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Introduction by Jacob Darwin Hamblin, Oregon State University

To scholars who work at the nexus of agricultural history and history of science, Justus von Liebig stands as an unavoidable patriarch. In the 1840s, Liebig reduced the mysterious notion of soil fertility to something readily identified: the presence in soil of the chemical elements nitrogen, phosphorus, and potassium. His and others' laboratory work provided farmers with tools to increase production and maintain fields that otherwise would have seemed worn out. As a figurehead in progressive narratives, Liebig stands unrivaled. With him, the era of chemical fertilizers and scientific agriculture appeared to have begun, sweeping aside the haphazard know-how and quaint beliefs of uneducated farmers.

Anyone who has known a farmer can imagine that changing agricultural practices likely was not as easy as that. Especially in mid-nineteenth century America, when farmers (including Southern plantation owners) received plenty of unwelcome and unheeded advice, we need to understand in historical context how scientific ideas and practices gained the assent of farmers. After all, it may have been the province of the scientist to describe the land, but when scientists advocated plans of action, they were competing for authority with the farmers. Who were the true experts, after stepping into the fields?

Benjamin R. Cohen explores this tension in *Notes from the Ground*. The title itself calls to mind two contradictory worldviews, one by Thomas Jefferson and the other by Russian novelist Fyodor Dostoevsky. The former's *Notes on the State of Virginia* (1787) embodied the values of the enlightened farmer, hard-working but wishing to increase production and enhance his livelihood with guidance from science. The latter's *Notes from the Underground* (1864) heaped scorn upon those who would pursue progress and civilization, embracing scientists' mechanistic worldview while divorcing themselves from the soil. Who could be trusted more, the laboratory scientist or the experienced, practical farmer?

Cohen argues that the new scientific practices did not merely provide higher production and increased material wealth, but that they spoke to the cultural values of the farmers and their communities. He sees agency not just in scientists but also in local citizens, informed by an improvement ethic that had powerful appeal in nineteenth century America. He calls it "georgic science." The term draws upon the ancient poet Virgil, whose *Georgics* described a world of hard-working people whose toil brought them both material sustenance and ethical virtue. In Cohen's telling, the scientific ideas did not simply replace traditional knowledge, but rather they fueled the georgic ethic that these communities already embraced.

One of this roundtable's commentators is **Steven Stoll**, Associate Professor of History at Fordham University. Like Cohen, he has investigated the circulation of ideas about soil fertility. In *Larding the Lean Earth*, Stoll explored what it meant to be a farmer in nineteenth-century America, and he focused on the debates about

what to do when soil failed to produce the abundance that American farmers had come to expect. Stoll pointed to the kernel of the conservation movement, as farmers confronted the consequences of their own practices. Addressing the problem of worn-out soil meant either the abandonment of fields (and emigration), or to more intensive use of manure to renew it.¹

R. Douglas Hurt has published so widely on American agricultural history that he was an obvious choice to participate in this roundtable. He has written books on Native American practices, agriculture under slavery, disasters such as the Dust Bowl, and focused regional studies. In addition, he has written about agricultural science and technology, including an international annotated bibliography of its history. His most recent book, *The Big Empty*, uses a range of actors, including farmers, scientists, politicians, and business people, to tell the complex twentieth-century story of the Great Plains.²

Daniel Goldstein shares with Cohen an interest in the dissemination of knowledge in nineteenth century America. In a study of local and regional voluntary societies, for example, he shows the extraordinary growth of scientific societies after the Civil War. These societies acted as the point of contact between local practices and scientific ideas. Goldstein emphasizes how such societies transformed private activities, previously considered personal hobbies, into public activities that participated in the growth of science. The proliferation of these societies marked a profound commitment to science after the Civil War. The act of joining one, Goldstein has written, served as a kind of declaration of intent to contribute to the civic good.³

I invited **Mark R. Finlay** to participate in this roundtable because of his expertise in the history of agricultural chemistry. In addition to his award-winning book on the importance of rubber to the United States in the twentieth century, he has worked for many years on the history of German agricultural experiment stations. He has noted that American scientists often mischaracterized the Germans' work, making them appear less utilitarian than they were. Although Justus von Liebig's 1840 *Chemistry and its Applications to Agriculture and Physiology* became the classic text that made agricultural work more "scientific," Finlay has written that even in Germany there were skeptics—though lesser known than Liebig—who felt

¹ Steven Stoll, *Larding the Lean Earth: Soil and Society in Nineteenth-Century America* (New York: Hill and Wang, 2002).

² R. Douglas Hurt, *Indian Agriculture in America: Prehistory to the Present* (Lawrence: University Press of Kansas, 1987); R. Douglas Hurt, *Agriculture and Slavery in Missouri's Little Dixie* (Columbia: University of Missouri Press, 1992); R. Douglas Hurt, *The Dust Bowl: An Agricultural and Social History* (Chicago: Nelson-Hall, 1981); R. Douglas Hurt, *The Big Empty: The Great Plains in the Twentieth Century* (Tucson: University of Arizona Press, 2011); R. Douglas Hurt, *The History of Agricultural Science and Technology: An International Annotated Bibliography* (Garland, 1994).

³ Daniel Goldstein, "Outposts of Science: The Knowledge Trade and the Expansion of Scientific Community in Post-Civil War America," *Isis* 99:3 (2008), 519-546.

laboratory research was unreliable compared to practical work answering farmers' specific questions.⁴

Before turning to the first set of comments, I would like to pause here and thank all the roundtable participants for taking part. In addition, I would like to remind readers that as an open-access forum, *H-Environment Roundtable Reviews* is available to scholars and non-scholars alike, around the world, free of charge. Please circulate.

⁴ Mark R. Finlay, "The German Agricultural Experiment Stations and the Beginnings of American Agricultural Research," *Agricultural History* 62:2 (1988), 41-50; Mark R. Finlay, *Growing American Rubber: Strategic Plants and the Politics of National Security* (New Brunswick: Rutgers University Press, 2009).

Comments by Steven Stoll, Fordham University

Notes From the Ground, Ben Cohen's marvelous first book, beautifully written and researched, asks questions larger than it can possibly answer. The singular quality of the book is the way it builds upon the material basis of an ancient literary form--asking whether we can understand nineteenth-century soil science as a georgic practice. The effect is to upend the old story that soil science came from theorists like Justus Liebig, replacing it with one that depicts discovery as a much more democratic, on-the-ground, farmer-generated endeavor. In these pages, the georgic is not a mere homily about virtuous labor and smallholder sufficiency but a historical interpretation of where knowledge comes from. Yet the georgic alone does not do all the literary work. There is another form that is just as important, mentioned in the book but then neglected. The pastoral.

The problem is this: The ideal at the center of the book does not measure the social change brought on by agricultural science, insisting instead that experiment derived from farmers in their own fields served the ideal rather than eroded it. As a literary form, the georgic is not very adept at integrating the kind of rapid change that came with capitalism--a word that does not appear in the index of *Notes From the Ground* and is present only obliquely. If change is part of georgic writing it is the change that originates with the farmer and the farm, the selection of seed and succession of crops that provide subsistence, a cycle that can be interrupted by war and enslavement but that is otherwise perfect. Pastoral literature does not come from farmers and has nothing to do with their plodding. It comes from people from that world of frantic capitalist change who wanted to depict the ambivalence they felt at their own struggle for accumulation. Nature (eternal) and culture (flux), peasants and capitalists, sufficiency and wealth--these are locked together like evenly matched wrestlers in a mutual hold that seems to last forever with neither able to flip the other.

But every pastoral painting and poem does end with a flip. Everyone knows how the match will end up--with the demise of the middle landscape and its transition into something else. The middle landscape does not exist in space as much as it exists in time. Cohen refers to Cole's *Pastoral, or Arcadian State*, the second of five that make up the *Course of Empire*. But the painting is suffused with fear and foreboding. Right behind the grazing sheep a ship is being framed and off on the left a man pushing a plow--both transforming technological tools that Cole places at the edges ready to close in. Without them, the next painting, the doomed-to-destruction Consummation of Empire, makes no sense. Only a robust agriculture--in which slaves harvest wheat on thousands of latifundian acres and ships conduct trade and warfare--can possibly explain the spectacular Imperium.

In Claude's paintings and Cole's, in Rousseau's *Discourse on the Origin and Basis of Inequality* and the writings of Scottish philosophers like Adam Smith and Adam

Ferguson, the middle landscape is soon to be invaded, logged into oblivion, its people dispossessed and put to work for the lord of the Chateau, its society gutted by poverty and dependency. Americans surely had their own way of looking at it, and this is where Leo Marx is useful. They continued to imagine a middle landscape long after the gardens of Mandan and Hidatsa women had been eradicated, all throughout the slow-motion dispossession of family farmers and the cannibalization of their land into roads for combines. In Cole's pastoral, the tension is resolved when vines complete the final takeover of the empire, but in almost every other example (to use Claude's elements) it's the chateau in the languid distance behind the dancing peasants and the trade flowing into the countryside from the harbor at sunset that shows us the end of the story.

The problem with *Notes From the Ground* is that while it presents the georgic ideal in operation among a variety of farmer-experimenters, and while it presents some of the contradictions of slavery in the work of Edmund Ruffin and John Taylor, it does not acknowledge its own pastoral tension. There is no society in which experimentation might take on different meaning. Consider that by the middle of the nineteenth century non-improving agrarian households had been fighting to hold to their land for two centuries in Britain, were escaping into the woods to settle their own garden plots in the Caribbean and all over the American South, and were already despised and spat upon by political economists, some of whom called them savages. As capitalists and their theorists saw them, agrarians could raise their own food only if they labored within a money and wage system--as sharecroppers, cottagers, or coal miners with subsistence gardens. In this sense, the literature of improvement invaded and took over the georgic from the very sort of people whose homely labor had inspired Virgil in the first place. Yet when we go looking for the voices of such people in the georgic literature we find George Washington and George III instead. They not only took over land from Indians and peasants and forced Africans and peasants to labor for them, they took over the ethic of the farmer--a pastoral story, not a georgic one.

Cohen's book raises questions: What happens when science becomes part of georgic practice? When did improvement cease to represent georgic goals? Can the georgic account for the pastoral tension produced by science and the capitalist context of science? Can a lettuce harvester have a georgic experience? It's a question that Richard White considers--arguing that people who labor in environments have their own experience of those environments, different from but equal to the leisurely appreciation of painters, poets, and environmental historians. No doubt. But a Mexican woman cutting a head of iceberg with a short knife in a field that is capital owned and machine cultivated, who has no propriety or control over the soil she touches and gains nothing from her labor but a vicious wage, would seem to be excluded from the material conditions that give georgic experience its meaning. The social context for georgic thought matters entirely.

In criticizing *Notes From the Ground* for running away with the georgic ideal at the expense of pastoral conflict I might just as well be saying the same for my own

Larding the Lean Earth. The books are cousins, and the latter work also views the world from the eyes of its protagonists a little too lovingly for my taste now. An author changes, but his books cannot. Reviews like this offer the chance to comment, reflect, and confess.

I cannot fault an author for doing what he set out to do, and Cohen depicts scientific knowledge as something that took shape on a thousand farms and not among the students of a German chemist. The factors that came together to produce this moment only existed in the United States--access to land, time and leisure to observe and think about local conditions, and a rural press that functioned like the Internet, allowing farmers to compare their findings. There is something in this story that resonates today in the writings of Wendell Berry, Gene Logston, Wes Jackson, and others who clearly believe that (as Jackson puts it) we all benefit by becoming native to our place and do so by growing our own food, to some extent. But that is only the kernel of their revolt. They point out the impossibility of this project as long as Americans continue to abdicate the 400 million acres of arable land that make up The Countryside to handful of corporations. It's a lonely fight. As Berry wrote in Orion Magazine in 2002, "We agrarians are involved in a hard, long, momentous contest, in which we are so far, and by a considerable margin, the losers." Farmer-generated knowledge requires farmers. And only farmers who refuse the allure of Monsanto and other agro-technology companies can remain independent of Liebig-like thinking to develop an authentic knowledge of land, a pastoral struggle in the service of the georgic ideal.

Comments by R. Douglas Hurt, Purdue University

I once told the chief historian of the Natural Resources Conservation Service that I needed a few yards of dirt to fill in some low spots in my back yard. In a good-natured fashion he responded by saying that, "We call it soil." Soil can be identified, categorized, and quantified in a host of ways. It can be measured more precisely than dirt hauled by wheelbarrow or wagon. Chernozem has different qualities than chestnut brown, as any agronomist in the prairie-plains transition area can attest. Soil is a product of science. Dirt is merely dirt—black, brown, red, yellow, sandy, clay. In a way Benjamin Cohen discusses the transformation of dirt to soil. He has done so in a complex book that does not require a degree in chemistry to understand. It is a fascinating and significant story about the emergence of agricultural science based on chemistry during the late eighteenth and early nineteenth centuries. In an age of enlightenment and reason, many agriculturists believed that chemistry could improve soil. The reliability of chemistry for agricultural improvement, however, remained disputable based on who conducted the experiments. It made a difference whether experiments for the improvement of agriculture were conducted by those who actually farmed or by scientists who worked in a laboratory. So, this is a book not only about how scientists knew what they knew, but also about whether farmers believed them.

Cohen's study is important for any historian of agriculture and science. He writes that, "This book is about how and why dirt became an object of scientific interest;" and, how science became the "dominant way to know nature" (ix). He concludes that science depends on culture and culture depends, in part, on custom and politics, although his contention that chemistry contributed to agriculture as a cultural and moral endeavor could be developed a bit more fully. Chemistry can be easier to understand than individual moral philosophy, or at least the practice of the latter. Significantly, Cohen argues that during the late eighteenth and early nineteenth centuries agricultural science did not stand alone. It did not result from pure experimentation to discover knowledge that could be applied to the farm for the improvement agriculture. In this context *Notes from the Ground* traces the cultural foundations for the linkage of science and agriculture. Cohen contends that, "Agricultural science became politically significant and economically relevant by the mid-nineteenth century" (4). Science promised improvement based on local experimentation. If science means controlled, verifiable experiments then the applied experiments of gentlemen farmers became science loosely construed. Gentlemen farmers who experimented had credibility but they permitted political and cultural concerns to determine what was right and wrong with farming practices.

Cohen bases his study on Virgil's Georgics which essentially premises agricultural improvement on hard work which has moral and cultural value. Jefferson accepted

this premise, which we know from his often-quoted belief about the relationship of agriculture to democracy. For Americans in the early republic, agriculture not only ensured life but also profit, morality, and community. Cohen develops this idea by dividing his study into two parts. The first discusses the applied or practice-based agricultural science in the countryside while the second traces the ways in which farmers learned about this applied science to improve their practices. His discussion of John Spurrier's *The Practical Farmer* (1793), Samuel Dean's *The New England Farmer, or Geological Dictionary* (1797), and Jon Binns' *Treatise on Practical Farming* (1803) as well as John Taylor's *Aratar* (1813) clearly show that farmers believed that agricultural knowledge was based on lived experience which included agricultural experiments. The debates about the value of science and experience led to a host of how-to-do-it books and journal articles in agricultural periodicals that were as popular then as today.

Farmers who systematically recorded agricultural experiments began the transition from dilettante science to "a systematic, chemistry-aided *georgic* science that held together the dual and moral and material mandates of American improvements" (20). Basically, Cohen contends that once chemists began counting things to explain experiments and make recommendations for specific procedures to improve the soil, agricultural science was born. Chemistry as explained by numbers (although Cohen does not use this term) can be used to present complicated things in easily understood forms. But, the bottom line was that nature could be controlled and the environment changed for the better. Yet, for many farmers applied chemistry meant experiments based on field conditions not laboratory experiments, and they had to decide whether the resulting suggestions for improvement were meritorious. Colloquially put, the proverbial proof was in the pudding. By combining agricultural science, hard work, and a moral commitment to family and community, no farmer could go wrong. Or so the argument went.

The agricultural press played an essential role in the dissemination of agricultural science because it reported place-based experiments that reduced book farming to practical applications. Farmers trusted agricultural periodicals such as John Skinner's *The American Farmer* and often distrusted books about agricultural chemistry. Local experience and experiments trumpeted laboratory science. Farmers could be agricultural scientists or at least experimenters too. Cohen's nuanced discussion of the differences between Daniel Adams' *Agricultural Reader* (1824), John Lorain's *Nature and Reason* (1825), and Edmund Ruffin's *Essays on Calcareous Manures* (1832) is complex and his analysis engaging as he parses out their differences. Each believed that science could improve nature and agriculture, essentially offering a precursor to the twentieth-century saying "better living through chemistry." Still, chemical approaches differed considerably among the proponents of agricultural science, where social status and reputation helped farmers gauge reliability and acceptability, that is, truth. At the same time, chemistry like a plow was a tool for farmers, and it would aid them if used properly.

Cohen also is interested in the "cultural standing of the sciences in agriculture" and "how scientific measures were used to define land and landscape," with a focus on Virginia. (127). If soil could be improved it could be "Studied, analyzed, and experimented upon" to make it more productive (129). If soil was political and cultural as Cohen contends, however, can he say a bit more about its improvement in relation to slavery? Readers, particularly non-specialists in agricultural science or history may need additional explanation about agricultural improvement and slavery beyond the narrative that experiments helped keep slaves busy and lands productive. Can anything be said about an increase in the use of slaves in areas where chemistry-based agricultural improvements occurred? I understand the limitations of the manuscript slave census, particularly since much of his study occurs before that data was regularly collected. But, is there any evidence that soil improvements from these experiments contributed to the increase in slave numbers on plantations in specific areas?

By the late 1840s Justus von Liebig's work, together with the cultural foundations of community, agricultural organization, and a moral belief in the relationship between successful agriculture and a stable family, as well as market forces, made the acceptance of professionalized agricultural science possible. But, if I read Cohen correctly, agricultural chemists such as Liebig won the day because farmers easily could understand and replicate the addition of an X amount of Y to replenish the soil. That is, inorganic chemistry replaced organic farm based experiments. Thereafter, professionally trained scientists defined soil and beliefs about moral values or natural philosophy faded away.

Cohen ends by advocating a new georgic in which farmers and the public develop a rational, scientific agricultural environmental policy to ensure sustainable communities. Culture still makes a difference, but I wonder about Cohen's faith in environmental policy considering that there are now probably more policymakers and environmental advocates than farmers. If environmental agricultural policy in the future farm bills is not handled correctly, will we once again live in a world of us (farmers) against them (scientists and environmentalists) to the detriment of the land and agriculture?

This is a smart, challenging book and it should be read with Alan I Marcus' *Agricultural Science and the Quest for Legitimacy: Farmers, Agricultural Colleges, and Experiment Stations, 1870-1890*. Yet, even in the early twentieth-first century, agricultural science produced at the land grant institutions, experiments stations, and corporate laboratories still does not entirely replace place-based experience. Kansas wheat farmers, for example, can tell when the crop is ripe for harvest by the way it smells on a hot southern wind or by the way that its heads shell between the hands, or by the bite of a kernel between the teeth. They do not need digital moisture testers developed in laboratories. Moreover, even today some farmers refuse to use GMO seeds, rbST, and antibiotics, because they do not trust these laboratory improvements for agriculture, although consumer and market pressures

also play a role. In some respects the georgics of agriculture still matter.

Comments by Daniel Goldstein, University of California, Davis

Benjamin Cohen has written a complex book on what he calls the scientization of nature in the early Republic through the process of the incorporation of chemistry into American agricultural practice. He presents a close reading of several texts including books by American agricultural reformers and farmers, agricultural society publications and the work of the Virginia State Geological Survey. Fundamental to his project (or, so it seems to me) is a commitment to articulate what scientific practices meant to the farmers and agriculturalists who evaluated and eventually employed them. To this end, he presents and explains all the elements in his source materials that he regards as especially important to their authors, not just those that are especially relevant to the historian. The result is in part, a compilation of a large number of disparate topics and themes, that eventually sort themselves (mostly) into two distinct narrative threads. For me, reading the book is a bit like looking at the famous drawing that appears alternately to be either a duck or a rabbit. Both of Cohen's narrative lines are compelling but I can't quite hold them in mind at the same time.

Viewed one way, the book is a narrative of the transformation of American farming from "tradition-laden, experience-based, locally derived knowledge of the land," to a practice based on externally derived "systematic, codified, and universal knowledge," that is received and applied locally. (p.8) Cohen argues that the development and adoption of agricultural chemistry by farmers between the 1810s to 1840s "helped produce and was witness to a shift from animistic and organic visions of agricultural land to the mechanistic philosophies of nature that underlay later industrial agriculture and an industrialized worldview of nature." (p.83). That is, he relates a complex, but relatively straightforward narrative of change over time. By the end of his period, not only had science become the dominant way of understanding the land, but a particular type of chemistry became the principal model for comprehending and developing agriculture.

But the book also describes how American farmers and agriculturalists evaluated, developed, tested and adopted scientific practices and theories to use them for their own purposes. At the same time that the land was being scientized and rendered mechanistic, the science itself was given new and different meanings as it was embedded into a specific set of cultural beliefs and practices characteristic of the early Republic. "Understood within an agrarian cultural context that valued the virtue of experience, science and agriculture were brought together neither passively, inevitably, nor without resistance, but as shaped by an ideology of work, knowledge, and citizenship." (p.198) The result of this process is to integrate a scientific understanding of the land into a set of fairly stable cultural beliefs that appear very much at odds with the mechanistic philosophy of nature.

Cohen operates successfully in the space between these two narratives. Most importantly, he identifies a georgic agricultural ethic, prevalent at the time and useful to historians today. It is a way of comprehending and valuing farming as expressed through the virtue of labor and provides historians with a fresh way of interpreting 19th century farming. He applies this ethic to science and articulates a concept of georgic science which he defines as follows.

“I mean the term “georgic science” to stand as shorthand for the conversation on moral and material goals of the American agrarian culture that debated the value of chemistry. Americans rooted their perceptions of chemistry for improvement, like georgic science itself, in an appreciation of virtue and values. The early Republic conjoined the place of chemistry, the georgic ethic, and systematic agricultural practices in conversations about its broad catchword, improvement.” (36)

As a result of this approach, Cohen has written one of the best discussions I have read of what engagement with science meant for a specific population, how they were pursuing scientific activity because it furthered their own interests, not because they might be contributing in some way to the science itself. Historians will, I think, find that his concept of georgic science is widely applicable and will open new areas for them to explore.

As productive as it has been for Cohen to develop and operate between these two narrative lines, I find that, in the end, I can't reconcile them. But what is important is that even though I can't see both the duck and rabbit perspectives of agricultural chemistry at the same time, apparently nineteenth-century Americans could. That, it seems to me is worth exploring.

Shifting focus from the overarching themes of the book to its rich content, there is a very different topic that caught my attention. Cohen's sources routinely, almost off-handedly make a direct connection between the practice of an individual farmer, his moral character and the political health and future of the nation. Cohen rightly incorporates this three-way connection into his description of georgic agriculture, and, referring to Jefferson and others indicates that it was generally accepted at the time. But the way nineteenth-century Americans linked these three aspects of prosperity was profoundly different from the way someone would relate agriculture to the economy today, and for that reason it is worth exploring.

This three-way relationship is directly connected to another of the book's recurring motifs—what I think of as the fertility narrative. The fertility narrative posits that the American landscape, fertile and fruitful in its native state, has become progressively less fertile due to human action; but human action has the potential to restore the land to a state as or even more productive than it was originally. This is a story upon which the whole idea of agricultural improvement depends and a key component to it is a sense of urgency, of the importance of getting it right.

Both of these motifs reflect the fact that nineteenth century Americans existed in and upon an intentionally designed landscape. The idea that God had designed and created the Americas with a specific character and that Providence intended North America as a place where European immigrants and their descendants should flourish was neither new nor controversial. We find it early on in the colonists' assertion that they were justified in taking Indian land because the Indians weren't using it properly. Equally, it figured into 18th century debates over the potential for the new American republic and its inhabitants, underlying the environmental determinism expressed by Jefferson in his *Notes on the State of Virginia*. It also plays a role in nineteenth-century debates about the character and cultural potential of American Indians.

Nineteenth-century Americans, of course, assumed that God looked kindly on the United States and had created the conditions that would enable the country to prosper if Americans followed God's preferred path for them. Failure to prosper, then, was evidence of straying from God's will. In this context, the fertility narrative documents the initial possibility of individual success and national prosperity, the squandering of opportunity and finally the potential for recovery. For the subjects of Cohen's work, then, there was a far greater than economic urgency in getting farming right. The link between farming practices, individual virtue and national condition lay in the fact that in a designed land all three were expressions of Divine intent. Cohen notes the role of Providence in his work, but not to this degree. Science assumes a particular authority in this context because of its roots in Natural Theology, the view that Nature is a second Gospel, and that understanding it is a way of learning God's will.

Living in a designed environment had implications for the early Republic in addition to assigning moral value and urgency to increasing the fertility of the soil. Most relevant to Cohen's work was the idea that God provided locally the resources optimally suited to meet local needs. There was, for example, a school of medical thought, championed by Ohio physician Daniel Drake among others, that asserted that every region contained the best treatments (usually plants) for the diseases found in that region; if a benevolent God permitted a disease to exist in a certain area then He also ensured that its treatment also existed locally. Similarly, the eccentric Texas naturalist Gideon Lincecum was not alone in believing that native grasses always provided the most nutritious fodder for livestock, giving them what they needed to thrive in a specific environment.

These examples relate to Cohen's work in that they contextualize the tension between local and externally generated knowledge found throughout the book. It characterized the book farming debate he discusses early in the work, but it was also integral to the Virginia State Geological Survey. Cohen's analysis of book farming and homespun science as debates about sources of cultural authority is impressive and can, I think, help us

understand other, analogous rhetorical dichotomies such as that between the field and closet naturalist which figures so prominently in the work of ornithologist Alexander Wilson and other natural historians. That these controversies take place in a designed environment complements and deepens the analysis Cohen already provides.

The tension between local and external knowledge plays out somewhat differently in the geological survey. There, authoritative scientific expertise (external knowledge) is applied to the discovery and proper utilization of local resources that can only be comprehended within the context of local conditions. If the survey is viewed in this way as a systematic investigation of a benevolently created landscape, then expectations for its success are themselves more than simple boosterish optimism.

As I read Cohen's book, I found myself thinking of two other, very different works I've read recently that also look at Americans' relationship with the land at about the same time. Richard Judd's *The Untilled Garden: Natural History and the Spirit of Conservation in America, 1740-1840* and Conevery Bolton Valenčius's *The Health of the Country: How American Settlers Understood Themselves and Their Land*.

Like Cohen, Judd also looks at the development of a scientific understanding of the land in the context of agricultural decline. But where Cohen's agricultural scientists believed in restoring the fertility, health and productivity of the land by subjecting it to human manipulation informed by science, the response to a narrative of decline reported by Judd was reforestation—restoration of the land by returning it to a more “natural” state. Both groups begin in the same place, apply scientific reasoning and knowledge to the situation but settle on divergent courses of action. But in both cases, it went beyond science and economics for as Judd asserts, “The treatment of trees reflected the soul of America.”⁵

Valenčius speaks to yet another way of perceiving agricultural land and the human relationship to it at the same time. She takes seriously comments by antebellum settlers in the lower Mississippi Valley describing the health characteristics of specific regions and plots of land. The Americans she studies perceive land in ways completely foreign to modern Americans—land can be healthy or unhealthy as well as fertile or infertile and its characteristics correspond directly to analogous states in the human body. As she describes it, this is a medical, scientific conception of the land, but it is a long way from the scientized land described by Cohen.

⁵ Richard W. Judd, *The Untilled Garden: Natural History and the Spirit of Conservation in America, 1740-1840* (New York: Cambridge University Press, 2009), p. 304.

How to make sense of it all? In part, as Cohen suggests, these are simply distinct populations who are confronting and resolving different issues. But, in the end, I find myself coming back to Valenčius who writes:

“‘Place’ in the antebellum nineteenth century was thick. It was not simply grass over which people strode. . . but an amalgamation of sense and essence filling the whole perceived world, a unified experience of external reality that mightily constrained, though it never fully circumscribed, the efforts and will of its inhabitants.”⁶

Perhaps what Cohen describes is not the substitution of one perception of the land for another, but the accretion of one atop another. Add to those the perspectives delineated by Judd, Valenčius and others, and then not just place, but the scientific understanding of the land and nature in this period was indeed “thick.”

⁶ Conevery Bolton Valenčius, *The Health of the Country: How American Settlers Understood Themselves and Their Land* (New York: Basic Books, 2002), p. 108.

Comments by Mark R. Finlay, Armstrong Atlantic State University

Ben Cohen's *Notes from the Ground* is a welcome and important contribution to the history of American science, technology, and the environment. Throughout the book, Cohen carefully unpacks what early American agriculturists actually thought about their land, why they deemed their stewardship of that land important, and how their activities laid foundations for the increasing legitimacy of scientific activity in the early nineteenth century. But this was not easy or inevitable. In a world in which farmers had daily contact with seemingly capricious Mother Nature, American proponents of agricultural improvement became convinced that success could be ensured only through personal and intimate knowledge of the soils, climates, and labor needed to extract produce from the land. Based on the assumption that science had to be "virtuously pursued" (51), American rural improvers claimed that they had earned a degree of intellectual credibility through their direct involvement in the study of nature. Cohen demonstrates that literate and socially conscious landowners came to hold a special position within the early American republic, persuasively making the claim that active engagement with the land could yield the lasting moral and material benefits of prosperous agriculture.

Cohen makes a number of strong assertions along the way. He contends, for instance, that "it was only...the American context" that provided the necessarily rich "cultural basis" for connections between agriculture and chemistry to thrive (34). In my view, *Notes from the Ground* is especially strong when covering examples in which the American case was demonstrably distinct from events and discussions that occurred elsewhere in the western world. Cohen's treatments of two iconic issues in the historiography of rural America stand out: the supposed promise of the frontier and the uncomfortable legacy of slavery. On the first point, Cohen successfully links the rise of the American agricultural science with soil fertility issues, concerns over westward migration, and hopes to maintain a stable agrarian society. Cohen's study of William Barton Rogers's soil surveys in rural Virginia also offers interesting insights into the history of early American science on the frontier. By recounting Rogers's continual headaches with broken thermometers, sick horses, shortages of hydrochloric acid, and other complications, Cohen offers good evidence that the transition from qualitative to quantitative perceptions of the land were difficult and contentious processes. As he sums up, "scientific agriculture took work" (161).

Cohen's treatment of enslaved persons' role in the production of agricultural scientific knowledge is an especially intriguing contribution. Slaves were the "ultimate invisible technicians" (156), he argues, and his evidence from the journals of William Fanning Wickham clearly reveals the hard labor that came with southern planters' search for agricultural improvements. Cohen also draws intriguing connections between efforts to maximize the efficiency of slave labor with another

emerging characteristic of early American agriculture: the ready substitution of mechanical tools and farm implements for human labor. I think Cohen has opened a promising line of research here, and I hope that he (or perhaps a student in search of a dissertation topic) will seize the opportunity for more thorough study of the connections between labor and southern agricultural science and technology. (Indeed, a comparison of African Americans' role in the project of agricultural improvement, both before and after the Civil War, may be an especially interesting topic).

Issues of slavery and the frontier converged in other interesting ways as well. The Pennsylvania writer John Lorain, for example, hoped in the mid-1820s that improved soil management could eliminate the economic argument for slavery and cause the institution to fade away. At about the same time, however, Virginian Edmund Ruffin suggested that agricultural improvement would help perpetuate slavery and sustain its dividends for the planter class. As a whole, the agricultural sciences of the antebellum United States emerged within a fascinating context of social and political circumstances.

But because Cohen makes the bold claim that the antebellum United States provides a "unique setting to think about when and how scientific agriculture began to be part of a new set of rural practices," (p. 5) it may be worthwhile to explore those assertions in this roundtable. It seems unfair, of course, to expect a book plainly rooted in the American countryside and backed by dozens of local primary sources to address discussions that took place thousands of miles away. Thus I move into this topic of transnational comparison with some trepidation, and I welcome this roundtable as an opportunity to have a conversation on issues of European models, American uniqueness, and the blurry boundaries between the two.

At times, Cohen does allude to similar initiatives that occurred on the other side of the Atlantic. He makes connections between the Americans and eighteenth-century British authors such as Francis Home, John Sinclair, William Cullen, and Archibald Cochrane; he certainly pays Humphrey Davy his due for the 1813 text, *Elements of Agricultural Chemistry*, which remained influential in the United States for a generation. Nevertheless, *Notes from the Ground* seems to shift its focus to the United States to such an extent that it suggests that American authors were not as deeply engaged with transatlantic dialogues on rural improvement as is evident in the antebellum American rural press and monographs like Edmund Ruffin's *Essay on Calcareous Manures*. In his effort to demonstrate that Americans were producers and reproducers of knowledge that could be useful in the young republic, rather the consumers of knowledge produced abroad, the impact of foreign works fades from Cohen's narrative.

Yet Cohen's continuous reference to "improvement"—a term used dozens of times—brings to mind Lord Asa Briggs's 1959 classic study of British culture, *Age of Improvement: 1787-1863*. According to Briggs, attitudes of moral, spiritual, and political amelioration dominated British culture for generations, years that

correspond rather closely with Cohen's timeframe.⁷ A less prominent work, Sarah Wilmot's *Business of Improvement* applies a similar analysis to the British agricultural sciences over the same era.⁸ Although the British landowning elite have often been dismissed as rooted to static traditions and social norms, Wilmot describes a class of agricultural improvers who saw science and its applications as essential for a changing rural society. Rural reformers also used scientific experiences as a form of cultural capital as they established connections with other leaders of Britain's scientific community, built and promoted utilitarian programs aimed to benefit large sectors of society, and saw their attention to agricultural improvement as a form of service to the larger society. In brief, the British case suggests that the search for the credibility of scientific knowledge, the shift to more quantitative analysis of the built environment, and political and cultural battles over such issues did not emerge in an American vacuum.⁹

I am more familiar with the situation in the German states, which similarly suggest that the American experiences were not unique.¹⁰ Although examples can be found in the late eighteenth century, the obvious place to begin is the work of the north German writer Albrecht Daniel Thaer. His comprehensive four-volume work, *Grundsätze der rationellen Landwirthschaft (Fundamentals of Rational Agriculture)*, published 1809-1812, stresses many of the themes found in American writings a generation later. Thaer's description of agriculture as a "trade" with the primary goal of maximizing profit for the landowner fit in well with Adam Smith's capitalist ethos that attitudes toward improved agriculture across the western world.¹¹

⁷ Asa Briggs, *The Age of Improvement, 1783-1867* (Harlow: Pearson, 1959; 2nd ed. 2000).

⁸ Sarah Wilmot, *"The Business of Improvement": Agriculture and Scientific Culture in Britain, c. 1770-c. 1870* (Historical Geography Research Series, No. 24), (Bristol: Historical Geography Research Group, 1990).

⁹ E. John Russell, *A History of Agricultural Science in Great Britain, 1620-1954* (London: Allen & Unwin, 1966); Nicholas Goddard, *Harvest of Change: The Royal Agricultural Society of England, 1838-1988* (London: Quiller, 1988).

¹⁰ Important studies of early efforts to bring the applied sciences into the public sphere in the German states include Denise Phillips, *Acolytes of Nature: Defining Natural Science in Germany, 1770-1850* (Chicago: University of Chicago Press, 2012); Henry E. Lowood, *Patriotism, Profit, and the Promotion of Science in the German Enlightenment: The Economic and Scientific Societies, 1760-1815* (New York: Garland, 1992); and Andreas Daum, *Wissenschaftspopularisierung im 19. Jahrhundert: Bürgerliche Kultur, naturwissenschaftliche Bildung und die deutsche Öffentlichkeit, 1848-1914* (Munich: Oldenbourg, 1998). For a focus on the political and cultural meanings of the emerging agricultural sciences in particular, see chapter one of Mark R. Finlay, "Science, Practice and Politics: German Agricultural Experiment Stations in the Nineteenth Century," (Ph. D. Diss., Iowa State University, 1992).

¹¹ Albrecht Daniel Thaer, *Grundsätze der rationellen Landwirthschaft* (Berlin: Realschulbuchandlung, 1809-1812). See also Albrecht Daniel Thaer [sic], *The Principles of Agriculture* (trans. William Shaw and Cuthbert W. Johnson) (New York: Greely & McElrath, 1846).

Thaer also expressed ideas that resonated with, and often preceded, Cohen's interest in the moral and material side of agricultural improvement in the United States. Like many of the Americans described in *Notes from the Ground*, Thaer believed that agriculture was too complex for landowners to count on others to unravel nature's mysteries. Similar to the "georgic" ideal that Cohen describes, Thaer insisted that farmers' hard work and personal effort lay at the foundation of agricultural understanding. He disdained any hint of idleness, whether found among uncurious landowners, indolent farm laborers, or draft animals not used to maximum efficiency. Thaer also taught that skilled farmers needed the moral clarity, intelligence, and attention to detail in order to actively investigate the land and shape farm practice. Thaer further maintained that the rational landowner had to be a conscientious traveler, continually learning through intense observation of successful farm practice *in situ*. Active engagement with the land, combined with some intellectual training, would allow the trained farmer to recognize such things as the wide variation in the chemical and physical characteristics of German soils. He thus called upon farmers to study soil color, to deduce soil properties by examining native vegetation, and even to learn from "the feel from riding over land" on horseback, in order to ascertain the presence of clays and other measures of soil quality.¹²

Skepticism was another essential trait, for landowners could not trust the validity of practices established by tradition, or by neighbors, until they had been subjected to serious scrutiny. Thaer linked all of this with demands for quantitative analysis. To that end, he presented complex calculations that explained how to determine the ideal plants for specific soils, the nutritive value of various livestock feeds, the proper wages for farm laborers, and much more. In all, he laid down guidelines for discovering the legibility of nature and bringing a spirit of scientific inquiry to the project of social improvement through agricultural science.

These foundations helped establish a cultural environment in the German states in which the ideas and practices of improved agriculture could emerge. The German situation also parallels Cohen's focus upon the budding interest in soil fertility, agricultural chemistry, and experimental agriculture in the generation before the chemist Justus von Liebig burst on the scene in 1840. German innovators formed increasingly complex agricultural societies, established new educational institutions, and honed rhetorical and communicative techniques that enabled them to persuasively promote agricultural improvement as a public good. Although Thaer's assumption that the soil component "humus" was the most fundamental of all measures of agricultural productivity did not stand the scrutiny of later scientists, his call for careful observations of rural phenomena, promotion of comparative trials conducted in the open air, and insistence that "nature acts everywhere on uniform and determined rules" resonated far beyond his homeland.¹³

¹² Thaer, *Grundsätze der rationalen Landwirtschaft*, I, 39.

¹³ Thaer, *Grundsätze der rationalen Landwirtschaft*, I, 8.

As in the United States, agricultural improvement in the German lands also revealed a social dimension. A new community of reformers—estate owners, agricultural school directors, and public officials—promoted the dissemination and vernacularization of agricultural science for social and political reasons that extended well beyond the promise of improved crop yields. Authors like Bavarian agricultural school leader Max von Schönleutner, a Thaer student, argued that it was “noble and patriotic” for students to overcome resistance to innovation and he hoped to awaken a common trust in rational agriculture that would benefit the larger society. The educated farmer, Schönleutner argued, could not simply follow traditional recipes for agricultural success, but needed to study and learn to manipulate relationships among crops, soils, and other conditions.¹⁴ Another Thaer student, August Gottfried Schweitzer, articulated the farmers’ patriotic duty to produce more food in view of rising threats of hunger and emigration. Not unlike concurrent writings of the Americans, Schweitzer insisted that the real scientific farmer “must have learned to farm with his own hand.”¹⁵ Before Virginians hired Rogers as their state geologist, Wilhelm Augustus Lampadius of the Freiberg Mining Academy urged states to employ a number of traveling “district-chemists” who would conduct soil analyses and dispense chemical advice among local governments, industrialists, and agriculturists.¹⁶ By 1836, Saxon landowner Carl Friedrich Groh proposed that a pan-German network of some two hundred local agricultural unions hire their own chemists, veterinarian/physicians, and natural historians in order promulgate the rural sciences.¹⁷ A few years later, another German agricultural chemist pushed even further for the intellectual independence of budding rural scientists by offering, for a “few dimes,” low-cost chemical apparatus to accompany his textbook.¹⁸

These are just a few of many examples that could be cited from the German area in the years that correspond with, and in most cases preceded, Cohen’s case studies. In general, it seems that the Germans’ spirit of concern about their soils, debates over the validity of claims emerging from scientific experts, demands that leading farmers conduct empirical studies themselves, and convictions that this work had

¹⁴ Max von Schönleutner, *Theorie des Ackerbaues, nach physicalischen, durch vieljährige Erfahrungen geprüften Grundsätzen* (München: Cotta, 1828), iv.

¹⁵ August Gottfried Schweitzer, *Über die Wichtigkeit des wissenschaftlichen Studiums der Landwirtschaft* (Dresden/Leipzig: Arnold, 1830), 3-7.

¹⁶ Wilhelm August Lampadius, “Ueber die zweckmässige Benutzung des jetzigen Zustandes der chemischen Wissenschaft für Menschenwohl,” *Journal für technische und ökonomische Chemie* 15 (1832): 1-11.

¹⁷ Carl Friedrich Groh, “Über die Organisation eines landwirthschaftlichen Instituts durch ganz Deutschland, in D. G. Kieser and D. J. C. Zenker, eds., *Amtlicher Bericht über die Versammlung Deutscher Naturforscher und Ärzte zu Jena im September 1836* (Weimar: Voight, 1837), 58-61.

¹⁸ E. N. Horsford, “Introduction,” in Julius Adolf Stöckhardt, *The Principles of Chemistry Illustrated by Simple Experiments* (Boston: Phillips, Sampson, and Company, 1857), x-xi.

value for the future of the inchoate German nation paralleled many of the experiences in the United States.

My point, of course, is not to challenge Cohen's decision to focus on the antebellum United States. And to be sure, my own somewhat provincial focus on the German situation deserves similar scrutiny. Moreover, I will concede that Cohen has been impressive in discerning precisely what kinds of scientific practice caught on in the antebellum United States, and that I have not noticed many explicit parallels with the "georgic" and "homespun" attitudes that Cohen has identified. Nevertheless, I hope that my comments in this roundtable may launch an exchange of ideas about questions of German and American similarities and differences. More broadly, I hope to offer a reminder that historians have a tendency to cite foreign examples as a foreground to the more nationalist story that they intend to tell, rather than look at the ongoing nature of transnational exchanges. Indeed, all historians are at risk of focusing on single time or place, without the requisite attention to alternatives. Whether or not the transnational issues I have raised are important, I certainly agree that Cohen's questions are significant ones. I am pleased that our parallel research has uncovered corroborating evidence of the rise of scientific literacy, quantitative thinking, and environmental consciousness in the early nineteenth century. In both cases, these trends emerged in surprisingly rural locales, often led by innovative farmers and landowners who were not empty vessels waiting for science to be delivered to them. Thus in the United States, the German states, and elsewhere, knowledge of the land was actively produced on rural estates and disseminated through increasingly professional agricultural societies. Despite some apparently rudimentary origins, this work eventually became systematic and widely accepted. An ambitious book, Ben Cohen's *Notes from the Ground* deserves scholars' attention and admiration for the many productive, provocative, and pertinent discussions that flow from his questions.

Response by Benjamin R. Cohen, Lafayette College

I'll start with the predictable, which in this case has the virtue of also being true: I am grateful to Mark Finlay, Daniel Goldstein, Douglas Hurt and Steven Stoll for their thoughtful and generous responses to *Notes from the Ground*. Each provides a complimentary account of the book's main points and then offers a respectful critique about aspects either underplayed, unexamined, or, perhaps, just unclear. The tenor of their replies is to advance the themes, arguments, and topics that the book explores. I want to take the responses in that vein because, although for the sake of reader interest I don't want to be too agreeable, I find that there isn't all too much to disagree with. It is to the commenters' credit that I have the chance to consider the book anew. It is with thanks to Jake Hamblin for instigating and organizing the forum that I can do so.

Admittedly, this kind of forum presents the author (me) with the great temptation to quote passages from the book itself (self-plagiarism, I recently learned it was called) to restate the goals that I sought there. Things like: I was interested foremost in exploring the cultural basis from which agriculture and science first came together in America. This led me to read up on views of science by those working the land, which required me to attend to the circulation of debates and the ways farmers and planters were knowledge producers about the soil, not just the cultural phenotype we call the agrarian. Or things like: I didn't want to study only the dirt and then the farmer and then glob them together; I was more interested in the spaces between the farmer and the dirt in an effort to see how actors developed this activity, science, to fill that space. Or, here's one more: I wasn't after what farmers knew and when they knew it, but something at the level of trust and credibility, something about why one would listen to another when given new information. I thought this might help me learn about larger patterns of environmental knowledge production, those understood not only from a professional or institutional perspective (like a college, or a government agency, or a textbook) but from a practitioner's view.

This kind of forum also gives me the chance to be up front about some of the core commitments that underlay my thinking when writing the book. To paraphrase Richard White and restate a line I just wrote, I wanted to do more than write the history of chemistry alongside a history of the land (the soil, more specifically) and call it a history of agricultural science. "This would be like writing a biography of a wife, placing it alongside the biography of a husband and calling it the history of a marriage," as he wrote.¹⁹ I was, like White, after a history of the relationship itself. I was a bit surprised in the reception of *Notes* that reviewers of the past few years and

¹⁹ Richard White, *The Organic Machine: The Remaking of the Columbia River* (New York: Hill and Wang, 1995), x.

the respondents here didn't out me for being more influenced by White's work than I admit to in a just a few scattered references in the book. But the history of a relationship indeed stuck in my head as the thing to write about and the difficulty in writing that history was one of capturing something in motion, something dynamic, something active. When that something is "knowledge," well, all the more elusive. Not just that, but White's more frequently cited contribution of "knowing nature through work," which Stoll and some reviewers do mention, led me to consider the deeper pragmatist principles at play of knowing-through-doing. The agrarian world of the early Republic was not generally one of quiet contemplation from afar. It was a world of active deliberation on the ground, where the concepts of nature and the ways people sought to manipulate their environmental surroundings were part and parcel of their daily lives. Or, as I sought to show, it was a georgic world.

Thus it was my concern to understand why people made decisions for one thing and not another inside that world, why actors in the early American Republic chose to adopt some sets of activities but not others. Put another way, and accepting that agrarian metaphors are unavoidable, I wanted to understand the cultural and material conditions from which science grew (how it was cultivated, who tended it, what a fertile subject, I could go on). This has science as a product of culture, not outside it, a human activity developing in real time. But enough self-reflection.

Steven Stoll makes the point that, if I wanted to explain why actors in the early American Republic chose to adopt some sets of activities but not others, the book needed to pay more attention to capitalist imperatives and the changing logic of the marketplace. That seems like a fair point. *Notes* could have built in more attention to an increasingly important kind of capitalist logic that treated soil management as an element of productive capacity and economic-rational farm organization. In relation to this request for more capitalism in the index, Stoll also comments on the explanatory value of the georgic ethic. It's a topic Hurt touches on too. I have a different sense of the georgic ethic's value than the one I read in their essays, though, and I'll return to that below.

In his comments, Mark Finlay makes the point that, to aim for that same goal of explaining why actors chose some sets of activities but not others, the book could have brought more attention to the ways actors in the American setting were part of wider debates on a global stage. In his example, Finlay points to Germans, and Albrecht Daniel Thaer in particular, as antecedents to the georgic dialogue of American farmer-writers. That too seems reasonable. Bringing more attention to the European debates (beyond Davy and Liebig) could have given additional context for the Americans and their georgic correspondents. It would have helped shape the book in ways that were more attentive to the features common beyond the American context rather than those which carved out that place's uniqueness.

Daniel Goldstein, in his comments, helps link the farmers under consideration in the book—in their role as knowledge producers—with others of the era, such as physicians (he mentions Daniel Drake), naturalists (the Texan Gideon Lincecum), and ornithologists (Alexander Wilson), while Douglas Hurt asks for more deliberation on the slavery question. Goldstein's comments add texture to the era and allow for readers to consider schools of thought like Natural Theology and Providential questions related to early Americans' deference to God's will. He adds a religious cultural dimension. Taken together, the responses identify religious, cross-Atlantic, labor, and the marketplace contexts, all of which were important.

My first thought in reading the responses was, that's a lot of things, who has the time? My second thought was more helpful, though, because the comments had me realizing that this very H-Environment forum is a chance to add texture to the book. In that way the forum is a kind of revision and embellishment, a path for future readers who could read the respondents' comments alongside the book. I'm thankful for that addition.

But beyond those straightforward calls and response to the commenters, there are some interesting issues of historiography, research, and narrative, not just topic and emphasis, lurking about. That georgic question, for example.

Except for scholarship by Laura Sayre and Timothy Sweet, the georgic ethic, in my readings, was far too concealed in the historical literature and ignored in two senses—first as an actor's category, as the ways the farmers and policy makers themselves understood their land and their lives; and second as an analyst's term, the ethic itself, something that could be recovered and put to use.²⁰ The pastoral has so dominated our perceptions of the so-called Romantic period that I wanted to offer something beyond it. It happened, as I was doing research and becoming more familiar with the cultural terrain of the era, that the pastoral did not help me understand much about the science of agriculture. The georgic did.

I'd been thinking about this ubiquitous improvement question throughout the book project—what does it mean to 'make things better.' Stoll then asks, and I think astutely, what happens when improvement ceases to represent the georgic goals that I characterized as dually moral and material. But I read that question as one about the long view that carries us far beyond the early Republic, about what happens after the 1860s where *Notes* ends, not one about the era itself. Addressing this question doesn't have me rethinking the book's argument, in other words, but it

²⁰ If I could move from self-plagiarism to self-promotion for a moment, I ended up working this out for an article called "The Once and Future Georgic," one that I thought of as 'a historian uses environmental ethics to speak to rural sociologists.' In the context of this review forum, I view this article as a response, albeit preemptively and unknowingly, to Hurt's question about how the georgic might work beyond the early Republic. See "The Once and Future Georgic: Agricultural Practice, Environmental Knowledge, and the Place for an Ethic of Experience," *Agriculture and Human Values* 26 (3) (2009): 153-165.

does demand more explanation of the end of the story the book tells. On that count, I see the shift from the georgic framework of the early Republic to a more capitalist framework thereafter not as one that moves from the labor-based georgic to the distanced pastoral ethic, but one that moves from an environmental ethic based on connection to the land to one based on connection to the marketplace.

It would be over-stating it for me to claim a strict demarcation of “before the 1860s” and “after the 1860s,” but for the purposes of thinking about what happens when improvement ceases to represent georgic goals, I’d offer that agricultural science’s new cultural credibility by mid-century allowed it to become the domain of rationalistic experts post-bellum, where agricultural science was no longer strictly georgic. I see the georgic ethic’s role in explaining trust and credibility mechanisms as one that more suitably follows from the early nineteenth century American cultural context than the pastoral. Whose knowledge mattered, not just what the knowledge was; those who had knowledge fostered through experience-based mechanisms were more authoritative than those whose knowledge was not. In this way, and again, the georgic ethic helped me recognize why actors in the early American Republic chose to adopt some sets of activities but not others in ways that the pastoral ethic did not. But once they chose those activities, once those practices became possible choices amongst the legislators of land policy and the participants in broader market economies, the story was different.

The science had been molded, as it were, into a public, organizational domain, one that we thereafter can understand through the capitalist imperatives that Stoll is pointing to. A “Mexican woman cutting a head of iceberg lettuce with a short knife in a field that is capital owned and machine cultivated,” to quote Stoll, surely is a kind of life excluded from the material conditions that gave the georgic meaning. Once the science becomes institutionalized and promoted by the codified social structure James Scott refers to in *Seeing Like a State*, then yes, policy-makers have marginalized that earlier georgic, homespun context. The georgic isn’t gone, but it isn’t central either.²¹ The Mexican laborer is in the capitalist agricultural world that thereafter developed, not someone in the fields of the early Republic who understood the value of systematic agriculture through a georgic lens. The georgic ethic was something that helped me bind together this subfield of the history of science, technology, and the environment, not something that explained the rise of an agricultural market defined through capitalist values.

I read in Finlay’s point something larger about a shift in environmental historiography. He asks how more attention to German currents of agricultural thought and European patterns of activity might add a stronger cross-Atlantic bent to the book. Because my initial point of departure in *Notes* was to get past a Davy and Liebig-centered account of agricultural chemistry, I had moved the center of the narrative from European scientists to American farmers. Finlay may be suggesting

²¹ Check out that prior footnote for my effort at discussing how we might bring the georgic in from the margins.

that doing so *re-centered* the story in a new place instead of *de-centering* a story that was more globally diffuse. I read this as a point about the shifting methods of historiography because it has me considering that my work could have been more attentive to the growth of global environmental history. I thus find that the book's historiographical place fits at the tail end of an era (the early 2000s) that was not yet fully engaged with global environmental historical research. I don't mean all work in environmental history is now global, nor that earlier work was not global at all. I mean instead that I was aware when the book came out that it had been researched and written at a time when my own training was not as fully emphatic that narratives in environmental history not be defined by political, national borders.

There's a Stanley Kunitz poem, "The Layers," where he suggests we "Live in the layers/not on the litter," something I've always taken to mean in Foucault's archaeological sense that we might dig below the top layer, rough as it is, to recognize the ways layers pile on top of layers. It's a versatile metaphor for environmental historians, apt as a reference to forest floors or geological strata or, in my case, layers of soil. Or it's apt for the craft of history itself, where it helps explain the palimpsest of historical thought, where the earlier modes of thinking and acting by historical characters are not so easily erased from the scroll but remain etched beneath the new ways of thinking and acting.²²

The "layers" could be about the historical record itself. But I also look to layers in the sense of how we write about those historical records. This is probably why I think the book is best read alongside a number of others, many of which the commenters have identified. *Larding the Lean Earth* (2002) is of course one of them, but so too is Conevery Bolton Valenčius's *The Health of the Country* (2002), and Richard Judd's *The Untilled Garden* (2009). In this regard, I would disagree with Goldstein, who suggests that *Notes* is providing an alternative explanation of what Valenčius shows in *The Health of the Country*. Rather, I understood the people I wrote about in *Notes* as living in a world of environmental knowledge very much in keeping with the one Valenčius's Missourian settlers lived in. Likewise for some of Judd's work and, I would add, Linda Nash's *Inescapable Ecologies* (2007). These studies all sit on the same part of the shelf at my house, where the books are arranged by, for lack of a better phrase, 'how people know nature,' not the location or era. I understand these as complementary, not competitive, accounts. Add in Alan Marcus's *Agricultural Science and the Quest for Legitimacy* (1985) and White's *The Organic Machine* (1995) before them and I imagine a trajectory in publishing into which *Notes* fits. As a contribution to environmental history, then, I want to add Finlay's own understanding of German agricultural science along with, perhaps, newer work by Greg Cushman (2013) and Ted Melillo (2012) that shows the North-

²² In that lies a challenge to Kuhnian incommensurability, but I'll leave that digression for another forum.

South axis from the Guano Islands and Chile as fully as the cross-Atlantic one. In that bibliographic relation, *Notes* is in the middle of a changing and growing account not just of the early Republic but also of historians' attempts to understand the traffic of environmental knowledge.²³

That speaks to the environmental history side of the marriage. Speaking to the history of science side more directly, I'll admit I chose the title of the book for the way it linked Jefferson and Dostoevsky, but it turns out the book was indeed a grounded view of science, one that must be as much a cultural history as a history of science insofar as the science is an outcome of that cultural foundation. For this reason, I can't say I entirely follow Goldstein's point about two perhaps incommensurate narratives inside this one book. He observes that one story addresses the means by which agricultural chemistry followed from earlier organic models to later mechanistic ones; the other narrative, he notes, traces the ways farmers and the agrarian class tested and vetted scientific practices. My concern with this perception of a split comes from Goldstein's reading that science was "embedded into" a cultural setting and that "science was given new and different meanings." The era, though, wasn't one where a stable entity called science waited patiently for others to deploy it. Part of the problem in discussing this is the language, and I don't mean to over-read Goldstein's comment, but my point in *Notes* was to present science as cultivated in the soil itself, not just in the books and armchairs of philosophers. To say this, though, is leading me to a mere restatement of my goals in the book.

I'll end, then, with one final act of self-plagiarism. I admitted in the book's preface that while the basic arc of the book and set of archival sources I used were from the history of chemistry and the farm, in its larger ambition *Notes* was a study of how science became a culturally credible means for humans to interact with the environment. I suspect that the critiques from these four respondents identify the area between the text itself and the larger ambitions that follow from it. If nothing else, I had hoped the book would be a reference in a conversation that moved from the historical conditions that made agricultural science possible to the ways the recent literature in agricultural, scientific, environmental history, *Notes* included, might make possible new works and open up the research field. I'm grateful for the chance to have talked about it more.

²³ Conevery Bolton Valenčius, *The Health of the Country* (2002); Richard Judd, *The Untilled Garden* (2009); Linda Nash, *Inescapable Ecologies* (2007); Alan Marcus, *Agricultural Science and the Quest for Legitimacy* (1985); Greg Cushman, *Guano and the Opening of the Pacific World: A Global Ecological History* (2013); and Edward Melillo, "The First Green Revolution: Debt Peonage and the Making of the Nitrogen Fertilizer Trade, 1840-1930," *American Historical Review* 117 (October 2012): 1028-1060.

About the Contributors

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