Grounded Science: The Shrinking Scale of the Local Environment in Agricultural Research and Extension at Iowa State, 1858–1914[1]

JOSHUA TONKEL

IN SIOUX COUNTY, IOWA, in the winter of 1903, Perry G. Holden, Professor of Agronomy at Iowa State College, stepped out of the cold weather into a room bustling with a heated discussion among local farmers. The lively conversation paused as he entered the room, and a Mr. Hawkins called out to Holden to ask him to weigh in on the matter—whether the agricultural experiments performed at Iowa State's campus in Ames had any relevance for farmers 200 miles away in Sioux County. Excited by this question, Holden told the assembled farmers that they had raised "a matter of very great importance to agriculture."[2]

---

1. This research was supported by multiple sources. First, from the State Historical Society of Iowa through their 2022–2023 Research Grant for Authors; thank you to the SHSI for their generous support. Thank you also to the Institute for Scholarship in the Liberal Arts at the University of Notre Dame for their support through their 2023–2024 "Technology and the Common Good" Annual Research Theme Grant. Finally, thank you to the anonymous reviewers and to Andrew Klumpp for their suggestions that have helped improve this article in many ways.

2. "Professor P.G. Holden," Perry G. Holden Paper, RS 16/3/11, Iowa State University Special Collections and University Archives, Ames, IA (hereafter ISU SCUA).

THE ANNALS OF IOWA 83 (FALL 2024).

In mentioning the agricultural experiments in Ames, the Sioux County farmers referred specifically to those performed by the Iowa Experiment Station established at Iowa State by the 1887 Hatch Act. This act tasked these new experiment stations with "acquiring and diffusing . . . useful and practical information on subjects connected with agriculture" by pursuing "experiments bearing directly on the agricultural industry of the United States . . . having due regard to the varying conditions and needs of the respective States."[3] The Iowa Experiment Station accepted this mission, taking up lines of work related to concerns of Iowa farmers. Initial research included the development of new grain varieties that would better resist diseases common in Iowa's climate, tests of why certain Iowa soils produced less corn than other soils, and the determination of crop varieties best suited to the Iowa environment.[4] This research agenda embodied an underlying principle that defined Iowa State's agricultural mission into the twentieth century: Iowa State's agricultural scientists should account for local environmental conditions in their research.

The Sioux County farmers' concerns, however, revealed a sentiment among farmers that Iowa State had not lived up to this mission. The scientists in Ames may have tasked themselves with accounting for environmental conditions, but since the conditions in Ames differed from those in Sioux County, the farmers doubted that the Ames experiments had relevance for their work. Agreeing with this assessment, Holden spoke to them of the "tremendous value" he placed in "local crop demonstrations close to

3. For a historical overview of the land-grant movement, including the impact of the Hatch Act, see Nathan Sorber, *Land-Grant Colleges and Popular Revolt: The Origins of the Morrill Act and the Reform of Higher Education* (Ithaca, NY, 2018); and Roger L. Williams, *The Origins of Federal Support for Higher Education: George W. Atherton and the Land-Grant College Movement* (University Park, PA, 1991). For an excellent overview of the broader literature on land-grant schools, see Nathan M. Sorber and Roger L. Geiger, "The Welding of Opposite Views: Land-Grant Historiography at 150 Years," in *Higher Education: Handbook of Theory and Research: Volume 29*, ed. Michael B. Paulsen, Higher Education: Handbook of Theory and Research (Dordrecht, NL, 2014), 385–422.

4. This outline of the performed and planned work of the Iowa Agricultural Experiment Station is laid out in *First Annual Report of the Iowa Agricultural Experiment Station, from March 1 to December 31, 1888* (Des Moines, 1889), 7–13.

the people." He declared that the best advice about agricultural practice would come from someone living in the county who could run a demonstration farm, and he backed this up by helping establish just such a county demonstration farm in Sioux County, near Orange City, later that spring.[5]

This conversation between Holden and the farmers in Sioux County represented an important shift in how Iowa State pursued its environmentally grounded research. Over the next few years, more and more county demonstration farms, modeled after the one in Sioux County, popped up across the state, and the rationale behind these demonstration farms echoed the rationale Holden gave in 1903. A 1907 report explained that the county farms had "grown out of a desire on the part of numerous farmers to see experimental work carried on near their homes under their own conditions."[6] And as a 1911 report concluded, since these county farms exhibited experiments performed with local seed and local soil, "the results have a vitality which appeals to the people."[7]

By creating county-based demonstration farms, Iowa State continued a long trend of refining its conception of what constituted the "local environment." Between the 1850s and the 1910s, Iowa State's conception of the local environment continually narrowed. Adonijah Welch, the founding president of Iowa State, defined the local environment in terms of broad geographic regions, declaring that the new school would serve the interests of "the west" rather than the interests of the East Coast. Through the 1870s and 1880s, agricultural scientists met to work out proper research methodologies and defined the local environment in terms of state boundaries, with Iowa State's Seaman Knapp calling for a national system of state-based experiment stations. By the turn of the twentieth century, farmers' complaints about the inapplicability of agricultural research redefined the

5. "Professor P.G. Holden," Box 1, Folder 2, Perry G. Holden Papers, RS 16/3/11, ISU SCUA.

6. M.L. Mosher, "Farm Crops: Annual Report, 1906–1907," Box 1, Folder 19, Extension and Outreach Annual Reports, RS 16/1/0/1, ISU SCUA.

7. M.L. Mosher, "Farm Crops: Annual Report, 1910–1911," Box 2, Folder 1, Extension and Outreach Annual Reports, RS 16/1/0/1, ISU SCUA.

proper scale down to the county level, resulting in Iowa State's creation of county demonstration farms. Finally, Iowa State's agricultural extension work, led by Perry Holden, insisted that farmers try out recommendations themselves, narrowing the focus to the level of individual farms.

As this history demonstrates, continual efforts to account for local environmental conditions defined the early work of Iowa State's agricultural research and extension work, a fact that earlier histories of Iowa State have not emphasized.[8] While works in agricultural history have highlighted calls for including farmers in agricultural improvement research, few works have discussed how late-nineteenth-century agricultural scientists accounted for increasingly smaller scales of the local environment by incorporating farmers as key players in knowledge production.[9] To highlight these features of agricultural research, this study of Iowa State's environmentally grounded research bridges agricultural history and the history of science by pointing out that scientific work is deeply shaped by the place in which it is done.[10] The early history of Iowa State's agricultural research and extension therefore exemplifies how science is embedded in society and the environment, offering an illustrative case of how scientists made

8. Though they do not emphasize the role of the environment in extension history, historians have well documented the social and economic responsiveness of agricultural extension; for example, see Dorothy Schwieder, *75 Years of Service: Cooperative Extension in Iowa* (Ames, 1993); and Alan Marcus, *Agricultural Science and the Quest for Legitimacy: Farmers, Agricultural Colleges, and Experiment Stations, 1870–1890* (Ames, 1985). For an excellent source on the institutional history of Iowa State, see Earle D. Ross, *A History of the Iowa State College of Agriculture and Mechanic Arts* (Ames, 1942).

9. For an insightful treatment of Wendell Berry as a late twentieth century advocate for involving farmers in the agricultural knowledge making process, see Jeffrey Filipiak, "The Work of Local Culture: Wendell Berry and Communities as the Source of Farming Knowledge," *Agricultural History* 85, no. 2 (2011), 174–94.

10. For a delightful discussion about the promise of bridging agricultural history and the history of science, particularly with regard to how their combination can highlight that sites of agricultural experiment were not merely "institution[s] for enabling science to get done, but also a place situated in a particular environmental context," see Deborah Fitzgerald, et al., "Roundtable: Agricultural History and the History of Science," *Agricultural History* 92, no. 4 (2018), 569–604. Quotation 572–73.

their work useful for farmers and their world by grounding their agricultural research in local natural environments.

Adonijah Strong Welch's Founding Vision for Iowa State

Standing before an assembled crowd at the University of Nebraska on a summer evening in the 1880s, Adonijah Strong Welch, first president of Iowa State College, laid out a vision of higher education that would train students to be proper managers of the natural environment—a vision he believed should guide the work of Iowa State. He began his address, entitled "The Kind of Higher Education Needed in the West," by describing the type of work Iowans did, emphasizing their management of natural resources. Welch characterized the unique environmental context of western states like Iowa, pointing to "the extent of the undeveloped wealth that slumbers in or beneath its soil" as the primary factor dictating the skills needed by those living and working in western states. He insisted that these conditions necessitated "men whose thought culminates in action, whose wisdom is proven by its immediate fruits" and "men who bring to every undertaking both the level head and the skillful hand."[11] In other words, for Welch, effectively managing their natural environment required Iowans to receive an education in the practical application of scientific knowledge.

Welch held a cornucopian view of the environment in Iowa and its surrounding states, proclaiming that within the United States, only in the Midwest could one "find an equal area combining such unlimited natural resources." As evidence, Welch pointed to the "vast pineries" across the north and to the south "boundless prairies" with "uniform and wonderful fertility." Welch argued that such abundant resources promised great rewards, and this promise provided a "perpetual stimulant to emigration" as people moved west to take advantage of this natural prosperity. But the growing population needed training to best utilize these resources. Welch lamented that "the resources of this

11. Adonijah Welch, "The Kind of Higher Education Needed in the West, delivered at Nebraska University, 1884 circa," Box 2, Folder 3, Adonijah Strong Welch Papers, RS 2/1, ISU SCUA.

profitable land . . . are largely wasted by crude management and misdirected effort," insisting that states like Iowa needed scientific experts, who could uncover principles by which Iowans could utilize these resources "with the least investment of muscle and money."[12] Welch therefore viewed the environment of western states as one of plenty, insisting that proper management was needed to effectively utilize this great abundance.

Welch saw scientific knowledge as the means for effective management of these natural resources and maintained that the value of that knowledge only came from its application to particular environmental contexts. This defined the character of the education he instilled at Iowa State. Outlining this quality, Welch spoke to his Nebraska audience about the differences between "the old education" of colleges emphasizing theoretical education and "the new education" he had instituted at Iowa State, which emphasized practical education. As Welch portrayed it, the old education remained inside "mystic halls," while the new education emerged "into the open air . . . reveal[ing] to her loving pupils the secrets of nature." Welch prioritized placing the student in the environment in which they would use the knowledge, a point he made using an analogy with swimming. As he explained,

> The old education . . . would prepare the tyro for swimming by giving him a muscular drill out of water so perfect and well balanced that if, by accident, he fell into water, it might be expected he would swim anyhow. The new education puts the tyro into water, gives him all needed instruction and help, declaring that the best preparation for the art of swimming is found in the act of swimming.

In light of this view, Welch insisted that proper agricultural training would come through actual farming. And rather than learning "out of the water," farmers would learn "in the water" by

12. Among the processes that Welch thought needed expert teachings, he listed the preservation of forests through responsible timber consumption, economical feeding of livestock to better utilize the crops grown by farmers, and better breeding practices to produce the best quality beef. Welch, "The Kind of Higher Education Needed in the West."

learning to farm in an environment like the one in which they would later work. After receiving this environmentally grounded training, Welch argued that Iowa farmers could provide balms to common Iowa environmental problems like "excessive drouths [*sic*], untimely frosts, violent storms of wind and rain, [and] diseases of animals and plants."[13] Welch therefore believed that education oriented towards the environmental contexts of Iowa agriculture would promote effective environmental stewardship.

Alongside this view of education, Welch promoted a style of agricultural research that accounted for the environment through the blending of scientific and practical expertise. He outlined this vision at a convention of land-grant leaders held about a decade before his Nebraska address. Welch pushed back against a common distinction between "the scientific and the practical," arguing that he had "never been able to see it." Rather than seeing two distinct classes of laboratory scientists on the one hand and practical farmers on the other, Welch maintained that agricultural scientists and farmers were two sides of the same coin. As he explained, "the so-called practical men . . . cannot do without the scientific workers, because there would not be any great or genuine progress without the application of scientific discovery to the work on the farm;" and on the other hand, "the scientific . . . men never could reduce their experiments, their discoveries, to practice on the farm without the muscular workers." In other words, because science only led to progress when farmers applied the science to farming practice, science relied on practice for its efficacy. And in order to successfully apply scientific knowledge, scientists needed practical knowledge related to "manipulations of the farm," something which included intimate knowledge of local environmental conditions—which for Welch meant the natural abundance of western states. He therefore tasked Iowa State with marking out a place for practical knowledge within scientific work in order to properly account for the environmental conditions of Iowa's geographic region.[14]

---

13. Welch, "The Kind of Higher Education Needed in the West."

14. Welch's speech is recorded in Richard Hatch, ed., *An Early View of the Land-Grant Colleges: Convention of Friends of Agricultural Education in 1871* (Urbana, IL, 1967), 79–80.

Many other land-grant leaders and scientists agreed with Welch's blending of science and practice in agricultural research. In fact, the delegates of the land-grant convention gave Welch a hearty applause after his comments.[15] But over the course of this convention and others that followed throughout the 1870s and 1880s, agricultural scientists focused on a different scale when defining local environments. Their new focus culminated in calls for a national system of experiment stations that could account for environmental conditions at the state level.[16]

Land-Grant Conventions about Agricultural Scientific Methods

During a series of land-grant conventions of the late nineteenth century, agricultural scientists from across the country acknowledged the challenges of agricultural research, often in terms of the difficulty of accounting for diverse environmental conditions. For example, a Michigan scientist described how the "great variation of soils" meant that experiments frequently gave very different results across different experimental trials. His solution was to "try experiments at quite a number of different points, having all the conditions precisely alike . . . making the conditions that vary simply those of climate, soil, etc." In other words, figure out the particularities of the specific environment of the experiment.[17] But beyond just affecting the value of scientific results, scientists maintained that disregarding considerations of the environment threatened the legitimacy of agricultural research itself. The first president of Illinois Industrial University spoke to this point,

---

15. Hatch, *An Early View of the Land-Grant Colleges*, 79.

16. Hatch provides a helpful overview of the land-grant conventions that convened in the 1870s and 1880s in *An Early View of the Land-Grant Colleges*, 146–47. To read the proceedings of a few of the land-grant conventions that continued conversations about agricultural experimental methods, see *Proceedings of the National Agricultural Convention, Held at Washington, D.C., February 15, 16, and 17, 1872* (Washington, D.C., 1872); and *Proceedings of a Convention of Agriculturists, Held in the Department of Agriculture, January 10th to 18th* (Washington, D.C., 1882).

17. This quotation comes from Manly Miles at Michigan State Agricultural College, recorded in Hatch, *An Early View of Land-Grant Colleges*, 10–11.

> Suppose you in Pennsylvania, or in Wisconsin or Michigan, go and work isolated and alone, and the rest of us wait until you have accomplished your experimentation; you reach a result and you publish it to the world, and the first practical farmer that makes a trial of that supposed result and law, discovers that it won't hold in his community, and at once throws contempt upon your agricultural science, and convicts you . . . of not knowing what you are about, and of pretending to discover things that are not true.[18]

To avoid this degradation of public trust, one Missouri scientist argued that because environmental contexts varied so much across the country, land-grant schools should "investigate the principles applicable to [their] own locality." He suggested that colleges "whose relations are very near to each other as to soil" perform experiments together, essentially ignoring the results of other colleges who do not "come within the range of its climate, soil, and stock."[19]

In many ways, agricultural scientists worked to ensure that agricultural research gave valuable results to both scientists and farmers by accounting for the influence of the environment on agriculture.[20]

Isaac Roberts, a professor of agriculture at Iowa State, exemplified the sentiments of his fellow agricultural scientists, also pushing for agricultural research that would account for local

---

18. This quotation comes from John Milton Gregory, first president of Illinois Industrial University, now known as the University of Illinois. Hatch, *An Early View of Land-Grant Colleges*, 29.

19. The proposal was put forward by George Swallow of the University of Missouri. Hatch, *An Early View of Land-Grant Colleges*, 31.

20. The examples of this paragraph are all pulled from the initial land-grant convention held in Chicago in 1871, but many more followed over the next two decades. Conversations about agricultural research methods continued at the later conventions. For discussion of how practical agriculture should be the foundation of agricultural science, see George Loring's argument in *Proceedings of the National Agricultural Convention, [. . .] 1872*, 82–83. For comments on the relationship between scientists and farmers in the production of agricultural knowledge, see Wilbur Atwater's comments in *Proceedings of the National Agricultural Convention, [. . .] 1872*, 61–62 or George Loring's comments (now as the Commissioner of Agriculture) in *Proceedings of a Convention of Agriculturists, Held in the Department of Agriculture, January 10th to 18th*, 4.

environmental conditions with an emphasis on state-level differences. To do this, Roberts pointed to his experience of experimenting on his own farm in Henry County, Iowa. He explained that when comparing those experiments with experiments in Ames on Iowa State's farms, the "wonderfully different" climate between these locations meant that "the experiments of crops that we tried [on campus] would not produce the same results as in my own county at home." Expanding on that lesson, Roberts said that when making comparisons between different states, the "climate and all things considered, will have such a different effect [between states] that you do not learn much." Experiments performed in Iowa then, because of those environmental differences, were hard to apply to the whole state of Iowa, Roberts explained, "much less to Illinois and Maine." Roberts therefore insisted that "to a very great extent, each college has got to be an experimental college for its own State, or as much of it as possible."[21]

Roberts' vision of agricultural research sharply departed from the goals commonly held up in other scientific endeavors. Recognizing the uncontrollable variables presented by nature, the difference of climatic conditions in different regions of the nation, and the resulting necessity of focusing on local conditions, Roberts espoused a vision of a science intimately related to local contexts. Dismissing any appeal for universal solutions, Roberts believed the real value of agricultural scientific work lay in its ability to solve local problems, as long as proper recognition was given to the environmentally contingent nature of those solutions. Roberts therefore urged, like his colleagues across the country, that scientists should account for the environmental context of agriculture by asking how the conditions of individual states relate to the applicability of the findings of agricultural experiments.

In an attempt to institutionalize this state-based environmentally grounded experimental mission, Seaman Knapp, a professor of agriculture at Iowa State, drafted legislation that would have created a national system of agricultural experiment

21. Hatch, *An Early View of the Land-Grant Colleges*, 106.

stations. Knapp's vision for these stations carried forward Welch's environmental focus, evident in a circular he wrote to garner support for his legislation. In this circular, he argued that the nation needed a widespread network of stations, saying that "the diversity in climatic conditions in the United States is so great that any attempt, by a single station to give information of general value, must be limited to pure scientific statements, so narrow as to fail in accomplishing the work designed." But echoing Roberts's concerns, even amidst his desire for a national system, Knapp insisted that the individual stations be grounded in the local needs of the state in which the station operated. He scoffed at the idea that "one or two stations on the Atlantic coast [could assist in] educating half a continent in the broad domain of agriculture" and offered one case of this disconnect, saying "the fruit trees, many of the forest trees, the wheats, the corn, the oats, etc., adapted to the Atlantic States, are totally unsuited to Iowa, and to nearly all that great territory between the Mississippi and the Rocky Mountains."[22] Just as Roberts had emphasized the need for state-level conditions to influence the direction of agricultural experimentation, Knapp believed that the research performed at an experiment station in Iowa or anywhere in the country should account for the local environmental context of the state in which it operated. Though Knapp's efforts to pass this legislation failed, other land-grant leaders carried forward his mission, and in 1887, the passage of the Hatch Act formally established his envisioned network of state-based experiment stations across the nation.[23]

---

22. Seaman Knapp, "Experiment Stations," Box 1, Folder 1, Seaman Asahel Knapp Papers, RS 2/2, ISU SCUA. This circular was reprinted in a number of outlets, including the *Twenty-Second Annual Report of the Secretary of the State Board of Agriculture of the State of Michigan, from October 1st, 1882 to September 30th, 1883* (Lansing, MI, 1884), 30–32.

23. For an impressively researched account of the political struggle of trying to ensure the passage of the Hatch Act, particularly George Atherton's involvement in this process, see Williams, *The Origins of Federal Support for Higher Education*, 97–116.

Improving Iowa Agriculture with Research at Iowa State

Iowa State accepted the provisions of the Hatch Act in 1888, and a consideration of Iowa's environment guided the Iowa State Experiment Station from the beginning, influencing the questions that researchers pursued. For example, much of the station's earliest work consisted of variety testing, a line of research intimately connected with environmental conditions.[24] In the station's first bulletin, station director R.P. Speer reported on an experiment testing how new varieties of fruit fared in Iowa's climate. Speer characterized a problem facing Iowa fruit growers, explaining that fruits adapted to the East Coast of the United States or to Western Europe tended to be "too tender in Iowa," except in cases where they were grown "in specially favorable locations, as on river bluff soils, and the loess soils in the southwestern part of the state." Speer therefore sought to find fruit varieties better adapted to the soil and climate of Iowa. To do this, the station staff planted a six-acre experimental orchard containing apples, pears, cherries, and plums. The varieties planted in this orchard had "proved hardy four hundred miles east of Moscow," a place where, as Speer explained, "the soils are similar to ours, and where the climate is colder, drier and more changeable than in Iowa."[25] Similarly, in a bulletin describing variety testing of various grasses to supplement Iowa corn, researcher John Craig explained that the list of promising grasses appeared long but assured readers that "the question of local adaptation . . . sifts out so many that it makes the list comparatively limited for

24. The first annual report from the experiment station lays out the importance of variety testing, saying, "We are however, of the opinion that the wants of the public demand that special attention should be given to the production of hardy and well adapted varieties of fruits, grasses and grains, by selection and cross-fertilization, and to these ends shall our best efforts be directed." *First Annual Report of the Iowa Agricultural Experiment Station*, 13.

25. *First Annual Report of the Iowa Agricultural Experiment Station*, 7–8. This orchard was reported to have contained 75 varieties of apples, 25 varieties of pears, and 45 varieties each of plums and cherries. Suggesting the importance of personal farming experience in the choice of experimental design, Speer also explained that he had grown many of the apple varieties being tested in this experiment having noted that over "five to fourteen years in Northern Iowa . . . they have proved sufficiently hardy."

particular localities." Craig suggested that rather than going to the standard lists of agricultural grasses from the eastern United States or Europe, Iowa researchers should turn their attention to "native grasses of this state, or from the states and territories west and north of our boundaries" to improve Iowa pastures and hay production.[26] In seeking crop varieties that thrived in Iowa's environment, variety tests like these therefore embodied the mission of agricultural scientists to account for their state's environmental conditions in their work.

But Iowa State scientists did more than variety testing. Researchers also investigated the influence of climate on agricultural processes, looking for implications these influences had for farming practice. For example, at the 1902 meeting of the Iowa State Horticultural Society, R.E. Buchanan articulated many influences that climate had on the growth of various plants. In focusing on climatic influences on plant growth, Buchanan consistently spoke of the value of the knowledge for farmers, saying it had "prime importance to the practical man whenever and wherever he comes into contact with plant life." He pointed to apple trees, saying that though apple trees suffered from rust in the east, the warmer and drier climate of Iowa led to thicker leaves on the trees, protecting them from rust. He also noted that northern plants tended to produce "larger and better seeds," advising Iowa farmers to use northern grown seeds, calling them "the very best."[27] Similarly, a series of experiments in curing cheese demonstrated this same feature of environmentally focused research. G.L. McKay explained that these cheese curing experiments aimed to investigate "the feasibility of central curing rooms" and "the effects of climatic conditions on the curing of cheese." As shown by their tying these two goals together, Iowa State researchers investigated environmental conditions so that they could offer better practical recommendations to Iowa farmers. In the case of cheese curing, the researchers found that "in

26. John Craig, "Promising Grasses of the Northwestern Territories," *Iowa State Experiment Station Bulletin* 3 (November 1888), 76.

27. R.E. Buchanan, "Plant Adaptations," in *Report of the Iowa State Horticultural Society for the Year 1902, Containing the Proceedings of the Thirty-seventh Annual Session* (Des Moines, 1908), 148–51.

Iowa, where the climate is warmer and dryer, it is necessary that more precaution be taken to quickly aerate and cool the milk as soon as it is drawn" and that "better curing rooms are necessary . . . so that the climate in the curing room would differ very little from the climate in the best cheese belts in the world."[28] By making environmental conditions the object of scientific study, Iowa State scientists like Buchanan and McKay pursued research they believed had crucial importance for Iowans' agricultural practices.

In the course of agricultural experiments, researchers relied on information gleaned through agricultural practice to verify information about environmental conditions. This occurred in one of two ways. The first way used field experiments at the experiment stations. R.P. Speer used field experiments to demonstrate that environmental change necessitated new practices in wheat growing. Speer explained that in the early years of Iowa agriculture, rust had not generally hindered wheat production. But in his report on years of field experiments, many of which saw crop failures from rust, he felt confident enough to assert that "the mechanical conditions of the soil are very different now from what they were then." Speer then proceeded to outline his suggestions for wheat growing in light of the environmental conditions that these field experiments revealed.[29] Second, scientists verified environmental information through consulting with actual farmers. In a bulletin about recommended drainage practices for Iowa farms, W.H. Stevenson and G.I. Christie grounded their description of existing Iowa drainage conditions not in their own expertise, but in the expertise of farmers. They asserted that "there is but one source from which reliable data regarding the present drainage conditions in the state can be secured . . . namely, the farmers and landowners." Because farmers had personal experience with the actual conditions of Iowa agriculture, Stevenson and Christie maintained that "[farmers'] judgment and knowledge is such that their statements of facts must stand as the

28. G.L. McKay, "Experiments in Curing Cheese," *Iowa State Experiment Station Bulletin* 57 (April 1901), 1.

29. R.P. Speer, "Experiment Station Wheat and Oats in 1889," *Iowa State Experiment Station Bulletin* 6 (August 1889), 199–203.

embodiment of the most reliable information."[30] By verifying their research findings through agricultural practice in the fields of experiment stations or the fields of actual farmers, Iowa State scientists ensured that their research remained grounded in Iowa's actual environmental conditions.

Finally, in writing their reports, researchers also demonstrated their attention to environmental contexts by frequently prefacing discussions of their experiments with descriptions of the environment within which they performed the experiment. Reporting on a study of the bacteriological effects of lime application, P.E. Brown described the characteristics of the soil that the researchers used. He told his readers that "the soil was typical of the Wisconsin Drift, being classed by the Bureau of Soils as Marshall loam." But beyond just the chemical composition, he also outlined the history of the soil, saying that they got the soil from an experimental plot where "no lime had ever been applied" and which "during the preceding five years had been continually in corn and which prior to that time had been in a general farming rotation."[31] Reminiscent of John Gregory's concerns that farmers might apply experimental findings outside of their original context, Iowa State scientists like Brown tried to better articulate the contexts in which their research would apply by detailing the environment where they performed their experiments.

A Deep Dive into Clover Experiments

Though the whole collection of research coming out of Iowa's Experiment Station displayed these characteristics, a 1908 experiment into clover production exhibited all of these features quite well, showing how an environmentally grounded focus shaped the arc of an entire agricultural scientific experiment. In June 1908, the Iowa Experiment Station published its Bulletin 98 on "Clover Growing on the Loess and Till Soils of Southern Iowa." The authors of this article—W.H. Stevenson, head of the Soils

30. W.H. Stevenson and G.I. Christie, "Drainage Conditions in Iowa," *Iowa State Experiment Station Bulletin* 78 (May 1904), 239.

31. P.E. Brown, "Some Bacteriological Effects of Liming," *Iowa State Experiment Station Research Bulletin* 2 (August 1911), 57.

Section of the experiment station, and E. B. Watson, an Iowa State student pursuing a Master of Scientific Agriculture degree—offered experimental findings showing the role clover growing played in remedying many of the challenges of Iowa agriculture. They also examined the best practices for growing successful stands of clover.

The bulletin opened by highlighting key features of Iowa agriculture and the environment that surrounded it, specifically recognizing the problem of "waning fertility" in Iowa soils. The authors expressed a "need of careful and systematic farming," which, according to their findings, should include the widespread growing of clover. They explained how clover could fill a number of roles, perhaps the most important being the replenishment of nutrients in the soil, as Stevenson and Watson believed clover to be "undoubtedly . . . the best legume to use in this state for increasing the nitrogen and humus content of the soil."[32] In this way, a desire to address the environmental problems of southern Iowa guided the choice of research question for Stevenson and Watson.

In order to address the particular challenges of Iowa agriculture, then, they sought a solution that was best suited for the climate and geography of Iowa, even if other solutions worked in other places. While Stevenson and Watson acknowledged that many other areas of the country employed different crops to solve similar problems, they maintained that the environment of Iowa, particularly southern Iowa, made clover the best choice over competing options of alfalfa, cowpeas, or soybeans. They explained that "alfalfa seems peculiarly adapted to the West, but it is not as yet sufficiently well suited to Iowa conditions," and that "cowpeas and soy beans are valuable crops farther south where clover cannot be grown." But they also recognized that clover presented its own set of challenges, especially the fact that the uncertainty of getting a worthwhile stand of clovers was especially difficult in dry years, on soils with low humus content, and on steep hillsides and rolling hills—all conditions which

32. W. H. Stevenson and E. B. Watson, "Clover Growing on the Loess and Till Soils of Southern Iowa," *Iowa State Experiment Station Bulletin* 98 (June 1908), 44.

were present in southern Iowa.[33] Despite these challenges, because they saw an overall positive value in growing clover on Iowa farms, Stevenson and Watson decided to undertake a study investigating the best practices for getting good clover harvests. As part of this investigation in practices, they set out to test the effects of nurse crops, manure, lime application, different fertilizing methods, and the time of seeding upon the growth of clover.[34]

The researchers believed that grounding their field experiments in the natural environment played a crucial role in verifying the results of their laboratory experiments. In particular, field experiments allowed the researchers to establish that their findings had practical value for the Iowa farmers who consulted their findings by making sure that researchers could test the application of scientific principles in conditions typical to Iowa agriculture. Stevenson and Watson ensured this by beginning the experiment with "a study in the laboratory and greenhouse with samples of soil brought from the field" with a bulk of the project consisting of "field investigations designed to check the results obtained in the laboratory and greenhouse to discover new factors of interest to the farmers living on the types of soil under investigation."[35] Though the researchers performed laboratory experiments in relatively controlled settings, they also made sure to "check" the findings of that laboratory work with field experiments to test whether they could apply the practical applications of the laboratory principles into more realistic environmental contexts.

Finally, Stevenson and Watson further demonstrated the value they placed on applicability by closing the article with a section entitled "Suggestions Regarding the Growing of Clover in Southern Iowa" in which they outlined how the results of their experiments could be put into practice on actual farms. But this applicability was still narrowly focused, as the researchers hesitated to make sweepingly generalized suggestions, instead opting to make recommendations for southern Iowa in particular.

---

33. Stevenson and Watson, "Clover Growing," 44.

34. Stevenson and Watson, "Clover Growing," 49.

35. Stevenson and Watson, "Clover Growing," 45.

For example, the researchers found that growing clover with nurse crops like oats actually hurt the clover crop in dry seasons. They explained that the "general practice in southern Iowa is to seed clover with a nurse crop," but cautioned that the "rolling topography" and "limited supply of humus" meant that "the soils of southern Iowa are unfavorably affected by drought more frequently and to a greater extent than the soils in the central and northern portions of the state." So, the researchers suggested that farmers in southern Iowa avoid growing nurse crops with their clover.[36] The practice of growing nurse crops might have been useful for other regions and should therefore be used there, but it did not work in southern Iowa's environment.

The history of agricultural research at Iowa State's experiment station demonstrates that Iowa State scientists accounted for the Iowa environment when developing and performing agricultural experiments. Agricultural scientists recognized that the results of their experiments usually only applied in areas with a similar environment and climate, and they shaped their research accordingly. In this way, the agricultural research at Iowa State was grounded in Iowa's local environment. This mission carried over into Iowa State's early extension work in the first decade of the twentieth century, but extension narrowed the scale of the local environment even further by focusing on county-level conditions and even farm-level conditions.

Perry G. Holden and Environmentally Grounded Extension

In many ways, Iowa State led the charge in growing the extension work of land-grant schools, particularly under the leadership of Perry G. Holden. Not long before Holden's conversation with farmers in Sioux County about county demonstration farms, Iowa State's president hired him in 1902 to be a Professor of Agronomy.[37] When taking the job, Holden had a new vision

36. Stevenson and Watson, "Clover Growing," 64.

37. One document in Holden's collection in Iowa State's archives provides a lovely story surrounding Holden's hiring. Before being hired by Iowa State, Holden had been invited to give some lectures on corn at the 1902 series of short courses at Iowa State. Much to the surprise of the short course organizers, the farmers took great interest in Holden's corn lectures, with many of them coming

for how Iowa State could engage with farmers. As he described it,

> When I was approached by [President] Beardshear . . . to interest me in accepting the position of Professor of Agronomy at Ames, I made it clear that my work would be of a different nature from that which the authorities might expect, that I had a strong feeling that . . . the college must see to it that everyone receives some direct help from the college and if this was true, that there was only one way be which it could be done and that was to take the college to the people. Go to the people and help them where they are, as they are, under their own conditions with their own problems.[38]

Holden followed up on this promise. By establishing county demonstration farms early in his tenure at Iowa State, Holden began to bring the college to the people of Iowa and inaugurated a major component of Iowa State's agricultural extension work.

The idea of farmer-led demonstration farms predated Holden's visit to Sioux County. In fact, state agricultural societies had done similar work in the late eighteenth and early nineteenth centuries.[39] But in building on this legacy, Holden's extension

---

forward and requesting extra time to cover that topic. When approached by these farmers, Holden jokingly proposed that they meet early in the morning, at which point the farmers asked if meeting at 5:00 am would work. Holden agreed to that time, and for the duration of the short course, Holden and the farmers met every morning at 5:00 am, lanterns in hand (because the school's electricity did not turn on that early in the morning), to discuss corn. It was this resounding success that ultimately led Iowa State President William Beardshear to offer Holden the position of Professor of Agronomy. This story was recorded in the unattributed source titled "Professor P.G. Holden" in Box 1, Folder 2, Perry G. Holden Papers, RS 16/3/11, ISU SCUA.

38. Holden wrote this to fellow Iowa Extension personnel Paul Taff. This quotation was recorded in Barton Morgan, "The Official Creation of the Extension Service and Its Early Development Under Holden, 1901–1912," in *A History of the Extension Service of Iowa State College* (Ames, 1934), 23–24.

39. For accounts of the extension work performed by agricultural societies in the decades before the 1862 Morrill Act, see Timothy Minella, "A Pattern for Improvement: Pattern Farms and Scientific Authority in Early Nineteenth-Century America," *Agricultural History* 90, no. 4 (2016), 434–58; Drew Gilpin Faust, "The Rhetoric and Ritual of Agriculture in Antebellum South Carolina," *The Journal of Southern History* 45, no. 4 (1979), 541–68; Nathan Sorber, *Land-Grant Colleges and Popular Revolt: The Origins of the Morrill Act and the Reform of Higher*

work marked a subtle but important shift in the environmentally grounded work of Iowa State. Though Iowa State's agricultural work had always accounted for environmental contexts, including through the involvement of farmers, Holden's philosophy of extension centered the farmers more directly than did the work of Iowa State's experiment station. Unlike the state-level scale of experiment station research, Holden insisted that the practices on Iowa State's new county demonstration farms reflect the conditions of their county to offer tailored recommendations to local farmers. Holden even took this one step further and emphasized the necessity of farmers trying these experiments on their own farms rather than simply trusting demonstrations in other fields.

In Sioux County, for example, Holden pinpointed a local problem, saying that "one of the principle reasons for low acre yields of corn was due to planting poor seed." So, he determined that "the first demonstration on the Sioux County farm . . . had to do with a comparison of yields of seed corn then actually being planted on Sioux County farms." The demonstration farm managers therefore collected seed samples from 80 farmers in the area and planted them alongside 20 additional seed samples from "professional seed corn growers and seed houses." To ensure environmental applicability, the different samples of seeds were also all planted throughout different regions of the field to "reduce errors due to differences in soil." This work proved to be effective, as one account described how "there were striking differences in yield due principally to the planting of weak and dead seed . . . provid[ing] much of the material used in the widespread educational campaign for better methods" of seed selection and planting.[40] Like the research at Iowa State's experiment station, the Sioux County demonstration farm still found its usefulness in considering local environmental conditions; but now the relevant conditions were those of Sioux County specifically rather than Iowa overall.

Education (Ithaca, NY, 2018), 28; and Rodney H. True, "The Early Development of Agricultural Societies in the United States," *Agricultural History Society Papers* 3 (1925), 299–300.

40. "Professor P. G. Holden," Box 1, Folder 2, Perry G. Holden Papers, RS 16/3/11, ISU SCUA.

In this way, the ability for farmers to engage in the demonstrations on these county farms marked an important new development in Iowa State's agricultural work. Rather than just relying on bulletins published by experimental farms across the state, these county demonstration farms "carrie[d] experimental and demonstrative work to the farmers." In other words, the farmers did not have to just receive the results, but could receive the experiments themselves. This allowed farmers to ensure that "experimental and demonstrative work [was done] under the same conditions with which the farmers of the county have to deal."[41] The farmers themselves could judge the results, bypassing the need for scientists to analyze the results and then report them. As the number of county demonstration farms ballooned between 1902 and 1915, Iowa State extension personnel celebrated the success of these farms in making knowledge relevant to local farmers.[42] One report proclaimed that the farms had brought new life to Iowa State's agricultural recommendations, saying that "since these experiments and demonstrations are with their own seed on their own soil and conducted at home, the results have a vitality which appeals to the people."[43]

The kinds of tests done on these county demonstration farms mirrored the work that experiment station personnel had performed for nearly two decades, but the vitality of their work came through the involvement of farmers. And by involving local farmers, Iowa State's county farms more fully embraced the school's pursuit of environmentally grounded research. The farm staff performed variety tests and experimented with different agricultural practices like deeper or shallower planting, both key parts of experiment station work. But crucially, though Iowa State personnel directed the work at these farms, students and

---

41. M.L. Mosher, "Farm Crops: Annual Report, 1906–1907," Box 1, Folder 19, Extension and Outreach Annual Reports, RS 16/1/0/l, ISU SCUA.

42. Starting from just one county farm in 1903, by 1908, the number had grown to 12. The number reached a peak in 1911 with 16 farms in operation and with 15 farms operating in 1915 before the program was closed down. Martin L. Mosher, "History, Purpose, and Plans of Demonstration," in *Early Iowa Corn Yield Tests and Related Later Programs* (Ames, 1962), 17.

43. M.L. Mosher, "Farm Crops: Annual Report, 1910–1911," Box 2, Folder 1, Extension and Outreach Annual Reports, RS 16/1/0/1, ISU SCUA.

local farmers helped with the planting and harvesting. By helping with this work, even farmers not enrolled at or affiliated with Iowa State learned from Iowa State personnel—a key feature of agricultural extension.[44]

The county demonstration farms also engaged farmers by hosting annual picnics. Hundreds and sometimes thousands of farmers attended these gatherings, where the farm staff led local farmers on tours of the site to explain its work. And following a picnic lunch, leaders from the local community and from Iowa State led "programs of general interest" to engage attendees even further in the agricultural improvement work of Iowa State researchers.[45] By providing a space for farmers to view and engage in agricultural experiments in their own local environments, these county demonstration farms therefore represented a culmination of Iowa State's pursuit of environmentally grounded agricultural research.

Outside of these demonstration farms, in his public lectures, Holden maintained that farmers must try out knowledge for themselves to ensure its applicability to their conditions. Holden demonstrated this well in his work with his famous Corn Gospel Trains. These consisted of a series of lectures held within train cars that traveled across the state, aiming to reach as many farmers as possible.[46] During his presentations aboard these trains, Holden would begin his talks "at a point where all could agree," by speaking to how "corn was of vital interest to Iowa farmers"

---

44. Mosher, "History, Purpose, and Plans of Demonstration," 17–19.

45. Morgan, "The Official Creation of the Extension Service," 32. Attendance numbers for early years of annual picnics recorded in M.L. Mosher, "Farm Crops: Annual Report, 1906–1907," Box 1, Folder 19, Extension and Outreach Annual Reports, RS 16/1/0/1, ISU SCUA.

46. To find some contemporary accounts championing the work of the Corn Gospel Trains, one can look to newspaper articles like "'Corn Specials' and the Farmer," *Chicago Daily Tribune* 1/30/1905 and "The Corn Gospel Trains," *The Ohio Farmer*, 3/11/1905. Many accounts are also recorded in internal institutional documents like the undated document "Professor P. G. Holden" in the Perry G. Holden Papers, RS 16/3/11, ISU SCUA. For an excellent secondary source describing the agricultural train phenomenon, and the important role of Perry Holden, see David D. Vail, "Farming by Rail: Demonstration Trains and the Rise of Mobile Agricultural Science in the Great Plains," *Great Plains Quarterly* 38, no. 2 (2018), 151–74.

and "how dependent all Iowan's [*sic*] were on a good corn crop."[47] Holden then exhorted his listeners to ensure that they used the best available techniques in the selection of their seed and their practice of planting. He grounded his suggestions in the most recent research into corn production, and as such he utilized a number of charts, figures, and images during his talks. But because he knew that this knowledge was only useful if it worked in the conditions present on Iowa farms, Holden also insisted that farmers apply his recommendations on their farms and see for themselves the benefits of these methods.[48] In one of his most common techniques, Holden used a collection of sawdust boxes with sprouting corn to show how farmers could test a given ear for its ability to produce a good product. Beyond just showing them boxes he had prepared, he demonstrated to the farmers how they could build and use their own boxes to perform the same test. During his corn talks, Holden gave "step by step" demonstrations by building a test box in front of the audience, marking off six sections in which to place six test kernels, and then taking six kernels off of an ear of corn and planting them in the sections, all of which Holden insisted "anyone could do."[49] Through this demonstration work, Holden employed environmentally grounded scientific principles to offer practical recommendations to farmers across the state, encouraging farmers to test this knowledge in their own agricultural environments too.

Beyond creating demonstration farms and hosting agricultural lectures, Holden's description of the ideal extension worker itself further revealed the importance he placed on the ability of extension workers to apply general principles to farm-level

47. R. K. Bliss, "Professor P. G. Holden—The Corn Foundation," Martin L. Mosher Papers, RS 16/3/55, ISU SCUA.

48. For a description of Holden's use of charts and figures, see C. M. Ginther, "The Corn Gospel Trains," and R. K. Bliss, "Professor P. G. Holden—The Corn Foundation." Holden also believed the creation of charts and visual materials as one of the most important aspects of extension work, as he described in Perry G. Holden, "American System of Agricultural Extension—Methods and Equipment," Perry G. Holden Papers, RS 16/3/11, ISU SCUA.

49. R. K. Bliss, "Professor P. G. Holden—The Corn Foundation," Martin L. Mosher Papers, RS 16/3/55, ISU SCUA.

environmental contexts. He noted that while it is difficult to find good teachers and researchers, "it is much more difficult to find men and women fitted by temperament and training for extension work." Among the special characteristics of proper extension workers, Holden emphasized the ability to apply general principles to specific situations. He explained that "the extension worker must not only know his subject, but he must know it in its application to the particular people he is trying to help." In particular, "the extension worker must know the needs of the people." By following the lead of the local conditions and teaching the applications of general principles, the proper extension worker, in Holden's mind, needed to show that the principles of agricultural practice "work out in practice under [the farmers'] conditions."[50]

Taken together, the accounts of Holden's extension work and his own beliefs about the value of extension reveal his consistent commitment to offering practical suggestions based on agricultural research. In Holden's view, agricultural extension should go hand in hand with the agricultural research that Iowa State scientists performed. Just as Iowa State researchers accounted for the environmental conditions of particular Iowa communities and offered solutions associated with the particular contexts of Iowa agriculture, Iowa State extension work under Holden had much the same goal. In this way, Holden's views on agricultural extension work seemed to be a natural continuation of the narrowing scale of how Iowa State leaders conceived of the local environment. From Welch, through Roberts and Knapp, and ultimately to Holden, Iowa State scientists continually refined the scale of focus needed to best account for environmental conditions in agricultural research and education.

In 1914, with the passage of the Smith-Lever Act, federal funding for a national system of cooperative extension provided solid footing for extension programs across the country.[51] This

50. Perry G. Holden, "American System of Agricultural Extension—Methods and Equipment," Perry G. Holden Papers, RS 16/3/11, ISU SCUA.

51. For more on the story behind the Smith-Lever Act and its impact on the relationship between farmers and land-grant schools, see Sorber, *Land-Grant Colleges and Popular Revolt*, 136–49.

marked a culmination of land-grant leaders' decades-long process of instituting environmentally grounded research and education in land-grant schools—a process that Iowa State's early history fully embodied.

Conclusions

Holden left Iowa State in 1912, and the experimental components of Iowa State's county demonstration farms ended in 1915 after the College trustees decided that the experiment station sufficiently covered experimental work. Though extension agents continued using local needs to direct their work, this shift broke the trajectory of Iowa State's accounting for increasingly narrow conceptions of the local environment. This decision also epitomized a new trend in Iowa State's extension work as by the 1910s, farmers played a less central role within Iowa State's research and extension apparatus. Despite the fact that national leaders encouraged extension staff to involve farmers in demonstrations, Iowa State returned primary authority to college personnel. This movement away from farmer leadership accelerated after the United States' entry into the First World War. During this time, the federal government responded to wartime demands on food supply by calling on the nation's extension service to encourage farmers to support the war effort through agriculture. Though this call came along with increased funding and lasting stability for the extension system, it also centered control of Iowa's extension activities closer to the state and national levels than the county or local levels. Extension continued to thrive into the twentieth century and to this day remains a vital means by which farmers reap the benefits of agricultural research performed at land-grant schools.[52]

But as the 1903 conversation between Holden and the Sioux County farmers demonstrated, this trend towards state and national level control of Iowa State's agricultural work was not

52. For more about the tendency of extension to retain authority among Iowa State personnel in the 1910s, see Schwieder, *75 Years of Service*, 26–28. For more about the success of Iowa State Extension in responding to agricultural crises in the 1920s and the Great Depression, see Schwieder, *75 Years of Service*, 35–98.

inevitable. To the contrary, prior to 1914, the trajectory in Iowa State's agricultural research and extension was towards increasingly narrow conceptions of local control as Iowa State tried to account for environmental conditions. Scientists and educators encouraged greater farmer inclusion, moving farmers' knowledge and experiences closer to the center of knowledge making and sharing. Welch called for a practical education grounded in the needs of western environments, and this characterized the "new education" he instilled at Iowa State. Roberts and Knapp proposed that agricultural research focus on state-level concerns, arguing that Iowa farmers only needed knowledge relevant to the conditions of Iowa. Taking up this mission, researchers at the Iowa Experiment Station used the practices of Iowa farmers as ways of keeping their research grounded in the agricultural conditions of the state's farmers. And finally, with Iowa State's county demonstration farms and the early years of Iowa State extension, farmers took an even more central role as Holden encouraged them to lead county demonstrations and test recommendations on their own farms in their own conditions.

In viewing the experimental work of Iowa State's county demonstration farms simply as replications of existing experiment stations, Iowa State's trustees marked perhaps the first case of onlookers failing to recognize that Iowa State's demonstration farms served primarily to ground the college's agricultural work in particular environmental contexts. In its focus on the political and social dimensions of Iowa State's extension work, historical scholarship has continued to gloss over the environmental dimension of this work, and thereby misses the notable shift marked by the 1915 decision. Though Iowa State extension followed a different trajectory as it grew and thrived in the post-war period, a focus on the early decades of Iowa State's agricultural work shines light on how agricultural scientists have incorporated both scientists and farmers into productive and environmentally-grounded research programs. Such a story provides important insight into how scientists can shape institutions to effectively engage the public around improvement of the natural environment.