, 46.
[160]T.C. Jones, "The Field Crops and Animal Industries of the Pacific Coast," in Hilgard, Jones, and Furnas, *Report on Arid Regions*, 77.
[161]Eugene Hilgard, *Report on the Physical and Agricultural Features of the State of California with a Discussion of the Present and Future of Cotton Production in the State* (San Francisco: Dewey, 1884), 76-78.

"enlistee … in the cause of environmental conquest," in part because of the remedies he had developed (and exported overseas) to address the "salt nemesis" of irrigation. With the benefit of hindsight, Worster notes the harms imposed by these remedies: the flooding of salt-affected lands inflicted ecological damage downstream, and the expense of laying tile drains could overwhelm small-scale farmers. [162] However, Hilgard was more cautious about the benefits and aware of the costs of irrigation than developers and settlement promoters were, and more balanced than Worster gives him credit for. In the *Arid Regions* report, Hilgard provided detailed chemical analyses of the quality of the lakes and rivers of the Central Valley to assess their suitability as sources for irrigation water.[163] Citing reports of alkali damage on irrigated but undrained lands in India, he concluded that the "facts as nature has made them should be elicited and plainly set before the people, so that money may not be invested in useless undertakings or damage done which it may be difficult to undo thereafter."[164] As the government scientist, his responsibility was to uncover the information to guide the decisions of the public.

Perhaps in an attempt to develop a theoretical basis for associating irrigation with democracy, Hilgard also developed in a short essay the historical hypothesis that irrigation of fertile desert lands, by requiring social co-operation for the "establishment and maintenance of . . . canals," served as the basis for a "high degree of social organization" and, hence, "highly complex polities" in the ancient Middle East.[165] (Others have associated the history of irrigation, especially on a larger scale, with despotism.[166]) He concluded his essay with the hope that the resurgence of irrigation in the current-day Middle East, together with the arrival of the railroad, would improve "civil and social piety."

Because Hilgard believed that irrigated farming of desert lands required little or no supplementary fertilization, it seemed preferable to the "intense production of foodstuffs now resulting from the copious use of fertilizers in the humid regions."[167] He would likely have characterized his promotion of farming on arid lands as aiding a more sustainable way to supply food and fiber to a growing population. Ironically, the intensive production of fruits and vegetables in California, facilitated by irrigation, required the increased use of hand labor, generally performed by disenfranchised immigrants, just as farm labor needs in other parts of the country were decreasing due to mechanization. And so, despite his hopes for irrigation as a method for promoting family-scale farming, California's conditions encouraged the production of crops demanding labor beyond the scope of family farms to supply.

In his support for irrigated, small-scale farming, Hilgard was engaging with a significant environmental movement of the time. In his study of the "Pacific exchange" between California

[162]Donald Worster, *Rivers of Empire: Water, Aridity, and the Growth of the American West* (New York: Pantheon, 1985), 153.
[163]See Hilgard, "Irrigation of the Arid Region," in Hilgard, Jones, and Furnas, *Report on Arid Regions*, 50 ff.
[164]Hilgard, "Irrigation of the Arid Region," in Hilgard, Jones, and Furnas, *Report on Arid Regions*, 58. See also Tyrrell, *True Gardens of Gods*, 106.
[165]Hilgard, "Ancient Civilizations," 314.
[166]See Worster, *Rivers of Empire*, chapter 2.
[167]Hilgard, "Ancient Civilizations," 315.

and Australia, Ian Tyrrell described the diversified, Jeffersonian horticultural ideal that was associated with the promotion of irrigation for small-scale settlement. This ideal of diversification was associated with the acclimatization movement of the mid- to late-nineteenth century, a movement concerned with introducing non-native species to improve the environment for both aesthetic and economic benefit.[168] The ubiquity in present-day California of Australia's eucalyptus, which (as Hilgard already realized in the late-nineteenth century) was "'a miserable failure' for timber,"[169] serves as an ongoing reminder of the acclimatizers. Of course, ideas about acclimatization and practices of species introduction date back much further. Jefferson had asserted that the "greatest service which can be rendered any country is, to add an useful plant to its culture,"[170] and he himself had introduced a number of new species and varieties to his Virginia home. Hilgard's embrace of this tradition in agricultural science points to yet another of the tensions his work in California embodies – the relationship between the universal aspirations of science and the peculiar localism of agriculture.

The Beginning of the Agricultural Experiment Station: Science and Local Needs

Because California was "naturally different," according to Wickson's account of the early years of the College of Agriculture, newly-arrived immigrants became convinced that "California's great products should consist of semi-tropical specialties, not producible elsewhere in the United States."[171] Given the "pressure toward diversified knowledge," Hilgard and his colleagues were forced to "take up a bargain-counter business, by research into foreign records, by local observation, and by current experimentation, which would supply … a throng of patrons each with the particular goods which he conceived to be desirable."[172]

In Hilgard's first years at Berkeley, much of his work was indeed driven by the demands of "doing as much as possible of whatever the public demanded,"[173] making for a kind of retail research science. For example, when a Mr. Ashburner asked about possible profits to be made from limes, Hilgard responded at length. "The market for lime juice here is quite limited," he wrote, and supplied by imports "from Tahiti chiefly," providing an opening for a California supplier. He was more enthusiastic about "citric acid … a very promising industry," although the manufacture of citric acid required "rather more technical knowledge & skill, and a more costly plant than can be afforded by anyone save a chemical manufacturer working all the year round." An even better option might be to make an "intermediate product, viz. the citrate of lime" that required little more equipment than "that needed for canning juice." Fruit in need of a market, limes provided abundant opportunities. "Already Los Angeles is at a loss" as to "what to do with all the limes from the hedges," Hilgard noted. "More are being planted in that way

[168]See Tyrrell, *True Gardens of Gods*, 21-26, for discussion of the promotion of acclimatization by nineteenth-century American conservationist George Perkins Marsh.
[169]As quoted in Tyrrell, *True Gardens of Gods*, 78.
[170]As quoted in Tyrrell, *True Gardens of Gods*, 23.
[171]Aside from the Panhandle, Florida was sparsely populated in the late nineteenth century, with commercial agriculture focused on sugar and cotton.
[172]E.J. Wickson, "The Beginnings of Agricultural Education and Research in California," *Annual Report of the Director, University of California Agricultural Experiment Station, 1918*, 41-42, as quoted in Scheuring, *Science and Service*, 36.
[173]Wickson, "Beginnings of Agricultural Education," in Scheuring, *Science and Service*, 36.

constantly; so that the material will be abundant" and otherwise wasted. He concluded the letter by prodding his correspondent: "what do you say to going into the business?"[174] Providing market analysis and consultation, Hilgard embraced the role of promoting California's potential farm industries.

As the funding and organization of the experiment station improved, Hilgard and his colleagues were able to shift from retail to wholesale operations, moving from the provision of individually oriented advice to conducting systematic research on common agricultural problems.[175] Hilgard's efforts on behalf of the state's wine industry were among his most important and celebrated. Although immigrants had been growing vines in California for years, the quality of the wines had been variable and the better wines were often sold under "foreign labels" in order to get better prices.[176] Shortly after Hilgard's arrival he prepared a lecture on phylloxera, prompted by an outbreak in Sonoma County, that was published in 1876 as Bulletin 23 of the university.[177] Four years later, in a long letter to state senator Nye, he pleaded eloquently for the passage of a law establishing a Board of State Viticultural Commissioners and appropriating funds for research on grapes and wine.

Given the market opportunity offered by the spread of phylloxera in Europe, Hilgard wrote, California was in a "critical period" upon which would "depend the rapid or slow development of one of the greatest and most promising industries of the state." Citing the perfect suitability of the state's "climate and soil" for vine-growing, Hilgard asserted that "once its products shall have found a definite place and rank in the markets of the world, nothing short of gross mismanagement could thereafter cause its precedence to be disputed." However, thus far Californians had produced good wine "only by fortunate accident." The "slow process of individual experimenting is quite inadequate," he explained, to ensure long-lasting and consistent quality. Instead, state support was required for "systematic and scientific investigation by competent persons" to create the basis of knowledge on which viticultural industries could succeed. For a crucial example, he noted that growers needed to "know, and that quickly, which of the 2500 grape varieties they shall choose" in order to "add untold millions to the wealth of the state."[178] Thanks in part to Hilgard's advocacy, the law passed, beginning a pattern of ongoing state support for viticultural research at the university. In the opinion of several scholars a century later, "[p]robably no other agricultural industry in any country has been as well served in research and extension by a public institution as the grape and wine industry of California has been served by the University of California."[179]

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[174]Eugene Hilgard to Mr. Ashburner, 21 March 1878, HFP.
[175]See Mary Lee Mayfield, "The University of California Agricultural Experiment Station, 1868-1924" (master's thesis, University of California, Davis, 1966), 35.
[176]Vincent P. Carosso, *The California Wine Industry 1830-1895: A Study of the Formative Years* (Berkeley: University of California Press, 1951), 25.
[177]Maynard A. Amerine and Herman Phaff, eds., "Preface," in *Bibliography of Publications by the Faculty, Staff, and Students of the University of California, 1876-1980, on Grapes, Wines, and Related Subjects* (Berkeley: University of California Press,1986), vii.
[178]Eugene Hilgard to S.G. Nye, April 3, 1880, HFP.
[179]Amerine and Phaff, "Preface," in *Bibliography on Wines*, ix.

Who was benefiting from or being served by the experiment station's activities? According to Mayfield, most of the letters by 1885 were not exchanged with small-scale farmers but with people interested in horticulture or scientific farming as a hobby and with large-scale growers and ranchers. The soil samples sent in to the station tended to come from farms of over 160 acres.[180] This may reflect who had the time, skills or resources to seek scientific advice, but it also marks a more widespread issue in land-grant agricultural research across the country. As historian of science Charles Rosenberg described it, "[t]o accept the ultimate worth of applied research in mid-nineteenth-century America was necessarily to accept the constraints of working with and through an economically oriented client constituency," especially people of power and influence.[181]

The College of Agriculture reached out to a broader swath of farmers in a different way. In 1890, the State Grange requested that the University's Board of Regents authorize Farmers' Institutes. Pioneered in the Midwest, these educational conferences were co-sponsored by land-grant colleges and community institutions. Using funds from the 1890 Morrill Act, the institutes, featuring experiment station researchers, served as the foundation of agricultural extension in California. Not surprisingly, the topic of the first one, in 1891, was "Alkali: Its Causes and Remedies."[182] Hilgard frequently complained in his letters about the burden of the Farmers' Institutes, but they did spread scientific knowledge, foster rural development and draw support for the college and the experiment station.

Although the university's experiment station was not fully responsible for these developments, the period of Hilgard's tenure coincided with the rapid transformation of the state's agricultural economy from extensive grain-growing and ranching to include the intensive cultivation of fruits, vegetables, and nuts, which constituted nearly one half of the state's farm output by the time of Hilgard's retirement. In a pattern very different from what was happening elsewhere in American agriculture, this change meant a decrease in average farm size and an increase in labor needs: "the shift to more labor-intensive crops overwhelmed the effect of mechanization."[183] Although, as noted above, the availability of cheap labor and the expansion of irrigation also speeded this transformation, one prominent factor was the "biological 'learning' about how to grow crops in the California environment" that would triumph in domestic and international markets.[184] In a partial fulfillment of Hilgard's ideas, crops and plants better suited to California's environment were being cultivated, resulting in farms of lower average acreage. The asexual propagation of fruit trees and vines enabled a rapid extension of orchards and vineyards.[185] As Olmstead and Rhode point out, "California attracted immigrants from all over the world who brought a diverse pool of biological knowledge suitable to the

[180]Mayfield, "Agricultural Experiment Station," 37.
[181]Charles E. Rosenberg, *No Other Gods: On Science and American Social Thought*, rev. and expanded ed. (Baltimore: Johns Hopkins University Press, 1997), 150.
[182]Scheuring, *Science and Service*, 44-46.
[183]Alan Olmstead and Paul Rhode, *Creating Abundance: Biological Innovation and American Agricultural Development* (New York: Cambridge University Press, 2008), 225-226.
[184]Olmstead and Rhode, *Creating Abundance*, 227-228.
[185]Olmstead and Rhode, *Creating Abundance*, 240.

state's environmental niches."[186] Although private horticulturalists and plant breeders such as Luther Burbank played an important role in importing and developing new varieties, Hilgard and his colleagues at the university and experiment station were also deeply involved in this process and fostered this 'biological learning.' The experiment station introduced and propagated new species. For example, in 1881 Hilgard obtained seeds of various species of Australian saltbush (*Atriplex*) from the German-born botanist Ferdinand von Mueller in an effort to redress the salt problem on irrigated lands; by the 1890s, thanks in part to the distribution of seed by the Tulare substation of the experiment station, saltbush was widely planted on alkali soils for fodder.[187]

Of course, the uncontrolled and widespread introduction of a diversity of non-native species was associated with the arrival and proliferation of multiple pests and diseases that required considerable attention from experiment station researchers. These threats were exacerbated by the lack of natural enemies and the "concentration of agricultural production" such that "by the 1870s and 1880s a succession of mysterious invaders" endangered the "commercial survival of most horticultural commodities." According to Olmstead and Rhode, university and government scientists made "stunning breakthroughs" in developing methods and plant varieties to combat these dangers. When the phylloxera aphid threatened to cripple the state's wine industry, Hilgard helped to pioneer the expensive but successful method of grafting European grape varieties onto American rootstock to resist phylloxera, thereby helping to save viticulture in California and worldwide. This important work built legislative funding and support for the College of Agriculture.[188] Although biological control through the importation of natural enemies to introduced pests was often successful, it was not in all instances, and chemical methods were also developed, fostering the growth of the pesticide industry.[189]

An examination of the twenty-four AES bulletins published between 1900 and 1903, close to the last years of Hilgard's tenure as director, indicates the significance of pests and disease in the research and outreach of the Agricultural Experiment Station. These bulletins were disseminated widely to newspapers and farmers in the state. Ten of the bulletins addressed issues such as alkali tolerance, soils of the Salton basin, "culture work" at the six substations, and the feeding of farm animals (recall Hilgard's outburst thirty years before, at the agricultural college meeting, against a treatise on the feeding of pigs!). However, the majority, fourteen of the twenty-four, concerned the identification, control, and mitigation of plant pests and diseases. This included topics ranging from phylloxera to "orange and lemon rot" to "arsenical insecticides."[190]

Public science, as well as state regulatory actions such as quarantine and inspection, played a crucial role in "plant protection" efforts. As Olmstead and Rhode point out, private initiatives alone would have failed to provide the "public good" of pest control. Instead, the College of Agriculture and experiment station through research and outreach, together with the

[186]Olmstead and Rhode, *Creating Abundance*, 239.
[187]Tyrrell, *True Gardens of Gods*, 72.
[188]See Olmstead and Rhode, *Creating Abundance*, 241-243.
[189]See the discussion of San Jose scale in Olmstead and Rhode, *Creating Abundance*, 248-252.
[190]*University of California Agricultural Experiment Station Bulletins 130-153* (Berkeley: University Press, 1900-1903).

USDA, filled that role.[191] As Mayfield notes, despite Hilgard's and his successor's resistance, the station even served for some time in a regulatory capacity, as a "police agency" entrusted with quarantine and other control measures, until the state Department of Agriculture was established.[192]

In the early decades of the experiment stations of the East, Midwest, and South, the testing and regulation of fertilizers, rather than pest and disease control or germplasm improvement, was a key function and the primary reason for farmers' support. In a letter to Samuel Johnson, the Yale agricultural chemist and founding director of the Connecticut experiment station, Hilgard wrote: "I have been forcibly struck with the contrast between the line of work that is asked of you and that which comes to me— It is exceedingly characteristic of the respective stages of agr. development in the two regions."[193] Nevertheless, farmers in California had some interest in fertilizers. Hilgard wondered when Johnson, the author of the popular texts *How Crops Grow* and *How Crops Feed,* would write "that Vol. III— 'How crops should be fed.' The subject of manures is among the most misty in the farmers' minds, and I wish you would save me the trouble of writing it myself!"[194] Johnson's reply underscored his belief in agriculture's need for scientists: "I don't know as anyone can help the farmer much on the manure question. It requires a course of Calculus to give the discipline needful to understand it."[195]

Initially, colleges of agriculture and experiment stations served multiple functions: not just regulation and research but also policy development, education of students and farmers, and public relations, to say nothing of fertilizer analysis and market consultation (think of the lime juice question). But as land-grant institutions and state and federal agricultural agencies became more differentiated over time, these functions were clarified and divided up. The research function was much strengthened by the passage of the Hatch Act in 1887 that, as described in Chapter 1, provided permanent federal support for a nationwide system of agricultural experiment stations affiliated with land-grant universities.

Agricultural scientists had pushed hard for such legislation. Part of their motivation was to bypass the difficulty of securing consistent and sufficient research funding from state legislatures. As Hilgard complained, "I am getting heartily tired of my biennial fight for existence."[196] He congratulated Samuel Johnson of Connecticut for his 1881 Experiment Station Report, adding a note of indignation. "You have done a wonderful amount of work with your $5000; but it makes one almost have the mad-itch to think of this pittance allotted to such work as this, when millions are wasted, and worse than wasted, in merely bolstering up old and new political hacks every year." After alluding to his own two-part essay, soon to appear in the April and May, 1882, issues of the *Atlantic Monthly*, Hilgard called for "a concerted movement on the part of the Agr. College and Exp't Station men and their appreciators" in support of

[191]See Olmstead and Rhode, *Creating Abundance,* 252-258.
[192]Mayfield, "Agricultural Experiment Station," 64-65.
[193]Eugene Hilgard to Samuel Johnson, 10 March 1882, HFP.
[194]Eugene Hilgard to Samuel Johnson, 10 March 1882, HFP.
[195]Samuel Johnson to Eugene Hilgard, 1 April 1882, HFP.
[196]Eugene Hilgard to Harvey Wiley, 29 July 1885, HFP. See also Rosenberg, *No Other Gods*, 165.

national legislation so that "we may all be enabled to work to some advantage, instead of gnawing our lips in disgust."[197] Hilgard and his colleagues nationwide clearly saw the advantages of systematic federal funding not just for agricultural education but also for long-term programmatic scientific research.

In the *Atlantic* essays, Hilgard invoked the language of national crisis to build public support for legislation funding agricultural research: the "inevitable and rapidly swelling wave of soil exhaustion sweeps westward."[198] Reviewing the arguments he had long made for the importance of scientific education in "rational agriculture," he made the point that the unenlightened practices of ordinary farmers would continue to damage the country's natural resources until farmers saw the economic advantage of applying agricultural science: "unless the 'improvement' of agriculture means *making it more profitable*, it will be of little avail to preach and teach it." The open frontier had hampered efforts to improve farming practices, despite agrarian inclinations: "[S]o long as unexhausted soils and an abundance of 'fresh' land shall enable the cultivator to obtain, even by the rudest tillage, what he considers abundant returns, his interest in agricultural improvement and education will be … more sentimental than practical."[199] However, the country was living on borrowed time: "the accumulated soil treasures of many ages" chiefly responsible for America's agricultural success "cannot hold out forever." The process of "soil devastation" had been hastened by "[t]he great perfection attained by agricultural implements for large-scale culture, under the hands of American inventive skill." It was imperative for the nation to maintain "profitable productiveness by means of systematic culture and returns to the soil." Whether the agricultural "menace" could be forestalled depended on "enlightened government action, in the face of the already inveterate bad habits of the vast majority of American farmers … promptly adopted by the European immigrant." Citing the example of the injury wrought by the monocropping of cotton, Hilgard took the government, and the nation, to task for failing to prevent soil exhaustion: "Such a crying evil as this would hardly have been allowed to exist so long in any country less averse to the least semblance of paternal government." The failure of "paternal government" had meant "the ravaging of the virgin soil."[200] In short, the government needed to devote its current economic resources to scientific research to make agriculture profitable as well as sustainable; Hilgard reasoned that this was the way to conserve the resource base for the nation's future prosperity. He may thus have believed that the government's agricultural research and policy should favor more efficient large-scale production rather than social and economic equity in farming.

Hilgard believed in the efficacy of an interventionist, expert state. As a civil servant he favored a scientifically-guided public policy of agricultural development and improvement. On the national level, he argued that the Department of Agriculture not be promoted to the Cabinet level (as it was in 1888) but remain under the direction of an expert civil servant, who would be judged by fellow scientists rather than in the political arena. (In 1889, Hilgard gave up an

[197]Eugene Hilgard to Samuel Johnson, 10 March 1882, HFP.
[198]Eugene Hilgard, "Progress in Agriculture by Means of Education and Government Aid II," *Atlantic Monthly* 49 (May 1882): 651-652.
[199]Hilgard, "Progress in Agriculture II," 651.
[200]Eugene Hilgard, "Progress in Agriculture by Means of Education and Government Aid I," *Atlantic Monthly* 49 (April 1882): 532.

opportunity for greater national influence by turning down an offer to become the first Assistant Secretary of Agriculture, in charge of the USDA's scientific work.[201]) After the passage of the Hatch Act, Hilgard argued for a decentralized, cooperative national system of experiment stations, for which the federal Department of Agriculture "digested and systematically set forth and correlated work"[202] and did business abroad, while the state experiment stations developed their own research agendas based on local needs. In an 1893 letter to Charles Dabney, the newly appointed assistant secretary of the USDA, Hilgard called it a "fatal mistake" "that the Dep't should have power to prescribe certain experiments to be made by the stations." It lacked "the knowledge of actually existing conditions in each state … necessary to … make such prescriptions advisedly and successfully." He dryly noted that the USDA was still sending its annual seed distribution to California after planting season, including seeds inappropriate for the climate, while "cottonseed and similar semitropic products have impartially been sent to Massachusetts." Given "the absence of elaborate agricultural surveys of all the states," the Department could not "possibly be acquainted" with myriad "local conditions."[203]

Hilgard oversaw the establishment of six substations to supplement the work of the Central Station in Berkeley. Intended to address the specific issues of different climatic regions of the state, they all closed within ten years or so of their founding due to funding and staffing problems.[204] Even after the passage of the Hatch Act, with its emphasis on scientific research rather than constituent service, Hilgard continued to see the value of direct interaction with the public: "I do not believe that a station so situated ought to make it their business to pursue recondite studies in vegetable physiology or animal chemistry, unless they have first satisfied this legitimate demand."[205] Unlike scientific researchers in some other fields, he thought his work should provide immediate and direct as well as long-term benefit for the public.

Anti-monopolists in the late nineteenth century were concerned about the use of public resources for private benefit. Hilgard was employed by public institutions for his entire career, generating knowledge for public use, unlike many American scientists, especially of an earlier era, who were supported by private wealth or institutions. However, like many of his government-scientist contemporaries, he did some private work on the side, starting in his earliest days in Mississippi. At the University of California Hilgard policed the boundary between public and private, assessing whether work he was requested to do by farmers, such as soil analyses, would be in the public interest or merely for an individual's private benefit. Given funding issues, Hilgard sought and received funding for experiment station research from commodity boards and industry groups but he strove to maintain his independence.[206] He differentiated the role of the government scientist from that of private researchers and developers in agricultural science. For example, in a letter about a proposed text on legumes, Hilgard

[201]See Amundson, "Philosophical Developments," in Warkentin, *Footprints in the Soil*, 150.
[202]Eugene Hilgard to Charles W. Dabney, 28 December 1893, HFP.
[203]Eugene Hilgard to Charles W. Dabney, 28 December 1893, HFP.
[204]See Scheuring, *Science and Service*, 40-41.
[205]Eugene Hilgard to A.C. True, 10 June 1896, HFP. See also Rosenberg, *No Other Gods*, 193.
[206]Scheuring, *Science and Service*, 47; see also Christopher R. Henke, *Cultivating Science, Harvesting Power: Science and Industrial Agriculture in California* (Cambridge: MIT Press, 2008), 56, on how commodity boards and large growers continue to fund extension research.

suggested a "general" treatment of peas and beans, rather than a discussion of commercial varieties, "considering the difficulty of steering clear of the private interests of propagators and seedsmen."[207]

Given his efforts on the public's behalf, Hilgard was incensed when, in response to his request for a leave of absence after 17 years of teaching and administration, one of the Regents insinuated that his "ill health" might be due to "over-exertion" from his work for "private parties" and further suggested that the University might pay him less because of this outside compensation. In response, Hilgard defended this "private work" (which, according to the Regent, included his supervision of the U.S. cotton census of 1880) that was primarily undertaken during his university vacations. He explained that, because the university provided no funding for research or collecting trips, private contract work gave him the opportunity to do fieldwork and thereby further science. He asserted that "all the PERSONAL knowledge I have of the state's agricultural and physical features" was gained in work of this kind, without which the advice he gave to farmers would "rest on hearsay." "Such 'private' expeditions," for example, enabled the entirety of his work on alkali soils, "including the establishment of a new industry— that of mining and preparation of gypsum for agricultural use." His payment was justified because he "gave his vacation time to it, and materially benefited a private party or corporation thereby, even though I did at the same time a part of the … agricultural survey, not only of the state but of the whole United States." To conclude, Hilgard asked if "the University was "injured or benefited by this work."[208] Granted the leave, Hilgard spent the 1892-93 academic year in Europe where, among other things, he prepared a "Report … on European Agricultural Schools and Experiment Stations."[209]

Some of Hilgard's private work had been done for Henry Villard, born Heinrich Hilgard, a cousin and railroad tycoon described by Richard White as "a superhero of bad management."[210] Villard hired Hilgard to head the agricultural division of the Northern Transcontinental Railroad Survey, which involved several summers of fieldwork, from 1881 to 1883, in the northern Rockies and Pacific Northwest. With celebrations attended by guests including Ulysses S. Grant and the father of German intellectual Max Weber, the Northern Pacific transcontinental link was completed in the summer of 1883, shortly before Villard's railroad company suffered massive financial collapse, requiring a bailout.[211] In a letter to his brother Julius, Eugene made note of the impact: Villard's "déchéance"— fall or humiliation— thanks to the "bears of Wall Street," and "the consequent abolition of the Transc. Survey would make a material difference to me." Hilgard was thus quite familiar with the perils and failings of capitalism.[212]

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[207]Eugene Hilgard to Liberty Hyde Bailey, 7 August 1896, HFP.
[208]Eugene Hilgard to Arthur Rogers, 7 February 1892, HFP.
[209]"Report of Observations Made on European Agricultural Schools and Experiment Stations," in *Report of the Work of the Agricultural Experiment Station of the University of California, for the Year 1892-93* (Sacramento CA, 1893), 27-41; see Scheuring, *Science and Service*, 46.
[210]White, *Railroaded*, 216-217.
[211]See White, *Railroaded*, 220-223. This was the first of two times that Villard bankrupted the Northern Pacific.
[212]Eugene Hilgard to Julius Hilgard, 28 October 1883, HFP.

Despite his efforts on behalf of the university and the state, Hilgard often talked about leaving his Berkeley position. Given how "much vexation" he suffered at the university, he wrote, "I am often strongly tempted to take a business bait held out to me…. I have taken a half-step … by buying me 25 acres of vineyard land near Mission San Jose, where I shall plant grapes in a month or two."[213] Fifteen years later, he reported that he "did not expect more than forty tons, if that much" in his annual grape harvest.[214] He continued to supervise the operations at his vineyard until it was struck by phylloxera, and he sold it.

Hilgard's role as a scientific researcher at a public university was necessarily interwoven with the tensions in the larger society between the public good and private interests, and between democratic citizenship and the economic and social inequity associated with commodity production. These tensions took a particular form in California and in the West. Hilgard was uniquely attuned to the significance of his location to his work in science as well as in politics, as will be shown in the next chapter.

[213]Eugene Hilgard to Otto Hilgard, Thanksgiving Day 1883, HFP.
[214]Eugene Hilgard to A.J. Salazar, 15 September 1898, HFP.

Chapter 4
The Reach and Outreach of Agricultural Science

If modern science aspires to produce knowledge that is universal and abstract, the practice of agriculture has generally been seen as more local, connected to the soils, climate, and labor that produce food and fiber. However, to varying degrees, agriculture has always had multiple links, both material and intangible, beyond the local— from sources for seed, stock, and water to markets and farming practices. Individually and collectively, farmers have long tried different methods and adapted their practices to changing conditions, but the rise of agricultural science to supplement (or supplant) farmers' knowledge, as discussed in the introduction above, has been comparatively recent.

Agricultural science has occupied a shifting middle ground between the local and the universal, and between the practical and the fundamental or abstract. There have been institutional as well as disciplinary reasons for this middle position. In his account of the debates surrounding the Hatch Act, historian Charles Rosenberg characterizes the work of the older generation of agricultural scientists, including Hilgard and Samuel Johnson, as limited by its responsiveness to local and immediate demands, compared to the more systematic research orientation of the better-funded generations that followed.[215] And indeed, as Hilgard's California career illustrated, he needed constantly to earn the support of the state's agricultural and political interests in order to obtain research opportunities.

But this instrumental understanding of the tension between the local and the universal is complicated by a closer examination of Hilgard's work and thought on the relationship between science and place. Hilgard envisioned his work as moving back and forth between practice and science, as more abstract than merely local knowledge but, at least in some instances, more regionalistic and particular than purportedly universal science. His views on agricultural education, discussed in chapter 2, reflected this approach as well. Appreciating the significance of place, he incorporated into his work a historical understanding both of the relationships among climate, soils, and vegetation, and of the interactions between farmers and the land.

Soils and Place

Hilgard differentiated between pioneers' experience and the "cultural adaptation" to soils developed by more settled communities familiar, from long experience, with the land they farmed. In the introduction to *Soils* (1906), the culmination of his work, he noted that, "from boyhood" on he lived "almost continuously in more or less direct contact with the conditions and requirements of newly settled regions, as well as with those hardly yet invaded even by the pioneer farmer; where the question of cultural adaptation was yet undetermined or totally in the dark."[216] Thus familiar with the margins of European settlement in America (and mostly disregarding the 'cultural adaptations' of prior and current indigenous inhabitants), he had been "constantly called upon to give information and advice to pioneer farmers or intending settlers in

[215]See Rosenberg, *No Other Gods*, 156-166.

[216]Eugene Hilgard, *Soils: Their Formation, Properties, Composition, and Relations to Climate and Plant Growth in the Humid and Arid Regions*, 1911 ed. (New York: Macmillan Co., 1906), xvii. 'Cultural adaptation' refers to adaptive farming practices.

regards to the merits and adaptations of virgin soils," whether in Mississippi or in California, where immigrants' efforts to transfer farming practices from the East had often met with failure. Hilgard reported that his "attention was naturally and forcibly directed toward soil investigation as a possible means of determining beforehand, the general prospects and special features of agriculture in regions where actual experience was either non-existent or very brief and partial."[217] This focus differentiated his work from the tradition of soil investigation in the eastern and southeastern states, in which soil depletion from long periods of intensive European-style farming had been a focus at least since the early Republic period.[218] For his career, the unfamiliarity of uncultivated soils rather than the depletion of long-farmed soils was the impetus.

Hilgard pointed out the limitations of chemical soil analyses, common in the mid-nineteenth century, that were performed by agricultural chemists in laboratories on samples of cultivated, often depleted, soils. These "disadvantageous external conditions" often required investigators to resort to "highly complex and frequently laborious methods and artificial appliances."[219] Instead, to gain knowledge of soils, Hilgard valued field observations, especially in undisturbed settings, 'virgin' landscapes, in which the "native vegetation" resulted from a centuries' long "process of adaptation of plants to climates and soils, by natural selection."[220] Plants growing on virgin soils "present to us an array of ready-made culture experiments whose cogency can rarely be approached by those of our experiment stations within less than a lifetime."[221] He noted the importance of "putting on record … the natural vegetation of the different regions while it exists either in fact or in recollection."[222]

These indicator plants could be a source of farmers' knowledge about soils and help them to adapt their practices: "The observant farmer or settler attaches to each tree or herb a … significance, based upon experience as regards the character and productiveness of the parent soil." In Mississippi, for example, a "productive and durable" soil would be indicated by a preponderance of walnut and wild cherry, while the occurrence of scarlet oak or pine would suggest decreased arable value. However, though potentially rich in contextual information, the knowledge even of settled farmers would likely be inadequate to answer questions about the best "crops adapted to the climate" that "will bring the highest returns and insure the longest duration of fertility under rational treatment." The issue of whether farmers' knowledge was superior to that of agricultural scientists was a common theme in nineteenth-century debates about agricultural improvement. Although Hilgard credited farmers' "intuitive empiricism,"[223] he believed local experience was not enough. Science had a unique analytical capacity to expand on the knowledge of soils in "natural conditions" to explain the distribution and value of soils across landscapes and to improve agriculture. Incidentally, this differentiation of scientific

[217]Hilgard, *Soils*, xvii.
[218]See, e.g., Cohen, *Notes from the Ground*.
[219]Hilgard, *Soils*, xx.
[220]Hilgard, *Soils*, xviii-xix.
[221]Eugene Hilgard, "Soil Investigation," in *General Discussion of Cotton Production*, 57.
[222]Eugene Hilgard to Liberty Hyde Bailey, 9 October 1896, HFP.
[223]Eugene Hilgard, "Soil Investigation," in *General Discussion of Cotton Production*, 56-57.

legitimacy from knowledge gained through farm work may have contributed to the devaluation of farm labor.

In his introduction to *Soils*, Hilgard explained that his experience in a range of climates had led him to rethink the science of soils and to question the generalizability of its findings. Referring to his discovery of the importance of climate in soil formation, he noted modestly that it "is but natural" that his "systematic investigation of soils over so large an area, covering both humid and arid regions, should lead to some unexpected and novel results."[224] As historian James Malin concluded about Hilgard,

> The dry climate of California provided the necessary stimulus, in contrast with both Mississippi and Michigan, to set his creative mind to work upon this unique contribution. Sharply contrasting environments were to an original mind the nemesis of provincialism. His understanding of all soils was sharpened by the experience in contrasts. Hilgard's treatment of the two areas made regionalism significant, whether from the standpoint of soils, geography, or history.[225]

Hilgard argued that the study of soils, so essential to agriculture and human welfare, had failed to advance not only because of the "intrinsic complexity and difficulty of the subject itself" but also due to "accidental, partly historic conditions," rooted in the birthplace of scientific agriculture. Until recently, soil investigations had been almost entirely on the "abnormally temperate, even, and humid climate of middle Europe, with its long-cropped, worn fields, and very predominantly calcareous soils."[226] To the detriment of agricultural progress, in "soil physics … chemistry, and even … vegetable physiology, the observations made" in these "exceptional" conditions "have often erroneously been construed as constituting a general basis for unalterable deductions."[227] What a different course might have resulted, Hilgard remarked, if only "agricultural science had been developed" in multiple sites where native vegetation could have served as a guide for systematic soil investigation. In a similar vein, Hilgard frequently reminded his Eastern and Midwestern colleagues in the land-grant world of their bias toward exhausted soils and well-watered climates "to the detriment of the agricultural experiment stations and of agricultural practice."[228] With his work on soils, he attempted to correct the biases resulting from universalizing on the basis of limited experience.

Global Reach

From his distinctive location, Hilgard developed a more global science. In close contact with investigators around the globe, Hilgard used his position at the Western continental margin of an expanding nation to point out the provinciality of European science. Imperialist expansion and the "carrying of minute scientific research into other regions, now rendered possible by the improved means of communication, has shown the one-sidedness" of older views which apply "only to accidental and rather exceptional conditions."[229] In his "cosmopolitan location" in Berkeley, Hilgard wrote, "whence our students go out directly to all the climates of the world, I

[224]Hilgard, *Soils,* xviii.
[225]Malin, *Grassland of North America*, 218.
[226]Hilgard, *Soils*, xix-xx.
[227]Hilgard, *Soils,* xviii.
[228]See Hilgard, *Soils*, xx.
[229]Hilgard, *Soils,* xx.

find it necessary … to comment upon the tropics and the arid regions with as much emphasis as upon the familiar practices and regime of the Atlantic states and Europe."[230] For example, he advised a Brooklyn, New York, resident about to travel to Guatemala that "the lands on the high plateau … of volcanic origin, are high in plant-food percentages and have been productive without fertilization for three centuries at least but are now beginning to falter."[231] Such long-lasting productivity would not have been predicted by the old soil science.

Hilgard was actively engaged in expanding the Pacific basis for knowledge and commerce. In an 1898 letter to the Secretary of Agriculture, he proposed that one of his Berkeley employees, deployed in the American invasion of the Philippines, gather "agricultural and horticultural" data on "the islands." Hayne, an assistant professor of viticulture and olive culture, could be "very useful and well-qualified" in studying "the methods of culture of the varied products of the Islands and of possible improvements therein, as well as in the industrial preparation of the commercial materials now exported." While hoping that there would be no "actual hostilities,"[232] Hilgard did not appear to find it problematic that this extension of the realm of federal agricultural science would accompany American military domination and serve as the basis for commercial expansion. To Hayne himself, Hilgard wrote enthusiastically: "as we are sure to retain a good sized hunk of the Philippines … you will be in clover so far as the outlook for interesting and lucrative work and investment is concerned; first come first served."[233] In Hilgard's view, the global reach of soil and agricultural science was intended to integrate the world's particularities into a productive system of knowledge; however, it went hand-in-hand with other kinds of global circulation.

Hilgard's "cosmopolitan" orientation to scientific agriculture derived in part from his California location and from his experiences of contrasting environments. For better or worse, he was more likely to detach agricultural production from particular political and social contexts than were some of his land-grant colleagues, including Liberty Hyde Bailey, on whom the Jeffersonian model of yeoman farming had a greater hold.

Hilgard and Liberty Hyde Bailey

Although younger, Liberty Hyde Bailey was one of Hilgard's East-coast counterparts. In fact, after Hilgard's retirement, Benjamin Wheeler, then president of the University of California, pressed Bailey hard to accept the position of Dean at the College of Agriculture. Bailey turned down the post, likely aware that California farmers would not easily accept an Eastern scientist.[234] Professor of Horticulture and Dean of the College of Agriculture at Cornell, New York's land-grant institution, Bailey later was appointed chair of President Theodore Roosevelt's Commission on Country Life in 1908, charged with developing ways to better rural conditions.[235] Despite their shared interest in agricultural science, an examination of the

[230]Eugene Hilgard to Liberty Hyde Bailey, 24 December 1898, HFP.
[231]Eugene Hilgard to N. Ekman, 20 February 1898, HFP.
[232]Eugene Hilgard to James Wilson, U.S. Secretary of Agriculture, 15 September 1898, HFP.
[233]Eugene Hilgard to A.P. Hayne, 15 September 1898, HFP.
[234]Scheuring, *Science and Service*, 60.
[235]After holding nationwide hearings, the Country Life Commission in 1911 recommended, among other actions, the establishment of a nationwide extension service (implemented with the passage of the

cross-country correspondence between Hilgard in Berkeley and Bailey in Ithaca suggests regional as well as philosophical differences and, perhaps, philosophical differences over the importance of region. For Bailey, the family farm, a legacy of prevalent conditions in the rural northeast from colonial times, remained the focus of organization and meaning, while Hilgard's Pacific perspective encouraged him to consider the differentiated wider economy of agriculture.

As the editor of an agricultural book series, Bailey asked Hilgard to write a volume on "Leguminous Plants: Comprising an Explanation of the Processes of Nitrogen-Gathering and Their Place in the Economy of Nature." Bailey explained that while the subject should be "treated from the farmer's side of the fence," the book should "rest upon a basis of fundamental science … bringing right up to date the latest researches of experimenters everywhere." After a discussion of how legumes improve the soil by gathering nitrogen, he wished the book to address the cultivation of specific legumes, their "place in farming systems, rotation of crops, etc."[236] Hilgard expressed interest in the project, but made several suggestions indicating his greater attention to issues of practicality and political economy, both local and global. To the legume's importance in the "economy of nature," he proposed adding the "economy of the farm;"[237] Bailey agreed to this addition. Hilgard further suggested that the book should address the use of commercial fertilizers, long an issue of urgent concern to farmers: "The question of the cheapest supply of nitrogen is so directly involved and is so pressing in view of the Peruvian nitrate syndicate that it would almost require 'dodging' to leave it out." Hilgard argued that it might be "really essential to the practical interest of the book that this wider topic, as well as that of nitrogen-waste ("*Kreislauf des Stoffes* [circulation of matter]"), should be included."[238]

Bailey responded that, while the book series might contain a separate volume on commercial fertilizers, he most desired the proposed work to emphasize on-farm techniques: to "explain the natural processes and philosophy of nitrogen-gathering, and … to enforce the fact that we can, to all intents and purposes, create available nitrogen-fertilizing by the use of judicious cropping and tillage."[239] In a subsequent answer to Hilgard's complaint that Cornell bulletins failed to prioritize "chemical examinations of soils," Bailey insisted that "tillage should come before the application of the plant food."[240] Bailey thus took a position against the use, or at least the routine use, of fertilizers imported from off the farm in favor of developing a tighter loop for nutrient recycling, a localized "economy of nature."

Although Hilgard advised farmers to use manure and crop residues on the farm, he was less sanguine than Bailey was about the universal sufficiency of such on-farm practices to maintain or improve soil fertility, especially as agricultural production intensified. Hilgard

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Smith-Lever Act in 1914) and the continuation of "fact-finding surveys, fostering the development of agricultural economics and rural sociology in universities and the federal government." "Commission on Country Life," in *Liberty Hyde Bailey: A Man for All Seasons* (Ithaca, NY: Division of Rare and Manuscript Collections, Cornell University Library), rmc.library.cornell.edu/bailey/index.html.

[236]Liberty Hyde Bailey to Eugene Hilgard, 3 January 1896, HFP.

[237]Eugene Hilgard to Liberty Hyde Bailey, 12 January 1895 (should read 1896), HFP.

[238]Eugene Hilgard to Liberty Hyde Bailey, 12 January 1895 (should read 1896), HFP.

[239]Liberty Hyde Bailey to Eugene Hilgard, 20 January 1896, HFP.

[240]Liberty Hyde Bailey to Eugene Hilgard, 15 October 1896, HFP.

favored the recirculation of human waste for use in agriculture, but looked to the broader economy to make that happen. After analyzing a fertilizer made from "night soil" that was submitted by a San Francisco manufacturer, he wrote: "I trust that the more extended demand for such fertilizers will in a measure help to stop the enormous waste of valuable soil ingredients that now occurs in our cities." He lamented that the "very essence of fertility of our soils is allowed to escape into the ocean, after polluting the atmosphere and slaying thousands of victims; making a curse of that which should, in the natural order of things, have blessed the soil with renewed productiveness."[241] Hilgard was not unusual for his time in recognizing the "metabolic rift" between waste and the growing of crops.[242] What is notable is that he hoped for a specific market solution to the problem.

After receiving a partial manuscript on legumes from Hilgard, Bailey requested that Hilgard further specify how legumes could be "worked into … the economy of rotations," with particular attention to clover, alfalfa and cow-peas, the latter being "the most important introduction into their [Southern] agriculture of recent years."[243] Responding to an objection from Hilgard that these "field-peas" were "no good" in arid regions,[244] Bailey also agreed to include as a topic "your own plants for the arid regions and the Pacific coast" to "make the book as broad and as representative of the agriculture of the whole country as possible."[245] Three years later, Hilgard finally acknowledged that he was unable to complete the book due to ill-health and eye troubles, but again complained about the "local color" of most farming books "which renders them largely unadapted to the transmississippi [sic] states, say two-thirds of the U.S., not counting the Phillippines [sic]," ceded to the U.S. by Spain weeks before. One such book was "misleading to our farmers, as there is no proviso against it being construed to be of universal application."[246] Bailey "very reluctantly" agreed to drop the legume volume and returned to the question of regional scope raised by Hilgard. "I fully agree with you that we should take into consideration the tropic and semi-tropic conditions in writing our agricultural books," Bailey wrote, but such volumes would not pay. "It is almost impossible to write any books of practice," he conceded, "which will apply equally to such widely different conditions as the humid Atlantic and the arid Pacific regions."[247]

Hilgard and Bailey may have differed with regard to whether the family farm was an essential element of agriculture, as seen in the contrast between Hilgard's last published book and a similar one written by Bailey. Each of the men was dedicated to the education of the young as a way of reforming rural practices and each wrote a textbook for schoolchildren on farming. *Agriculture for Schools of the Pacific Slope*, published in 1911 and co-written by Hilgard and W.J.V. Osterhout, emphasized demonstration and experiment in addressing such topics as "how plants are propagated" and "what water does in soils." Consistent with their

[241]Eugene Hilgard to A. Haas, 16 October 1882, HFP.
[242]See, e.g., John Bellamy Foster, *Marx's Ecology: Materialism and Nature* (New York: Monthly Review Press, 2000), chap. 5.
[243]Liberty Hyde Bailey to Eugene Hilgard, 7 September 1896, HFP.
[244]Eugene Hilgard to Liberty Hyde Bailey, 9 October 1896, HFP.
[245]Liberty Hyde Bailey to Eugene Hilgard, 15 October 1896, HFP.
[246]Eugene Hilgard to Liberty Hyde Bailey, 24 December 1898, HFP.
[247]Liberty Hyde Bailey to Eugene Hilgard, 5 January 1899, HFP.

agricultural science approach, the authors gave a thorough review of the varieties of field crops, orchard fruits, and garden vegetables that may be grown on the Pacific slope, but did not mention the organization of the farm or the labor that might produce the harvest. Some of the photographs, however, depicted farm workers: a crew packing apples in Oregon, for example, and a woman picking olives, accompanied by a small child.[248]

Taking a different approach, Bailey's *School-Book of Farming*, published nine years later, not only covered topics such as "the soil" and "root crops" but also idealized the farm household: "the end and purpose of farming" is not to "grow good crops and raise many animals or solely "to make money," he wrote, but is to "develop the best personal home life." In some ways, Bailey's work refers back to the farmer-led reform movement of the mid-nineteenth century that was based on the premise that rural regeneration would emerge from farm-based changes.[249] Assuming the model of a family farm where "the farm and the home are one,"[250] Bailey offered prescriptive advice on issues from the lay-out of fields to the provision of an office for farm records and a "rest-room for the mother, where she may be at ease and free from annoyance."[251]

For Bailey, a leader in the nature study movement,[252] the farm should aspire to be close to a self-contained system; he tended to play down the commercial aspects of family farming, which even in the northeast had long involved shipping valuable products off the farm. Hilgard saw farming as a more open system, connected with local and global markets. He was not bound by a regional tradition that linked improvement of the family farm with moral betterment and civic virtue. His focus in this book and more generally was consistent, not with an agrarian, decentralized vision, but with the populists' emphasis on modernizing agriculture with the support of government science. Unfortunately, the populists' modernization project, although democratic in some respects, excluded non-white workers, whether in agriculture or other fields. This failing was particularly glaring in California, where the emerging agricultural economy had co-evolved with a large, generally disenfranchised workforce, composed of several waves of immigrant and migrant workers, who would not benefit from the "improvements" that agricultural science promoted.

Because the science of agriculture is an applied science, dedicated to improvements in production of food and fiber, it necessarily engages with the everyday world of farming, land, and labor. This engagement has put agricultural science in a particular position with regard to the world of academic science.

The Place of Agricultural Science Within Science

> [A]griculture… is a science of the very first order. It counts among its handmaids the most respectable sciences, such as Chemistry, Natural Philosophy, Mechanics,

[248]E. W. Hilgard and W.J.V. Osterhout, *Agriculture for Schools of the Pacific Slope* (New York: Macmillan, 1911). For photographs, see 303 and 308.
[249]See generally Marcus, *Agricultural Science*.
[250]Liberty Hyde Bailey, *School-Book of Farming* (New York: Macmillan, 1920), 373.
[251]Bailey, *School-Book of Farming*, 375-376.
[252]See "Nature Study and Rural Education" in *Bailey, Man for All Seasons.*

> Mathematics generally, Natural History, Botany. In every College and University, a professorship of agriculture, and the class of its students, might be honored as the first.[253]

Jefferson asserted that agriculture should be the fundamental science, but in developments over the course of several centuries agriculture became separated from other fields of inquiry, and fell below them in terms of intellectual prestige. The Mayers described the American agricultural complex of land-grant institutions and the USDA as an "island empire," referring to the disciplinary isolation or institutional barriers that kept agriculturally-related sciences so evidently separate from the scientific mainstream by the mid-twentieth century.[254] But in Hilgard's time this separation had not been fully institutionalized, and disciplinary boundaries in science were in flux. On an individual level, Hilgard's scientific career might as easily have followed other paths—for example, at the Smithsonian, where he was given lab space in the 1850s, or fulltime in national survey efforts, like his brother at the Coast Survey, or as a professor of experimental chemistry, as he was initially at the University of Mississippi. If he had stayed on at Michigan, he would have been in the field of natural history and ecology. Even in the path he took, his accomplishments could be distributed into multiple current-day categories.

Agricultural science, and Hilgard's California work, occupied a contested and sometimes uncomfortable middle ground between disengaged research and direct market production. As seen above, much of the initial work of scientists at agricultural experiment stations was driven by specific place-based constituent demands, more than may have been the case for scientists in other settings. At the beginning of the twentieth century the Carnegie Institution funded the founding of a research station near Tucson to be, according to the report recommending the project, the world's first "desert botanical laboratory." The establishment of such a laboratory seemed critical because "the phenomena presented in the adaptations of plants to desert conditions are among the most interesting and significant, from an evolutionary point of view, of any in … botany." Beyond the evolutionary interest, the report offered a utilitarian rationale for the proposed research. It predicted the "enormous development of population and industries . . . bound to take place in our arid region during the next hundred years" that would be based on "agriculture, both with and without irrigation." The laboratory would have the distinctive role of investigating "the peculiar fundamental processes of plant growth" in arid conditions, work "of so general a character, so expensive, and so difficult that no agricultural experiment station has as yet undertaken [it], and there is no prospect that any station will do so." Only when the 'fundamental' work had been done would "the botanists of the agricultural experiment stations in the arid states …be in a position to make a practical application of this knowledge to the special agricultural crops of the region."[255]

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[253]Thomas Jefferson to David Williams, 1803, as quoted in Henry A. Washington, ed., *The Writings of Thomas Jefferson* (New York: Derby and Jackson, 1854) 4:513.
[254]Andre and Jean Mayer, "Agriculture, the Island Empire," *Daedalus* 103 no.3 (1974): 83.
[255]"Report of Advisory Committee on Botany," *Carnegie Institution of Washington Year Book No. 1, 1902* (Washington, D.C.: 1903, repr.1919), 5, accessed March 25, 2012, http://archive.org/stream/yearbookcarnegie01carn#page/4/mode/2up. The committee that prepared the report included Gifford Pinchot. See also Kingsland, *Evolution of American Ecology*, 99-103.

The belief, or the prejudice, of the scientists charged with reporting to Carnegie was that experiment station investigators were too limited, by the lack of independent funding and the immediacy of local demands, to research "fundamental processes." Although Hilgard would doubtless have appreciated the research time and funding afforded those at the desert lab, he did not easily fit into that division of labor, as he moved back and forth between the applied and the more "fundamental."

In some ways, agricultural science has been tainted by its association with economic production and environmental alteration, as contrasted with fields such as zoology and ecology. This may be a reworking of the tension in education, seen in Hilgard's day, between agriculture (and other applied fields) and the liberal arts. But at the end of the twentieth century, as Pauly has argued, university-based biology and genetics, emphasizing "the manipulation of reproduction" put "culture, in its biotechnological meaning, back at the center of biological science." Citing interviews with molecular biologists "disturbed . . . by the idea that products could be as important as fundamental knowledge about nature," Pauly claims that at least some of this recent research has been directed "not toward understanding nature, but toward its manipulation and improvement. Their science is linked to technology, industry, and profits."[256] For agricultural science, 'improvement" had always been the goal, although at public institutions the knowledge produced was public.

The question left open, then, is who benefits from this improvement, who owns it, and who gets to say what kinds of improvements researchers will aim to develop. Hilgard's position – geographically on the margins, and historically coming after the era of romantic, utopian reform – meant he could never fully accept the Jeffersonian model of the independent, self-contained yeoman farm as a satisfactory answer to this problem. He was too aware of the complexity of agriculture, the regional variation of land tenure, climate, and soil, and the presence and significance of the market and market production, to ever accept such a simplistic view. And yet, as adept and perceptive as he was, he was still to some degree a captive of the tensions inherent in this complex system. The efforts he made throughout his long career as a university scientist helping to support the agricultural development of his state were always fraught with these tensions. Hilgard retired from active service to the University of California and the state in 1905, but within a decade, a new program would emerge to advance the aims of Hilgard and others like him on a national scale. Not surprisingly, the nationalized version of this extension program would replicate the very tensions that had shadowed Hilgard's career.

Cooperative Extension: The Smith-Lever Act of 1914

Outreach to farmers constituted a crucial element in the development of scientific agriculture, for research would be of service only through diffusion to practitioners. As required by the Hatch Act, experiment stations published bulletins reporting their research but, perhaps unsurprisingly, these "were less than effective as a teaching device" and did not change farming practices as much as scientists and reformers had hoped.[257] In practice, few working farmers may have possessed the education, time, and motivation not only to acquire and peruse the latest

[256]Philip J. Pauly, *Biologists and the Promise of American Life from Meriwether Lewis to Alfred Kinsey* (Princeton: Princeton University Press, 2000), 243.
[257]Roy Scott, *Reluctant Farmer*, 138-140.

scientific farming bulletins, but to implement their recommendations. This frustration with the pace of diffusion of agricultural knowledge led to creation of yet another element in the federal land-grant system.

Outreach programs, including farmers' institutes, had been conducted by agricultural societies and land-grant colleges in the nineteenth century in order to disseminate new farming practices and knowledge. After the Hatch Act, outreach strategies included cooperative experiments involving research stations and farmers. In the first decade of the twentieth century, the USDA "special agent for the promotion of agriculture in the South,"[258] Seaman Knapp, developed community or 'cooperative demonstration work' for farmers, notably cotton farmers who were battling the boll weevil.[259] At the same time, Booker T. Washington and George Washington Carver of Alabama's Tuskegee Institute were developing the Jesup Wagon to carry seeds, fertilizer samples, tools, and other devices to use in traveling demonstrations for African-American farmers. Tuskegee became "the first college to cooperate directly in Knapp's program." [260] After Knapp's county agent system developed in the South, Northern and Western farm interests pushed for the adoption of similar techniques, and by 1910 support had developed for the establishment of a nationwide agricultural extension system funded at least in part by the federal government.[261]

The Smith-Lever Act of 1914 subsidized a nationwide system that included not only county agents to advise farmers and disseminate the findings of agricultural research but also youth programs and women's home demonstration work. Support for this legislation came not only from the USDA and the land-grant agricultural colleges but also from railroad, food-processing, and trading interests eager to drum up business, with less enthusiasm shown by farmers themselves.[262] Broad public favor was built up by the Country Life Movement, reformers concerned about how to stem the migration from rural areas, where living conditions were poor, to cities, which provided at least the hope of better employment and social and cultural life.[263]

The 1920s have been described as the "golden age" of agricultural extension: county agents demonstrated farming methods, held 'production contests,' and organized social networks that engaged in community improvement projects.[264] Even several decades later images of agricultural extension resonated in popular culture. A colored print from 1948 by Norman Rockwell entitled "The County Agricultural Agent" depicts a white farm family gathered around to observe the agent's examination of a girl's heifer, a 4-H project. In this benign vision, a governmental representative presumably responds to questions and offers advice in the farmyard while grading the project according to productionist standards. However, underlying the

[258]Scott, *Reluctant Farmer,* 210.
[259]See Scott, *Reluctant Farmer,* chap. 8.
[260]Scott, *Reluctant Farmer,* 233.
[261]Scott, *Reluctant Farmer*, 289.
[262]Niek Koning, *The Failure of Agrarian Capitalism* (London: Routledge, 1994), 129; see also Kloppenburg, *First the Seed,* 12.
[263]Scheuring, *Science and Service*, 74.
[264]Scheuring, *Science and Service*, 115-117.

nostalgic appeal of this image, as agrarian activist Wes Jackson points out, is the message that "expertise and youth are central while tradition and experience are peripheral."[265] The outside expert guides the next generation of farmers on the basis of experiment station research, while the farming parents stand aside.

In his study of agricultural extension in Monterey County, California, Christopher Henke discusses the tensions that emerged in this element of the land-grant system:

> Extension work was intended to mend the broken structures and economic conditions of rural life, but no one seemed to agree on what this meant. Science and rational planning were to provide the answer, but what was the question? . . . Mission ambiguity has allowed a whole host of competing influences to shape the direction of extension work.[266]

For example, larger growers often provided funding and resources for field trials, which could mean that the needs of smaller or entry-level farmers would not be met.[267] However, in counties that lacked large commercial farmers, extension agents would be free to focus on other needs. Henke concludes that the "diversity" of extension work demonstrates that it "both shapes and is shaped by the local ecology in which farm advisors find themselves living and working."[268]

In addition to its shaping by the dynamics of local power, cooperative extension also has served, according to Henke, as the local representative of the federal government. "A convenient point of access to rural communities," it "acted as a kind of organizational technology for the state, allowing the implementation of national policies on a broad but also very local scale." The most striking (or egregious) instance of this role occurred during the Second World War, when, thanks to the political power of the American Farm Bureau Federation, the USDA gave county farm advisors the responsibility for expediting the placement of Mexican nationals, prisoners of war, and other workers in order to meet the labor demands of local growers.[269] The extension arm of the land-grant complex, rooted in visions of scientific agriculture and an educated rural citizenry, had become a labor agency.

Eugene Hilgard had spent much of his career focusing on ways to shape the tools and institutions of the state and higher education to solve agricultural problems, focusing on these elements of the complex world of agriculture most responsive to his talents and capacities, and avoiding those elements, like labor and land tenure, over which scientific agriculture had little authority. But these elements of the agricultural complex apparently least amenable to resolution through scientific or technical means would return, ineluctably, and reappear on the margins, beyond the reach of agricultural science.

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[265]Wes Jackson, "On Norman Rockwell's The County Agent," *Land Report* 63(Spring 1999), http://www.landinstitute.org/vnews/display.v/ART/1999/03/01/3aa407b12.
[266]Henke, *Cultivating Science,* 65.
[267]Henke, *Cultivating Science,* 52.
[268]Henke, *Cultivating Science,* 66.
[269]Henke, *Cultivating Science,* 84-86.

Chapter 5
Conclusion:
Assessing the Land-Grant Complex

In the early twentieth century agricultural education flourished, as did the research budget of the Department of Agriculture, making the USDA "one of the greatest research organizations in the world."[270] Additional legislation at the beginning of the century had expanded farming in the west through the 'reclamation' of arid areas and boosted federal funding of state experiment stations. Without question, publicly funded scientific agriculture, embedded in land-grant institutions, was successful in boosting agricultural production. According to agricultural economists, "a number of studies have shown that public funds invested in research by the land grant universities and the USDA have had a payoff in production far surpassing that of any other investment."[271] The rapid diffusion of hybrid corn in the 1930s and '40s to replace open-pollinated varieties and the resulting increases in production are an often-cited example of high returns for public investment in agricultural research.[272] This investment also had profound effects on farming practices and technology, the selection of research problems, plant breeding, and the distribution of benefits of agricultural progress, to say nothing of food availability and quality. Land-grant universities— 'democracy's colleges' – provided an education in agriculturally-related subjects that came to be sought by people from all over the world, and the research and extension system was also emulated internationally.

In Hilgard's California, the Morrill, Hatch, and Smith-Lever Acts made higher education more broadly available and extended research beyond the enhancement of productivity, although the boundaries between agriculture, natural resource management, and the rest of the university continued to be contested and to shift, and the role of extension and outreach to be debated.

However, according to James Scott among other critics, scientific agriculture became a "simple 'production and profit' model of agricultural extension and research" that "failed in important ways to represent the complex, supple, negotiated objectives of real farmers and their communities" and "the profusion and complexity of real farms and real fields."[273] Moreover, the land-grant institutions did not succeed in realizing any recognizable version of the Jeffersonian social vision, underlying the Morrill Act, of independent, educated rural citizens in an agrarian republic. This aspect of the vision was eroded by the overwhelming focus on production in agricultural research and development, and by the absence of significant countervailing efforts to sustain or promote the social and political values that Jefferson endorsed. Congress and state legislatures, by repeatedly funding new agricultural research and infrastructure, have shaped the production of knowledge and the practices of agriculture. Dissenting views in land-grant institutions about 'good' and 'desirable' outcomes for rural communities and for the nation at large have often been muted for political reasons. In this process, national politics of science and nature may have been re-imagined by the trajectory of

[270]Niek Koning, *The Failure of Agrarian Capitalism* (London: Routledge, 1994), 129.
[271]R.J. Hildreth, *Agriculture and Rural Areas Approaching the Twenty-First Century* (Ames: Iowa State Press, 1988), 29.
[272]See Kloppenburg, *First the Seed*, 91-92.
[273]James C. Scott, *Seeing Like a State* (New Haven: Yale University Press, 1998), 262.

the land-grant complex.

Fault Lines in the Land-Grant Mission

> There will be established in the open country plant doctors, plant breeders, soil experts, health experts, pruning and spraying experts, forest experts, recreation experts, market experts, . . . [and] housekeeping experts, . . . [all of whom are] needed for the purpose of giving special advice and direction.[274]

> We are likely, relatively, to overvalue the farmer's production as his contribution to society—the commodities that he raises and provides for the market. His best contribution, immediately, is himself and his family. Or . . . with the long look ahead . . . his chief contribution is to maintain the earth fit for human habitation, beautiful and fertile. And he is the keeper of it . . . . I fear we are in danger of losing something of our ideal, sacrificing it to expertness. [275]

The two somewhat contradictory quotations above come from the writings of Liberty Hyde Bailey of the Cornell College of Agriculture and Roosevelt's Commission on Country Life. Together the excerpts illustrate the tension between, on the one hand, expertise and production in scientific agriculture and, on the other hand, democratic citizenry and stewardship of the land in the agrarian ideal. Despite what many regard as great accomplishments, the land-grant system has been criticized over the course of the past century on multiple grounds, often related to its 'capture' by the interests of private wealth and the politically powerful at the expense of a broader public interest. By the 1950s many questioned who was being served by the system, wondering why American agribusiness— "in some ways the envy of the world"— was being provided "subsidized technical assistance."[276] A related debate, to be discussed further below, concerns the privatization of agricultural research and its significance for the interests of society at large. Many critics have focused on the grim conditions of farm labor, the social impacts of technological innovation, and the environmental and health costs of the input-intensive 'petro-farming' that began after World War II. In the 1960s agricultural economists, hardly known for their radicalism, expressed concerns that the complex was failing in its mission, one noting that the "Land-Grant-USDA System is losing its dedication to the welfare of the entire rural community."[277] As will be discussed below, rural sociologists, funded within the land-grant system, have provided a critical perspective on the trajectory of American agriculture.

Which Public? The Suppression of Dissent and the Narrowing of Knowledge Production

The beneficiaries of the land-grant system have shifted over time. When the land-grant institutions were established, the (chiefly European-American) farmers they were designed to serve made up a significant portion of the population. But, in part due to the success of agricultural science and mechanization in increasing the efficiency of agricultural production, the

[274]Liberty Hyde Bailey, as quoted in Scott, *Reluctant Farmer*, 286-287.
[275]Liberty Hyde Bailey, as quoted in Gordon True, "Response: The Teaching Responsibility of the Agricultural Colleges," *Journal of Animal Science* (1928), 214.
[276]Scheuring, *Science and Service*, 189.
[277]James Bonnen as quoted in Hildreth, *Agriculture and Rural Areas*, 24.

proportion of the population that lived in the country and that worked in agriculture declined steadily. Many of the technological developments (some emerging from land-grant institutions) that improved the productivity of American agriculture also reduced its labor needs, resulting in rural unemployment and migration to cities. At the same time the seasonal labor demands of certain agricultural specialties, such as fruit and vegetables, grew with increased production. The costs of mechanization drove some small-scale farmers out of farming and tended to increase the concentration of land ownership. The benefits of land-grant research and technological progress favored larger farms and business interests, often through deliberately discriminatory practices. The well-documented history of institutionalized racism in USDA programs—what current Secretary of Agriculture Tom Vilsack describes as a "sordid civil rights record at USDA"[278]—as well as discrimination against and failure to meet the needs of agricultural workers and of the poor underscores the narrowness of the 'public' served.

These shifts in the dynamics of rural life are the subject matter of rural sociology. Prompted by the agricultural depression of the 1920s, the Purnell Act of 1925 provided federal subsidies for research, teaching, and outreach not only in agricultural economics but also in rural sociology.[279] Despite the centrality of concerns about rural life to the origins of the land-grant vision, rural sociology was not central to the productionist mission in the USDA- land grant complex and in fact was seen by some to impede that mission. William Friedland considered the issue in a paper entitled "Who Killed Rural Sociology? A Case Study in the Political Economy of Knowledge Production."[280] Written in 1979 but not published until 2010, the paper analyzed the institutional forces that shaped rural sociological research in the mid-twentieth-century.

Friedland provides several examples of inhibited inquiry. A University of California study in the 1960s lost its funding, most likely because it investigated the effects (on the 160-acre limitation for irrigation subsidies, among other issues) of the building of the California Water Project and Interstate 5 in the San Joaquin Valley. A further, well-publicized California example concerned Walter Goldschmidt's nearly suppressed study in the 1940s, originally supported by the Bureau of Agricultural Economics in the USDA, of the effect of farm size on rural communities. (Notably, both of these examples invoke an important element in the Jeffersonian vision, the 160-acre 'family farm' allotment of the Homestead Act that was carried forward into the Reclamation Act of 1902.) Friedland wryly notes the advisability of choosing "topics that do not arouse the ire of powerful, established economic interests." Other studies Friedland identifies as being subject to "social control" within the agricultural research field concerned race relations, class structure in agriculture, and the nutrition and health of farmworkers and their families. The Bureau of Agricultural Economics, Goldschmidt's

[278]As quoted, *New York Times*, July 22, 2010, http://www.nytimes.com/2010/07/22/us/politics/22sherrod.html.
[279]See Alfred True, *A History of Agricultural Experimentation and Research in the United States 1607-1925* (U.S. Dept. of Agriculture misc. publ. no. 251, 1937), 277.
[280]William Friedland, "Who Killed Rural Sociology? A Case Study in the Political Economy of Knowledge Production," *International Journal of the Sociology of Agriculture & Food* 17(1) (2010): 72-88.

erstwhile employer, was dismantled.[281]

Friedland also describes what kinds of work in rural sociology found favor in the twentieth-century land-grant complex, notably 'diffusion research' "concerned with the process by which innovations are adopted by farmers," a subject of particular use to government grant administrators and agribusiness. As Friedland points out, neither research on the factors leading to different kinds of innovation nor research on the social consequences of new technology was funded,[282] even though such work might have led to outcomes that were more socially and environmentally optimal.

Although Friedland focuses on the subdiscipline of rural sociology, his analysis of how knowledge production has been affected by the sponsoring "land-grant network and its clients (or, more accurately … patrons)" illuminates how areas of research become "restricted" and "fail . . . to raise critical questions."[283] The suppression of criticism was not intended by the nineteenth-century shapers of land-grant institutions; in fact, Hilgard had supported the acreage limitations for irrigation subsidies that the disfavored studies above had investigated. However, as the goals of agricultural research and development became more focused on production and more closely connected to corporate interests, the egalitarian element of the original land-grant mission was lost.

Privatization of the Products of Agricultural Research

The tension about the boundary between public and private realms, between government and private capital, threads through the history of American agricultural research and development. As the Supreme Court noted in *Diamond v. Chakrabarty*, a decision that established the patentability of genetically modified organisms, none other than Thomas Jefferson wrote the U.S. Patent Act of 1793 in order that "'ingenuity should receive a liberal encouragement,'"[284] although he could not have foreseen the implications for the involvement of private capital in agriculture. In his study of plant breeding and the emergence of agricultural biotechnology, Jack Kloppenburg argues that, at least until the biotech era, public plant breeders associated with experiment stations not only "creat[ed] the product itself" ("whereas in other sectors of the economy the state may act indirectly to shape the nature of a product via regulation") but also "discipline[d] the market as to quality, price, and structure," restricting capital accumulation by private breeders.[285] Historically, then, compared to some other sectors of the economy, the government, chiefly through land-grant institutions, has been actively involved in agricultural innovation and development.

However, in the course of the twentieth century, the line between public and private shifted, even before the development of biotechnology. Kloppenburg argues that "the emerging

[281]Friedland, "Who Killed Rural Sociology?" 80-81.
[282]Friedland, "Who Killed Rural Sociology?" 81-82.
[283]Friedland, "Who Killed Rural Sociology?" 85.
[284]Thomas Jefferson as quoted in 447 U.S. 303 (1980); see also Sheila Jasanoff, *Designs on Nature: Science and Democracy in Europe and the United States* (Princeton: Princeton University Press, 2005), 49.
[285]Kloppenberg, *First the Seed*, 13.

social impacts of the new … technologies … are, substantially, logical extensions of historically established processes" characteristic of capitalism, including "the concentration and centralization of capital in the seed industry, the commodification of the seed, the decline of the petty commodity producer" and battles for control over the government research complex.[286] The rise of hybrid corn, which was "amenable to commodification," at the expense of open-pollinated varieties, which "resist" commodification and retain greater genotypic and phenotypic variability, provides a compelling case.[287] Despite these processes, he asserts that

> to view the public research institutions as mere automatons blindly advancing the interests of capital is both to misread history and to fail to assess the contemporary political possibilities for enhancing the degree of public control over important and productive organs of the state apparatus. [288]

Kloppenburg relates the tension between public research and private interests to another persistent thread in the history of American agricultural development, the contested distinction between 'basic' and 'applied' research. As the discussion in previous chapters has shown, agriculture became isolated within academia from what some referred to as 'pure' science[289] while outside the university the call from farming interests was for 'useful' findings, a need that the agricultural experiment stations filled with marked success. However, Kloppenburg argues the distinction between basic and applied research rests on "idealizations" that "persist because of their ideological utility in focusing attention on the search for knowledge rather than on the search for the commodity,"[290] a tension at the heart of the land-grant mission. The core issue, for him, at least in crop research, is "the relationship of the research to the commercial product, to the *commodity-form*."[291] The importance of resisting privatization and maintaining public research is to allow for investigations and developments that do not have the potential to generate private profit although they may have more "socially optimal" results.[292] "Unfettered by the need to turn a profit, public breeders," for example, can develop "real alternatives to conventional varieties," [293] such as multi-lines that have the potential for greater disease resistance but are less easy to patent because of their lack of "stability" and "distinctness."[294]

For geographer Richard Walker, the issue in California agriculture, distinctive within the U.S. for many reasons, is not a failure of the agrarian vision but the "perfection" of capitalism in California agriculture that has effectively silenced dissent and obliterated a distinct public sector: "If the problem is perfection, not failure of laws, governments, organizers, or environmentalists to stop a mutant form of agrarianism, then we have a different kind of opponent on our hands . . . an unrestrained, naked form of market society" notable for the "ferocious exploitation of harvest labor" and for how "agribusiness has drained and poisoned waters; forcibly reengineered and fed

[286]Kloppenberg, *First the Seed*, 276-277.
[287]Kloppenberg, *First the Seed*, 129, and see chapter 5 generally.
[288]Kloppenberg, *First the Seed*, 39.
[289]Mayer and Mayer, "Agriculture, the Island Empire," 90.
[290]Kloppenburg, *First the Seed*, 45.
[291]Kloppenburg, *First the Seed*, 42.
[292]Kloppenburg, *First the Seed*, 150.
[293]Kloppenburg, *First the Seed*, 285.
[294]Kloppenburg, *First the Seed*, 150.

the plants and animals; and changed forever the landscape of the Golden State."[295] In Walker's account, the land-grant complex in California, indeed all of state government, unsurprisingly was the junior partner of agribusiness in developing "this astonishing system of transforming nature into products for human use:"[296]

> Agribusiness has a deep interest in government policy and in using the powers of the state to its advantage on everything from tariffs to technology. The hidden hand has maneuvered to get a good grip on the neck of the government. Growers not only influenced legislatures, governors, and congressmen, they organized to establish their own service agencies, such as the College of Agriculture . . . . In short, agrarian capital is deeply involuted with government, in the classic manner of the American state . . . .[297]

Walker attributes this close connection to "a highly localized federalist state" and "a long cultural identification with capitalism."[298] In Walker's version, unlike Kloppenburg's, distinctions between public and private are flattened; the university-research complex appears to have no role in altering the trajectory of business interests, although it continues to engage in technological innovation.

Science, State, and Society

Historian Charles Rosenberg argues that "many of the precedents for government-designed and supported research—and the ramifications of this dependence for the scientific community— were forged most prominently in the agricultural colleges and experiment stations." Splicing European "ideas and institutional forms" into the American context, the agricultural researchers of the mid-nineteenth century in their commitment to "applied science" set the path for the "development of the sciences, of technology, and of a technologically oriented economy."[299] Rosenberg further asserts that this "generation of the 1850s" helped "forg[e] the habit of seeing all social and economic problems as solvable through the deus ex machina of increasing productivity— a position which has conveniently obviated the need to examine social alternatives."[300] As Marcus has argued, by the 1890s many farmers believed that agricultural science provided them "a viable alternative to both direct political action and farmer-based reforms."[301] The land-grant complex thus may have provided a technocratic, politically popular and ostensibly neutral model for the expansion of American science in the twentieth century.

For much of the past century and a half, the land-grant institutions and agricultural research have received the reliable funding that reflects political support. The reasons for this ongoing public support might include citizens' awareness of the "utility" or yield of its investment—the nationwide network of cooperative extension and the presence of land-grant

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[295]Richard Walker, *The Conquest of Bread: 150 Years of Agribusiness in California* (New York: New Press, 2004), 305.
[296]Walker, *Conquest of Bread*, 302.
[297]Walker, *Conquest of Bread*, 276.
[298]Walker, *Conquest of Bread*, 337 n. 34.
[299]Rosenberg, *No Other Gods*, 151.
[300]Rosenberg, *No Other Gods*, 141.
[301]Marcus, *Agricultural Science*, 6.

universities in every state as well as the mid-twentieth century increases in productivity may have made government involvement in agriculture continue to seem both familiar and benign, and the public (aside from the farming sector) has likely appreciated the low cost of food. It is worth considering whether the entrenchment of U.S. agricultural policy results from the persistence of the land-grant vision of science in support of agriculture in the mid-nineteenth to early twentieth century, even though there is little Norman Rockwell left in Cargill or Monsanto. Of course, the security of funding for the government-agricultural complex may also have depended on the political insularity of the Congressional Agriculture Committees described by the Mayers and others —the "island empire" may have lacked broad-based democratic support, but it had powerful allies. Whichever account is more apt, the public has been engaged in an ongoing way with land-grant universities and with cooperative extension.

Perhaps the sociotechnical, scientific vision actually veils the machinery of power. Jasanoff comments that in the U.S. the "idea of value-free science retains its firm hold on the national imagination" among critics of biotech as well as among promoters: "science was repeatedly invoked to close, or foreclose, political debates on biotechnology, *particularly in the agricultural sector"* [emphasis added], invoked through "expert institutions," with "boundary work" being done to disentangle science from politics.[302] Left unstated, however, is the role of capital and private accumulation and their impact on nature and society. The land-grant vision may deftly conceal agribusiness's influence on—or capture of – public institutions and the power of corporate money in the polity.

To borrow a phrase from Charis Thompson about science and technology studies, is there a way in which government-agricultural science is "*the* story of the modern world and *the* story of the modern political order"?[303] Here is a version of the story: The land-grant institutions promised "useful science" and broad-based benefit for the democratic, and at the time chiefly rural, citizenry of a new nation. Government investment in agricultural science and technology did yield remarkable increases in agricultural productivity, cheap, abundant food, and surpluses for trade (perhaps inspiring government investment in other science and technology projects), yet in its impact devastated rural employment and the rural population (an important part of the intended land-grant 'public'), contributed to urbanization and the concentration of wealth, caused extensive environmental harm, and posed new threats to human health. It favored science and technology oriented solely to commodity production rather than to stewardship of nature. While unjustly neglecting the poor and non-white, these institutions of government agriculture ended up often serving narrow, entrenched corporate and political interests and were politically untouchable and often unaccountable. The rise of biotechnology and corporate intrusion into universities threatened public research and thus the possibility of developments that would favor socially optimal and environmentally sustainable results rather than the accumulation of private capital. Yet at least some elements at public land-grant universities, despite efforts to suppress dissent, also generated critiques and continue to press for change.

Alternatives

[302]Jasanoff, *Designs on Nature*, 288.
[303]Charis Thompson, *Making Parents* (Cambridge: MIT Press, 2007), 33.

The legislation and funding that gave rise to the land grant institutions and scientific and technological innovations such as corn hybridization clearly changed American agriculture; these developments, as we have seen, had deep connections to a complex of ideas. If agriculture is to change again to meet environmental and social as well as productionist goals, how might this transformation emerge from ideas, laws, institutions, and practices? More pointedly, how might it deal with the "path dependency" problem, of the way that what has already happened, the events and institutions already in place, have created some possibilities and foreclosed or discouraged others?

Looking backward, was there an alternative path for land-grant institutions and American agriculture that would have been more environmentally friendly and socially equitable? As Richard White points out,

> the past once contained larger possibilities, and part of the historian's job is to make those possibilities visible . . . . The inevitability of the present violates the contingency of the past, which involves alternative choices and outcomes that could have produced alternative presents. To deny the contingency of the past deprives us of alternative futures, for the present is the future's past.[304]

Over three centuries, American society has entertained different agricultural visions and practices spawned, in part, by environmental and cultural variations, with different kinds of relationship to the nation-state, Amish communities providing but one well-known example. Several of these visions have had national purchase, one the rise of productionist scientific agriculture that has been the focus of this thesis, and another more recent one being the emergence of organic farming.

In his analysis of the development of federal regulation of organic agriculture, Timothy Vos observes how the "historically persistent cultural paradigm" of organic farming and agroecology, involving stewardship and a "truly democratic, participatory agrarian economy," "resonates strongly with the agrarian ideal of the middle landscape, a still compelling part of the American mythos." [305] This organic vision, never dominant in commercially-oriented European America, challenges not only the chemical-intensive agribusiness model but also, in Vos's words, the "dualistic modernist ontology that objectifies nature and keeps it separate from, and thus subservient to, society."[306] The organic, "holistic approach," calls positivistic science into question, and in recent years it has also confronted the top-down regulatory and expert state. Vos points out that the non-governmental organic farming standards that preceded the federal rules emerged from a "grassroots tradition" of "hands-on learning, sharing knowledge, and working together to refine principles and practices,"[307] informed by a cooperative vision of rural

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[304]White, *Railroaded,* 517.

[305]Timothy Vos, "Visions of the Middle Landscape: Organic Farming and the Politics of Nature," *Agriculture and Human Values* 17 (2000), 252-53.

[306]Vos, "Visions of Middle Landscape," 252. Although Vos refers to the "environmental/ecological imaginary in contemporary culture," (245) the existence of several current, potentially conflicting environmental imaginaries seems more plausible, one being Vos's organic vision and another the environmentalist-regulatory state, oriented to expertise and technology, that emerged in the 1970s.

[307]Vos, "Visions of Middle Landscape," 253.

life and partnership with nature.[308] The USDA organic standards, by contrast, provide a "technical fix… focusing primarily on a set of materials that can or cannot be used" and, according to geographer Julie Guthman, are ill-suited in and of themselves to transforming farming.[309]

Guthman's vision of an "alternative agriculture of substance" entails "the decommodification of food *and* land" – for example in "new institutional forms" such as subscription farms or community-supported agriculture. Drawing on the history of land use in California, she traces the destructiveness of industrial farming back to "the dynamics that arise from private property in land": "as an investable and transferable commodity, it can never support a kinder and gentler form of food production without substantial policy interventions that maintain or reduce the cost."[310] Her argument thus decouples alternative agriculture from private ownership in land— the central element in the Jeffersonian agrarian vision embodied in the legislation of 1862.[311] Given the resistance of some organic farmers to central aspects of the land-grant system, how might they contribute to the reformation or transformation of the land-grant complex?

Alternative Agriculture and the Land-Grant University

At several land-grant institutions, centers have been established to do research on alternatives in agriculture, but not without conflict and resistance. In California, frustrated by the Division of Agricultural Sciences' lack of attention or antagonism to environmental issues, the state legislature in 1986 passed a law creating a U.C. research program in sustainable agriculture. It took "litigation and legislation to persuade the Division to revamp some of its traditional practices and priorities." [312] In a recent interview about the "conflicts of interest between universities and the food-production complex," food scientist and activist Marion Nestle noted that "[p]roponents of sustainable and organic production systems have a difficult time at … land-grant agricultural universities." [313] Nestle alluded to the 2005 demotion of Fred Kirschenmann, the head of Iowa State University's Leopold Center for Sustainable Agriculture who has supported not only organic farming but also the "agriculture of the middle," the mid-sized farms endangered by the increasing power of agribusiness.[314] "Alternative

[308]See Carolyn Merchant, *Reinventing Eden: The Fate of Nature in Western Culture* (New York: Routledge, 2003).

[309]Julie Guthman, *Agrarian Dreams: The Paradox of Organic Farming in California* (Berkeley: University of California Press, 2004), 179.

[310]Guthman, *Agrarian Dreams*, 184-85.

[311]It should be noted that the 'family farm' tends to be invoked in the rhetoric of both the organic and agricultural establishment imaginaries, sometimes to refer to small-scale farming and sometimes to family-owned enterprises. Friedland notes the "preoccupation" of land-grant rural sociologists with "the fate of family or small-scale farming" rather than with the sociology of agriculture, especially agricultural production, more generally ("Who Killed Rural Sociology," 86 n. 6). Guthman analyzes the problematic use of the 'family farm' by the organic farming movement in California (*Agrarian Dreams*, 174-175).

[312]Scheuring, *Science and Service*, 217-219.

[313]"Big Food, Big Agra, and the Research University," *Academe* 96(6) (2010): 47-48.

[314]Wendy Wintersteen demoted Kirschenmann when she was interim Dean of the ISU College of Agriculture and a candidate for the deanship, saying that he was not "sufficiently responsive to Iowa

agriculture," Nestle commented, "is perceived as a threat to the entire agricultural enterprise, which, of course, it is."[315] Given the antagonism to dissent, what are the prospects for research on alternative agriculture at land-grant institutions, institutions with deep connections to agribusiness?

The university-research establishment could play a significant role in generating alternative trajectories for farming that improve ecological and social resilience. For one thing, it could produce and disseminate a wealth of knowledge about farming practices that achieve benefits, such as socioeconomic equity, in addition to commodity production. Guthman notes that "[r]esearch and extension funding for sustainable agriculture has been dismal compared with that for conventional chemical agriculture." Reformers seek to "encourage the USDA and the land grant colleges to reconsider their research priorities;" [316] reordered priorities could include the health of consumers and farmworkers, the reduction of greenhouse gas emissions, and the restoration and management of critical ecosystem services. This reordering reflects social and environmental challenges not contemplated by the scientists who drafted the research agenda outlined in the Hatch Act.

Public science and technology is important in fostering agriculture not geared solely to maximizing commodity production or private profits. In his study of the political economy of plant breeding, Kloppenburg asserts that "[w]e cannot understand science without reference to the commodity,"[317] especially as private industry expands its influence over research. He argues for the "[p]reservation of an autonomous public capacity to develop new technology" for a sustainable and socially optimal agriculture as a "legitimate and vitally necessary objective of social policy."[318]

However, the social and environmental consequences of new technologies are difficult to predict. Walker describes the developing practice of 'precision agriculture' in which technology can detect and adjust application of inputs for in-field variability in temperature, soil moisture, nutrients, and other factors, potentially improving efficiency and reducing environmental damage, as "compensat[ing] for decades of homogenization of field practices and the suppression of natural diversity under agriculture's version of Fordism."[319] In some ways these precision techniques further Hilgard's goal from over a century ago of developing science closely attuned to local conditions of soil and climate. However, although precision farming has potential benefits, some critics view it as another iteration of agro-industrialism, "a defensive or conservative reaction of an agricultural system struggling to maintain legitimacy in the face of

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stakeholders." Shortly thereafter, she was appointed Dean. See "New Dean at Iowa State," *The Rural Populist* (blog), December 21, 2005, http://ruralpopulist.org/2005/12/21/new-dean-at-iowa-state/; see also "One More," *The Rural Populist* (blog), November 9, 2005, http://ruralpopulist.org/2005/11/09/one-more/#more-94.

[315]"Big Food, Big Agra," 47-48.

[316]Guthman, *Agrarian Dreams*, 179.

[317]Kloppenburg, *First the Seed*, 45.

[318]Kloppenburg, *First the Seed*, 150.

[319]Walker, *Conquest of Bread*, 171.

mounting social, economic, and ecological challenges." [320] The consequences of precision agriculture may depend on who has a hand in using, developing, and adapting it, and the constraints under which that work is done.

The social organization of 'doing science' needs to take a central place in reforming agriculture. In a reworking of some of Hilgard's concerns in the nineteenth century, agricultural reformers need to figure out appropriate scales and strategies for addressing diverse problems. For example, increased environmental and health regulation has burdened smaller growers and contributed to concentration of ownership and intensification of farming, a problem that calls for institutional solutions. The land-grant model of education, research, and extension lends itself to addressing the challenges of reforming agriculture. Collaborative scientific research attentive to and deriving from local needs and knowledge can fit well into the extension system. In his study of cooperative extension, Henke concludes that "the kind of local expertise employed by farm advisors is most suitable for promoting modest change," including adjustments to climate shifts, rather than the transformation of agriculture, "especially given the structures of power that local elites shape and control." Transformation, he argues, is more likely to result from changes in state and national policy,[321] for which land-grant-based research could provide support. Improved governmental policies and regulation –for example, limitations on chemical use and greenhouse gas emissions and requirements for improved labor practices—could neutralize the most destructive aspects of commercial agriculture. More participatory and democratic landscape-scale governance and land tenure could transform farm production to be more supportive of socioeconomic equity and sensitive to the complexity of agroecological systems. One of the lessons to be taken from Hilgard's career of 'science and service' concerns the long-term consequences, the perils, of ignoring the egalitarian, democratic thread in the land-grant mission. The rise of agricultural science, as Marcus argues, undermined the independence of farmers; in the information age, farmers could be re-empowered to develop a more sustainable agriculture.

In these ways an evolving, reframed land-grant mission could help to rearticulate the relationships among science, farming, and citizens in order to generate new and better options for managing common resources.

[320]Stephen Wolf and Fred Buttel, "The Political Economy of Precision Farming," *American Journal of Agricultural Economics* 78(1996): 1271, as quoted in Walker, *Conquest of Bread*, 324 n. 41.
[321]Henke, *Cultivating Science*, 179.

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Hilgard family papers

The Hilgard Family Papers (abbreviated in footnotes as HFP) are located in the Bancroft Library, University of California, Berkeley. The materials pertaining to Eugene Hilgard consist of 31 volumes of letterpress copybooks and 25 boxes of outgoing and incoming letters as well as five cartons of subject files, clippings, manuscripts, reprints and other miscellaneous papers. Carton 1 contains an incomplete autobiographical work that is inconsistently paginated. In addition to the letters and autobiography, other materials from the HFP cited in the thesis include "Obituary of George Engelmann," *The Universe* (St. Louis), Vol. V No 5 (May 1885), and Eugene Hilgard, "All Cotton and No Comfort," *Rural Carolinian* (no date), Carton 1, HFP.

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