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Draining the Heartland:
Power and Pollution in Agroindustrial Iowa

By

Anaya Lynn Hall

A dissertation submitted in partial satisfaction of the

requirements for the degree of

Doctor of Philosophy

in

Energy and Resources

in the

Graduate Division

of the

University of California, Berkeley

Committee in charge:

Professor Youjin Chung, Co-Chair
Professor Kathryn De Master, Co-Chair
Professor Nathan Sayre

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Abstract

Draining the Heartland:
Power and Pollution in Agroindustrial Iowa

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Doctor of Philosophy in Energy and Resources

University of California, Berkeley

Professor Youjin Chung, Co-Chair
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Despite decades of awareness of the causes and consequences of nitrate pollution, surface and groundwaters in the state of Iowa remain perilously contaminated with the agrichemical, a potent environmental and human health hazard. The lack of progress on reducing agricultural non-point source pollution, which affects both urban and rural drinking water supplies, is increasingly prompting politically charged social conflicts as well as robust responses from entrenched industry interests. This dissertation traces the problematic of persistent drinking water contamination in Iowa to examine how unseen infrastructures, ideologies, and institutional power dynamics construct and interact with local socio-ecological relations to perpetuate drinking water degradation. Through a critical ethnography of American prairie capitalism, I contribute a deeply situated analysis of the internal politics of contestation at the heart of the contemporary global food regime.

Thinking from and across a symbolic-materialist conception of drainage, I draw connections between the historic hydrological transformation of the Iowa landscape wrought by extensive subsurface farm drainage and the extractive capitalist practices that are hollowing out rural communities. I explore the enduring political-ecological effects of a widespread, yet largely invisible, hydraulic technology to explain enclosures of both physical spaces and agricultural imaginaries. Drawing on in-depth qualitative interviews, document analysis, and participant observation, I detail the concealed ideologies and infrastructures that continue to (re)shape Iowan's livelihoods and landscapes and explore the nuanced ways community members experience and contest environmental harms.

Across the three papers that comprise this dissertation, I delineate the circuits of capital, narratives, and knowledges that mutually constitute the ongoing nutrient pollution crisis. I ground the analysis in the hydrosocial history of agricultural drainage and industrial corn cultivation to document the enduring socio-ecological significance of draining the wet prairie. This underexplored history is vital for understanding the contemporary landscape of capitalism, which constrains farmers in a debt-ridden model of intensive row-crop cultivation and perpetuates nitrate runoff from fields into the state's lakes, rivers, and streams. I then turn to the cultural and ideological infrastructure that effaces this history through an interrogation of the responses to a polarizing lawsuit brought by the capital city of Des Moines. I articulate three interconnected myths that rationalize and naturalize the

damage caused by productivist agriculture. Finally, I explore state-capital institutional imbrication and the contradictory role of scientific expertise in forestalling reductions in nutrient loading and legitimizing continued accumulation by agroindustrial interests.

This study centers the intrinsic complexity obscured within the monocultured landscape and the power relations that enable the socio-ecological draining of Iowa. I conclude with a discussion of the ways contaminated water is a threat not only to human communities and ecologies, but to the power structures maintaining industrial agricultural production. These hidden structures are exposed in discursive and territorial struggles over clean water, revealing opportunities to forge common cause between rhetorically fractured Iowans, who all suffer the effects of the dominant paradigm. Through the contentious politics of water quality in Iowa, I survey the costs of agrarian capitalism – clean water, prairie biodiversity, rural vitality, embodied knowledge – and raise critical questions about the future of this contested landscape.

For Maizie



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Preface: Why Iowa?

I was asked countless times during my fieldwork why someone from California would come to Iowa to study water. Didn't we have our own issues that I could study?[1] When I introduced myself as a PhD student studying agriculture to farmers and rural residents at town halls or field days, most initially assumed I was a student at Iowa State University (ISU). After clarifying that I was a student at UC Berkeley, another land-grant university, my new acquaintance would often ask, "So why come to Iowa?"

Following feminist geographers, I practice critical reflexivity in my work, remaining attentive to my identity and positionality in relation to the world I am studying[2] (Rose 1997; Sultana 2007). Although I was born and raised in California, my earliest observations of the nuanced entanglements of landscapes and livelihoods were formed on yearly road trips with my grandparents from our home in San Diego to eastern Iowa. The two-thousand-mile drives were filled by stories of the family farm, once inhabited by pigs, dairy cows, and a robust garden, and the agricultural recession after the Korean War that pushed my grandfather to move his young family west. Looking out at the contemporary landscape of monoculture corn and soybeans, I began to understand the transgenerational impact of converging ecological and political economic processes. More important, I felt the enduring connection of people and place.



Figure 1. Ralph Jesse Hall raking hay on the Hall family farm circa 1954. Photograph by Ralph Deane Hall.

[1] This was a fair question. The repeated and extended droughts in California have made water quantity, and the politics that surround water distribution, a critical area of research in the state. In some ways studying the politics of water in California would have made fieldwork easier given my own geographic location, but here we are.

[2] Attention to positionality has long been a feature of feminist geographers' methodology and a key tool for ensuring ethical fieldwork and research integrity (Caretta 2015; Kobayashi 1994). Citations within this Preface can be found in the Reference section of Chapter 1.

I began most of my interviews by identifying this positionality in relation to the land and the farming practices I was trying to understand. By the time I began my fieldwork, my family had long sold the acreage where my grandfather grew up as well as the homestead across the way where my grandmother's family used to live. But we still owned the 76-acre farm just outside Wellman, Iowa. Growing up, the Hawkeye Motel, in the nearby town of Washington, Iowa, became a de facto family reunion site where far-flung cousins met for the annual Fourth of July parade through Wellman's main street. We would visit the farm, check in with our farm manager, and visit the church where my grandparents were married, now long in disrepair[3]. Our farm, apparently the smallest farm our manager oversees, today grows corn or soybeans, depending on the year, just like most of the rest of the state. We practice no-till farming, but don't cover crop (yet). We have subsurface drainage, even though our farm is at the top of a slight rolling hill, and will likely put in more in the coming years.



Figure 2. Franklin Church outside of Wellman, Iowa. On the left is the church as it stood when my grandparents were wed there circa 1955 (Photograph by Ralph Deane Hall). On the right is all that remains of the church as of July 2024 (Photograph by author).

In Iowa I am both an outsider and an insider. I was not raised there. I do not farm there. But I was brought up to appreciate the land and the unique identity of the Iowa farmer. My grandfather, forced out of agriculture by low prices and an inability to acquire enough land to be profitable, maintained his deep connection with the place he grew up and shared that with me. Having a conventionally managed farm (one that grows glyphosate-tolerant corn and beans) also gave me access to farmers who might otherwise be uninterested in visiting, in the Iowa sense of the word, with a Berkeley student. I shared their attachment to place and at least could appreciate the federal

[3] Like many small rural towns in Iowa, Wellman is steadily shrinking as the population ages and young Iowans move to nearby urban centers like Iowa City or Cedar Rapids.

farm policies and market structures that condition their farming practices (even though I did not have to navigate those myself).

As an outsider, though, I was able to ask questions about landscape changes, circulating discourses, and management decisions. Many of my participants, both farmers and community members in the state, treated me as potential conduit for sharing their stories, their truth, beyond the state's borders. As I discuss in Chapter 4, a few university scholars and state resource agency staff members told me that I was able to discuss the politics of water in ways that they were not because of their work.[4] Occasionally when I met people around town and talked to them about what I, a Californian, was doing in Iowa they assumed that I was necessarily in favor of increasing regulation. I always responded by insisting that I was there to listen and to learn. I had studied agriculture science and policy for nearly a decade on both coasts of the United States but wanted to hear from Iowans themselves.

As a white-presenting woman, my identity was both constructive and limiting. Many of the farming events I attended were predominantly white spaces and so, wearing the standard farming uniform of jeans, boots, a baseball cap and a white tee or button down, I fit right in. At Practical Farmers of Iowa field days and Iowa Farm Bureau Young Farmer events where farmers and their spouses were present, no one gave me a second look. However, most of my farm interviews were with middle-age men, and my identify as a younger woman occasionally felt significant when we were riding around in the country.[5] At the Ag Expos I attended and equipment retailers I visited, I often felt out of place among an overwhelmingly male crowd.

Most of the time, though, I felt welcomed into the world of agriculture and conservation and the Iowans I met graciously answered my questions. Farmers drove me around their land in gators and farm trucks. I rode combines and tractors. I walked up and down streambanks and roadside ditches. I drove for hours (and hours) along narrow country roads and state highways through a seemingly endless sea of corn and soy, occasionally passing clusters of hog confinements and wind turbines, and depending on the season, past bare ground. A kind Des Moines resident offered to take me up in his plane to see the landscape from above and I saw the oxbows of the channelized rivers reclaiming their ground. I toured restored prairie and learned the names of dozens of beautiful prairie flowers. I came to love the humidity and the vibrant greenery of the landscape (even in years of drought), the sweet smell of the Quaker Oats plant in Cedar Rapids, the evening thunderstorms, and, most of all, the people of Iowa. This is for them.

[4] Briana Farber discusses a similar hesitancy she encountered in Iowa, suggesting a discordance between "scientific truths and agricultural realities" (Farber 2018, 64).

[5] I also discuss how my identity as a mother influenced my fieldwork dynamics, especially when I brought my daughter to the field, in "Situating Reproduction: How Becoming Mothers Impacts Field Work and Why It Matters" (Price and Hall 2024).

Acknowledgments

No intellectual work is ever truly authored alone. This dissertation is the result of the encouragement and support of many individuals and organizations, to whom I am immensely grateful. First, I thank my dissertation committee: Youjin Chung, Kathryn De Master, and Nathan Sayre. Kathy, I thank you for welcoming me with open arms into the world of critical agrarian studies. Your kindness and guidance from the early days of my PhD journey were instrumental in allowing me to seriously pursue this project. Nathan, thank you for consistently affirming my interest in Iowa's water quality challenges and helping me sharpen my scholarly voice. Youjin, I am beyond grateful that you joined ERG during my time there. You inspired and emboldened me to embark on the ethnographic fieldwork that grounds this work; I would not have done this without you.

Other advisors and mentors whose names do not appear on the title page of this document also deserve special recognition. Nancy Peluso, Loka Ashwood, Richard Norgaard, and Isha Ray have been invaluable mentors and teachers, helping me to ascribe language to my intellectual curiosities and develop as a humanistic social scientist. I am deeply grateful to David Anthoff and Matthew Potts, who served on my qualifying exam and continuously provided enthusiastic support throughout my doctoral program, even as my research program shifted directions. Theodore Toombs, Kathleen Epstein, and Kathryn Anderson have also been treasured interlocutors and collaborators, and I am grateful for their intellectual community. Veronica Jacome, your mentorship and, more importantly, your friendship nourished my spirit through it all.

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Figure 3. Sunrise over the Hall farm circa 1954. Photograph by Ralph Deane Hall.

"Once a drainage ditch was complete, the water poured out, and a former lake or marsh became a field. No longer could it shelter ducks, geese, cranes, turtles, muskrats, mink, otters, and beavers. No longer would it purify water or hold back floods. No longer would it reflect sunrises and sunsets and remind people of the glaciers which had once melted here. It now looked like all the other land around it, bare in winter and covered with crops in summer. But it would also have made a lot of money for the investors who had bought it and paid for its drainage."
Robert Sayre, "The Landscape of Capitalism" (2000, p. 124)

"By its very nature, industrial agriculture has done tremendous damage to our land and water resources. It has also drained the economic life out of once vibrant rural communities. But it doesn't have to be this way."
Neil Ritchie, Executive Director of the League of Rural Voters (cf Hauter, 2012, p. 291)

Chapter 1

Introduction:
Confluence and Crisis in Iowa's Struggles for Clean Water

"Norman Borlaug, he kept a lot of people going, but there's a price to be paid"
Ralph S., Wapello County, IA. June 2021

"We [in Iowa] are all collateral damage."
Art Cullen, Buena Vista County, IA. July 2023

Abbreviations

CWA	Clean Water Act
DMWW	Des Moines Water Works
DNR	Department of Natural Resources
IDALS	Iowa Department of Agriculture and Land Stewardship
EPA	Environmental Protection Agency
MCL	Maximum Contaminant Level
NRF	Nitrate Removal Facility
NRS	Nutrient Reduction Strategy
NPDES	National Pollutant Discharge Elimination System
UMRB	Upper Mississippi River Basin

Bill Stowe had had enough. As CEO and general manager of the Des Moines Water Works (DMWW), he was keenly aware of the increasing presence of nitrates in the Raccoon and Des Moines rivers, the sources of drinking water for metropolitan Des Moines, Iowa. Nitrate pollution from agricultural fertilization has been documented for over half a century, as have the corresponding significant health and environmental risks (Shuval and Gruener 1972; Singh and Sekhon 1979; Stewart, Viets, and Hutchinson 1968). Still, the utility serving over half a million Iowans around the state's capital city continued to struggle with serious water pollution problems. In fact, the utility's problems were escalating, and they required ever-more-expensive treatment facilities to remove the nitrates entering their water supply before it could be safely distributed.

Bill knew the source of the stubborn nitrates coming into his plant. They infiltrated streams and creeks, and eventually the Raccoon and Des Moines rivers, trickling through the subsurface pipes that drain millions of acres of corn and soybean fields in the intensively cropped Des Moines Lobe.

In Iowa, the heart of the Corn Belt[1], the overwhelming majority of the nitrates flowing downstream can be attributed to farming practices, including the use of synthetic fertilizer, manure amendments, and the bare fields left exposed between crop cycles (Hatfield, McMullen, and Jones 2009; Libra, Wolter, and Langel 2004). Fed up with apparently ineffectual approaches to source-water protection and a growing water quality crisis in central Iowa, Bill Stowe decided it was time for another approach. On a balmy spring morning in 2015, he and the Board of Trustees of DMWW filed a federal lawsuit against three upstream, heavily agricultural, counties, alleging that farm drainage constituted a point source pollutant and therefore violated the Clean Water Act.

The unprecedented action drew national attention and ignited fierce debate over the roles and responsibilities of farmers and the state (e.g., Eller 2019; Olson-Sawyer 2016; Smith 2015). Politicians portrayed the lawsuit within a cultural narrative of urban–rural polarization, with then Governor Terry Branstad declaring that "Des Moines has declared war on rural Iowa" and one state assemblyman calling on all Iowans to boycott the capital city (Masters 2016). This suit was ultimately dismissed, but tensions remain high and social conflicts over water impairment continue to erupt. Since the DMWW lawsuit's dismissal, two more lawsuits have been brought against the state's Department of Natural Resources (DNR), revealing ongoing contestations over public health, environmental protection, and the future of agricultural production in Iowa.

Impaired water quality in Iowa resides at the juncture of cultural and material social relations, encompassing unseen discursive, technological, and hydrological dynamics. Although resonant with similar processes of enclosure across agrarian spaces, struggles over control of entangled land and water resources are always a product of historical–geographic particularities (Peluso and Lund 2013; Raffles 2002). Understanding the causes and consequences of the contemporary water quality crisis requires thus attention to the unique historical and relational interplay of hydrology, infrastructure, ideology, and politics in Iowa. It requires an analytic of power.

This dissertation is a case study of American prairie capitalism and the circuits of nutrients, narratives, and knowledges that have (re)shaped rural landscapes and livelihoods. Through the struggle over water quality in central Iowa, I interrogate the subterranean processes and everyday struggles constituting the global industrial food regime as it is experienced by those living among the monocropped expanses of corn and soybeans (Friedmann and McMichael 1989). I examine the debate over water quality in the Des Moines Lobe to explore what the contentious politics of nutrient management and agroindustrial transformation in Iowa reveal about the uneven geographies of agrarian capitalism.

Put simply, this dissertation investigates why, despite decades of awareness, surface and groundwaters in Iowa remain perilously contaminated with excess nitrates. I ask what historical processes have led us to the present moment of nitrate pollution? What power relations travel along with nitrates through the state's rivers, streams, and creeks? How do discursive and knowledge practices construct and interact with local socionatures to perpetuate chronic water quality degradation?

[1] The "Corn Belt" is a region in the Midwestern U.S. where corn maize is the predominant crop, covering Iowa, Illinois, Indiana, Nebraska, Minnesota, and Ohio. The area is characterized by its fertile soil, favorable climate, and intensive farming practices (USDA, 2023).

Nitrates, Environmental Health, and Litigating Clean Water

By the time of the lawsuit, DMWW had been tracking, and battling, dangerously high nitrate levels in the water entering their facility for over 25 years. In 1991, DMWW had installed a nitrate removal facility (NRF) to treat the persistent pollutants. Municipal ratepayers footed the bill for the $4.1 million facility, at the time the largest of its kind in the world. Although costly, treating excessive nitrates in drinking water is implicated most notably in methemoglobinemia, or "blue baby" syndrome. (As will be discussed, it likely causes other health problems, as well.) In 2015, the utility had to run the NRF a record 177 days to combat the contaminant that threatened the health and safety of the local population. Updating the system to meet the rising crisis was expected to cost around $80 million (Masters 2016). Thus, that spring DMWW opted for a novel tactic, one that would not rely on expensive upgrades or rate increases to water bills, but that may have instead incurred a significant social cost: a lawsuit.

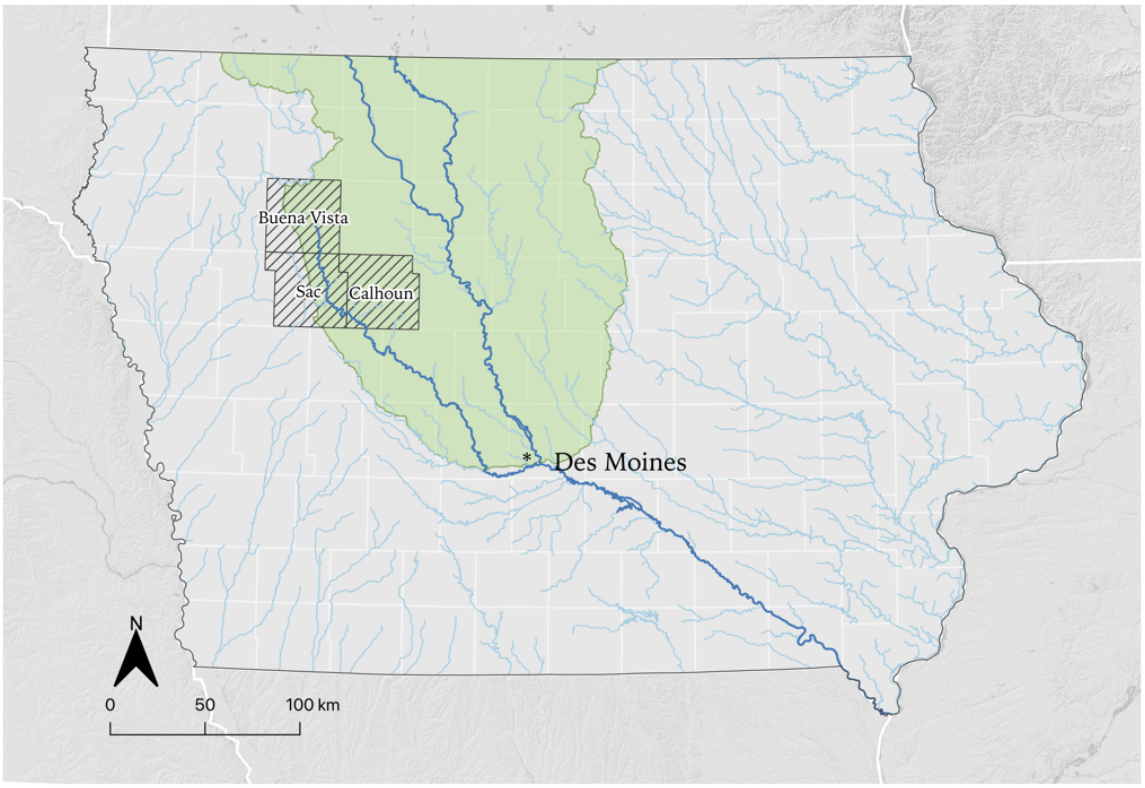


Figure 4. The state of Iowa and the Des Moines Lobe (green). The three counties targeted by the DMWW lawsuit are shown in the hatched area. The city of Des Moines sits at the bottom of the Des Moines Lobe at the confluence of the Raccoon (left) and Des Moine (right) rivers.

Bill Stowe and his legal team filed a complaint against thirteen drainage districts in three Iowa upstream counties in the Raccoon River watershed, alleging that they had violated the standards set by the Clean Water Act (CWA) and provisions of the Iowa Code because they did not secure necessary permits to discharge nitrate-laden water into the Raccoon River (See Figure 4). At the core of the lawsuit was the artificial subsurface drainage infrastructure built, owned, managed, and maintained by the districts. This infrastructure — the subterranean pipes and open ditches that collect water from farm fields — are point sources, they argued, and thus should be subject to CWA

regulations that require National Pollutant Discharge Elimination System (NPDES) permits for the nitrates infecting downstream water supplies[2].

The lawsuit provoked quick and immediate outrage. In Iowa, where nearly 90 percent of the land is used for agriculture, the idea of a city using legal means to resolve a water quality conflict was not received well. Only three counties in the Raccoon River watershed were targeted — Sac, Buena Vista, and Calhoun, but disdain for the action was felt across the state[3]. After two years of intense public debate, putting "Iowa nice" to the test[4], the case was dismissed by the Iowa Supreme Court. Nitrates, though, continue to plague drinking water systems. As I write this Introduction, heavy spring rains have returned to Iowa after years of drought and DMWW has once again resorted to using its NRF to meet Environmental Protection Agency (EPA) standards (Gerlock 2024).

***

Nutrient loading[5] is one of the most pressing environmental challenges of our time, rivaling climate change as a threat to both ecosystems and human societies (Carpenter et al. 2009; Richardson et al. 2023). The challenge is felt across the globe, but the particularly severe in the U.S. Corn Belt and Mississippi River watershed where nutrient pollution has resulted in sustained hypoxia[6] in the Gulf of Mexico, charismatically known as "the Dead Zone." Nitrates enter the Gulf through the Mississippi River, driven largely by land management practices in the Mississippi River Basin, especially in the Midwestern Corn Belt. Iowa is the leading contributor of nitrate pollution to the Mississippi River, releasing an outsized amount of the chemical based on its size in the watershed (See Figure 5). Fertilizer and manure applied to fields contain nitrogen (N) as ammonium, which readily converts into the plant-available form, nitrate, in the soil. Nitrate N is soluble in water, meaning it easily escapes farm fields in water: when it rains, excess nitrates leach into groundwater or run off into surface waters through drainage tiles (See Figure 6), contributing to water pollution for all who live downstream.

---

[2] Many farmers remarked to me how shocked they were when they found out what DMWW did with the nitrates their removal facility extracted from water (they discharge them into the river in accordance with their own NPDES permit). To many, this signaled that the lawsuit was not about cleaning up the water, but rather about attacking farmers.

[3] Even years later, when I began fieldwork in Iowa, I found that the lawsuit sparked strong emotions.

[4] Due to the nature of the claim, the defendants could not use insurance to cover defense costs. Attempting to sort out how his county was responding to the case, Art Cullen, intrepid reporter and editor of the *Storm Lake Tribune* in Buena Vista County, published a series of editorials exposing back-door dealings that resulted in the Agribusiness Association of Iowa and Farm Bureau coordinating the defense funds. His reporting won him a Pulitzer Prize and for some, secured him a place right next to Bill Stowe on the list of Iowa's pariahs. Although Stowe was a native Iowan who had grown up on a farm in Nevada, Iowa, he was reviled by farmers within and beyond the three counties listed as defendants. The short-lived political group, Iowa Partnership for Clean Water, released a series of negative advertisements targeting DMWW and questioning Stowe's competence and integrity. Most of these videos are no longer available, and the group is no longer active, but some advertisements remain online, including "What is Bill hiding?"(Redwave Digital 2016). Although the suit was dismissed, and Stowe has since passed, I found that his name still stirs up ire in certain parts of the state.

[5] A note about language: In this dissertation I try to primarily use the term "nitrate pollution" rather than "nutrient loading," although I do occasionally use them interchangeably. Many of the activists and conservation professionals I interviewed felt that the term nutrient loading minimizes the environmental public health implications. Nutrients sound like a good thing. Pollution, on the other hand, is easily recognizable as a harm.

[6] Through eutrophication, excess nutrients (nitrates and phosphates) stimulate the excessive growth of algae. When those algae die and decompose, they consume large amounts of oxygen, lowering the store of dissolved oxygen to levels too low to support marine life (Richardson et al. 2023).

In recognition of the growing hypoxic state in the Gulf, a Mississippi River/Gulf of Mexico Hypoxia Task Force was assembled in 1997. This group brought together federal and state representatives throughout the Mississippi River Basin (MRB) to coordinate efforts to reduce nutrient loading into the Gulf. In 2008, the group released an action plan, which set a goal of 20 percent reduction of nutrient releases to the Gulf. Observing minimal improvements, the acting assistant administrator of the U. S. Environmental Protection Agency (EPA) Office of Water, Nancy Stoner, put out a memorandum in 2011 urging states to "make greater progress" on reducing agricultural nutrient runoff (Stoner 2011). The memorandum, colloquially known as the Stoner Memo, was interpreted by some as threatening federal intervention in agricultural practices in the MRB states if reduction in nitrogen and phosphorus loading was not accelerated.

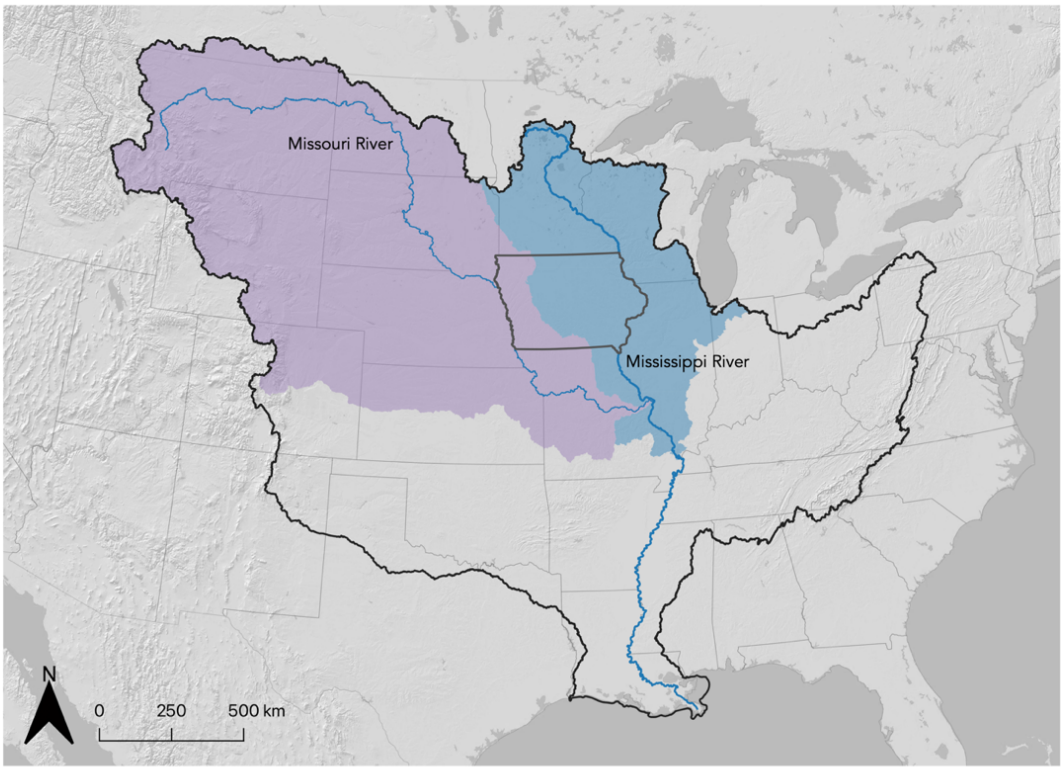


Figure 5. Mississippi River Basin, outlined in black, with Iowa at the center. The area in purple is land draining to the Missouri River and in blue is land draining to the Upper Mississippi River. Map by author using USGS data.

In addition to causing eutrophication and hypoxia in water bodies, nitrates are a potent human health hazard. DMWW, like other public water utilities, must treat the water to accord with the EPA and Clean Water Act (CWA) mandated standards. In public water systems, the water utilities bear the cost of the expensive treatment needed to remove nitrates[7]. Although costly, treating nitrates is essential to protecting public health. The EPA has set an enforceable standard, a maximum contaminant level (MCL) of 10 ppm of nitrates in drinking water. Above this level, research has documented that nitrates can cause methemoglobinemia in infants, a potentially fatal condition in which some proportion of the hemoglobin in blood takes the form of methemoglobin, restricting

[7] Owners of a private well, who are not attached to municipal water sources, must pay for this crucial treatment themselves.

the ability of the blood to carry oxygen. Infants are particularly susceptible and often develop a blueish-gray pallor due to poor oxygenation, earning the disorder the common name "blue baby syndrome" (Knobeloch et al. 2000).

The current drinking water standard was established in 1962 to protect pregnant women and young children from acute effects of nitrate pollution (Brender et al. 2013). Increasingly, though, there is evidence that sustained intake of nitrates, even at levels below than the MCL, can lead to serious health complications, including several types of cancers (Ward et al. 2010; Weyer et al. 2001). Long-term studies in Iowa and surrounding region have linked elevated nitrate levels in drinking water to higher risks of colorectal, ovarian, and thyroid cancers, prompting calls to the EPA to reduce the allowable nitrate level in drinking water sources (Inoue-Choi et al. 2015; Iowa Cancer Registry 2024; Lede 2024). Iowa currently holds the dubious distinction of experiencing the fastest-growing rate of new cancers in the nation and the second highest cancer rate overall. While this alarming trend cannot be attributed to a single factor, oncologists and public health researchers emphasize the need to examine the potential contributions of agricultural practices. River to river, the state is awash in agricultural chemicals, they assert, and public health is on the altar (Miller 2024).

Iowa's primary approach to addressing nutrient (nitrogen and phosphorous) pollution in waterways is the Iowa Nutrient Reduction Strategy (NRS). Developed collaboratively by state agencies, researchers, and agricultural stakeholders, the plan was released in 2013. The NRS does not regulate practices, but rather focuses on voluntary, incentive-based approaches to encourage farmers to adopt conservation practices that reduce nutrient runoff, such as cover cropping, buffer strips, conservation tillage.



Figure 6. Tile drain emptying into drainage ditch in Franklin County. Photograph by author June 2023.

Even with the NRS, the extent and intensity of nitrate pollution in Iowa is severe. Numerous studies have documented that more than half of Iowa's waterways regularly surpass the EPA's safe drinking water limit of 10 mg/L for nitrates, with some levels reaching up to 20 mg/L or more. DNR's required reporting to the EPA shows that the number of impaired water bodies in Iowa continues to rise as nitrate loading spurs toxic algal growths in lakes, streams, and rivers. The Des Moines and Raccoon rivers, key sources of drinking water, frequently exhibit nitrate concentrations that necessitate expensive treatment processes to ensure safety. Beyond the state capital, which sits at the confluence of these two rivers, communities across the state have also been dealing with rising nitrate levels for years, many without the resources of Des Moines. Nitrate pollution affects all Iowans, both in its largest cities and its smallest.

Nutrient loading is increasingly no longer just a distant environmental problem in the Gulf of Mexico, prompting new and emerging conflicts around the public-health-entering threat in Iowans' homes and bodies and its relationship to the state's largest industry. I trace the problem of drinking water contamination to examine the terms, mechanisms and stakes of control over Iowa's agrarian terrain. At the core of this case study is the challenge of governing a shared resource — complicated by competing claims, inequitable impacts, and political entanglements between agroindustry and the state. Through a critical ethnography, I contribute a deeply situated analysis of the internal politics of contestation in a capitalist agricultural landscape. I employ qualitative interviews, document analysis, and participant observation, detailed next, to expose hidden operations of power and document the battle for future of Iowa. I argue that the territorial and discursive struggle over water in Iowa, a place at the heart of the contemporary global food regime, reveals the pervasive, if unseen, influence of physical, ideological, and political infrastructures on socio-ecological conditions.

This dissertation builds on the scholarship of critical studies of agrarian capitalism in Iowa and the U. S. Midwest, which have documented the global social costs of twentieth -century industrialized farming (e.g., Durrenberger and Thu 1996; Goldschmidt 1978; Lobao and Meyer 2001). I advance this body of work through an evaluation of the politics of the social-hydrological cycle in Iowa, connecting historical entanglements of land, water, and capital through contemporary debates rooted in the materiality of nitrates. By taking seriously the ecological transfiguration of Iowa agricultural development and looking beneath the surface to the more-than-human subjects at work in this system (including nitrates' biophysical attributes and the infrastructure through which they travel), I unveil the socio-natural relationships and rationalities governing water quality. Next, I review the foundational theoretical scholarship that I drew from to explore how drinking water degradation is produced, reproduced, imposed, negotiated, and experienced.

Grounding Perspectives of Prairie Capitalism

This work draws on two related literatures to explore the place-based politics of nitrate contamination in Iowa. I begin with critical agrarian studies to attend to social organization and political subject-making in agrarian communities, and braid in insights from historical-political ecology, which examines resource distribution as an uneven socio-natural process articulated within power hierarchies. Together, these fields situate the current moment within sociopolitical patterns and processes that have shaped the material and symbolic landscape of the U. S. Corn Belt.

New Agrarian Questions

Critical agrarian studies historically centered around the agrarian question, which explores the mechanisms and effects of capitalism's penetration into agriculture and rural areas (Kautsky 1899/1988; Lenin 1899/1982). First, formulated by Karl Kautsky, a Marxist scholar writing at the turn of the twentieth century, the agrarian question is an inquiry into the persistence of smallholder farms as well as the means and impacts by which peasant, autonomous farmers are drawn into capitalist modes of production. Kautsky's seminal investigation laid the groundwork for evaluating the capitalist transformation of rural social relations[8] as well as the obstacles to capitalist penetration into farming (S. A. Mann and Dickinson 1978).

Though some scholars have declared the utility of the classic agrarian question to be irrelevant in the present system of globalized capital (e.g., Bernstein 2004), the agrarian question continues to provide analytical structure for the exploration of rural livelihoods, political subject formation, and the contestations that emerge with capitalist agricultural relations. In the current era of industrialization, farmland consolidation, and the expansion of contract farming in Midwestern agriculture, there is increased need for the empirical study of agrarian politics (Akram-Lodhi and Kay 2010; Araghi 2000; Ashwood et al. 2022; MacDonald 2020). I engage the framework of the agrarian question to probe the contentious politics and forms of rural resistance in contemporary Iowa. Far from being a settled issue, I ask how capital continues to reshape social relations and advance new enclosures across the countryside. In the chapters that follow, I examine how the penetration of capital, in its myriad social forms, is transforming agrarian landscapes and livelihoods through new socio-ecological metabolic relations.

Policies, institutions, and production practices each influence social organization and ecological crises under capitalism (Edelman and Wolford 2017). I lean on the concept of the food regime, first introduced by Friedmann and McMichael (1989), to contextualize the politics of agricultural production in Iowa within globalized economic structures and industrial trends[9]. While this

[8] Around the same time, Vladimir Lenin (1899/1982) and Alexander Chayanov et al. (1925/1986) also sought to address the agrarian question with divergent conclusions. Lenin asserted the standard Marxist theory that in agriculture, much like in industry, capitalism results in differentiation of the peasantry toward extremes (Lenin 1899/1982). While admitting that capitalism's penetration into the countryside took place slowly in varied and contingent manners, his analysis followed the classic Marxian conception of class differentiation into rural proletariat and rural bourgeoisie, and ultimately a disappearing petty commodity producer. Chayanov challenges the application of both Marxian and classic economic thought to peasant farms. He cites the fundamental distinction between capitalist farms that rely on wage labor and family farms, which employ no outside hired labor. Like Kautsky, Chayanov took the family household as his unit of analysis. Where Kautsky saw this unit subsumed under the capitalist logic, Chayanov asserted that it operates under an entirely different economic logic, which lends competitive power to the peasant farm. Meticulously tracing the balance of drudgery and needs of satisfaction, he presented the concept of self-exploitation, in which the family reduced consumption in order to meet production goals and remain viable as a farming enterprise through cycles of production. This theory of self-exploitation echoes Kautsky's assertion that small family farms persist due to their capacity for overexploitation, or their willingness to accept under-consumption and excessive labor.

[9] Through a detailed historical analysis of changing international power relations from the late nineteenth century through the 1970s (and associated agro-industrial complementarities), Friedmann and McMichael delineated two distinct food regimes, characterized by periods of dynamic stability governed by implicit rules followed by crises and transition. McMichael (2009) posited that we are currently in a third regime distinguished by corporate power, new technologies, consumer relations to sustainability, and an emerging food–fuel agricultural complex. Scholarship in this field has examined agriculture's role in the formation of the modern nation state, in colonialist and geo-political state-building projects, and in contemporary state-sanctioned land grabs (Friedmann and McMichael 1989; McMichael 2001; Scott 2017; Wolford et al. 2013).

framework allows for an analysis of the role of agriculture in the development of transnational capitalism and the hegemony of U. S. agriculture, I contribute a deeply situated account of the historical–geographic context of Iowa and the hidden technical, political, and ecological forces that made this possible.

Through a granular ethnographic and sociological investigation, embedded in global food relations, I trace historical patterns of enclosure through modern practices of extractivist agriculture. Using the DMWW lawsuit as a focusing event, I interrogate the roots of the so-called urban–rural divide and the processes of primitive accumulation that enable its enduring appeal. First introduced by Karl Marx, primitive accumulation is the often violent process that strips free workers (the majority of the populace) from the means of subsistence and results in the accumulation of surplus value by the few at the expense of the rural dispossessed[10] (Marx 1977, 874). While Marx focused his analysis on the *economic roles* individuals inhabit in commodity exchange, later scholars built on his insights to incorporate axes of difference beyond class distinctions and the secreted social relations that allow for capitalism to function (e.g., Barca 2020; Fraser 2016). Through a historical analysis attentive to the destruction of women's social power and the subjugation of the body, Silvia Federici highlighted the state-sanctioned practices of exclusion that remain a critical component in the development of capitalism (Federici 2014). For Federici, capitalism fundamentally relies on this social differencing in the proletariat, typified by violence and "legislated and enforced" by the state (Federici 2014, 108).

David Harvey extended Marx's insights, arguing that capital accumulation in modern times continues to rely on dispossessing people of their land, resources, and rights (Harvey 2017). Accumulation by dispossession, as he dubs this process, includes practices such as privatization, financialization, the management and manipulation of crises, and state redistributions of resources that entrench social hierarchies. Science, technology, and the law all become agents of capital shaping contemporary environmental politics of agrarian spaces. Within agriculture, accumulation of enclosures of critical agricultural production factors such as land, seed, livestock, and agrochemicals (Kloppenburg 2004; Montenegro 2018; Thu 2001).

Political Ecologies

The insights of agrarian political economy born out of critical agrarian studies are crucial for understanding the social conflict around water in Iowa. Yet, this lens is insufficient without deeper engagement into the political, cultural, and hydro-ecological dynamics that contour capitalist agriculture as well as the co-constituting discursive and material flows of water that produce uneven resource access.

Like critical agrarian studies, political ecology has roots in Marxist political economy, recognizing that social systems are produced in historical and changing material conditions and that surplus value in the capitalist mode of production comes from simultaneous extraction of labor and land (Marx 1977). One effect of the capitalist enclosure of agrarian spaces is the *metabolic rift*, a breakdown in the metabolic relation between humans and nature. Industrialization of agricultural furthers this rupture in nutrient cycling between agriculture and its biological foundations. Simultaneously social and ecological, the metabolic rift provides a rich conceptual framework for understanding ecological

[10] The classic case is the enclosure of the English countryside. Land that was once commons became private property, concentrating power and wealth for landlords while depriving feudal serfs of the ability to reproduce their daily lives.

flows and spatial relationships through explicit considerations of power (Foster 1999; J. W. Moore 2011). Iowa's water quality crisis, and the political rhetoric of urban–rural opposition deployed by agricultural groups in response, emerges from such ruptures in nutrient cycles and can be usefully understood as capitalist material estrangement from the perspective of socio-ecological metabolism (Foster 1999; Schneider and McMichael 2010).

Political ecology helps us see that not only are our ecological systems fundamentally political, but our very ideas about them are delimited and directed through political and economic processes. In modern Western constructions of nature, the environment is often depicted in a dualistic relationship to humans and defined as a space devoid of reason (Cronon 1996; Plumwood 2003). This nature–society dualism alienates people from land (even those actively engaged in managing it) and objectifies resources through mechanistic interpretations of environmental relations (Leiss 2023; Merchant 1989). Narratives of progress and development undergird environmental politics, shaping the forms and functions of resource governance (R. H. Moore, Parker, and Weaver 2008; O'Reilly 2017). Extractivist and domineering orientations toward land and other resources are reinforced by science and technology to facilitate both accumulation and hierarchies of knowledge (Katz 1992; Merchant 1989; Montenegro 2018). In agriculture, state research infrastructure and agribusiness interests coalesce around discourses of modernization to define and control knowledge (Bell 2004; Buttel 2005; Farber 2018). As some ideas and forms of environmental knowledge are privileged, others are systematically disempowered (Escobar 1995)

A recurring critique is that political ecology, and human–environment geography broadly, can be thin on ecology (Walker 2005; Zimmerer 1994). This dissertation, however, foregrounds and integrates the ecology and materiality of the Iowa landscape, both of which mediate the socio-political processes impacting drinking water quality. Widespread subsurface drainage has dramatically transformed the wet prairie landscape and the resulting changes in hydrosocial relations are necessary for understanding contemporary debates about shared water resources (more on this in Chapter 2). I draw on a strong and growing lineage of "first-world" political ecology (e.g., Galt 2013; Gillon 2010; Martin et al. 2019; McCarthy 2002; Ogden 2011; Walker 2003) to provide a critical exploration of the biophysical arrangements and ideological paradigms that reproduce socio-ecological inequities. I contribute to this scholarship with an account of the hydrosociality of Iowa's agrarian landscape and the ways that unseen historical power dynamics produce contemporary socionatures and inform disparate resource access (Boelens et al. 2016; Chung 2019; Duarte-Abadía, Boelens, and Roa-Avendaño 2015; Raffles 2002; Swyngedouw 2009; Watts 2017).

Rural Environmental (In)Justice

The impacts of cascading ecological crises wrought by capitalism are not evenly felt by all members of society as material benefits from resources are ultimately informed by social power (Ribot and Peluso 2003). Robust environmental justice (EJ) literatures document how marginalized groups and communities are unfairly denied environmental protection and they ways in which they resist and challenge disproportionate harm. Framed within social justice and the U.S. civil rights movement, EJ emphasizes meaningful and democratic community participation in land use decisions (Malin and DeMaster 2016). Although this literature grew out of Bullard's (1983) study of toxic dumping in the rural southern United States, more recent scholarship in the Global North has implicitly focused on urban spaces or has left out spatiality as an important category that shapes EJ struggles (Ashwood and MacTavish 2016; Pellow 2016). Attention to the spatial dimensions of environmental inequities alongside race and class may help reveal the policies, discourses, economic arrangements, and

biophysical mechanisms underlying resource access (Bray 2021). Rurality thus nuances the focus on social power at the heart of political ecological analysis (Ashwood and Bell 2016). A rural EJ analytic does not, however, ignore fundamental and intimate interconnections between urban and rural social spaces. Rather it allows for these relationships to be explored more deeply through attention to the spatial dynamics and tensions among communities in environmental inequity formation, especially as it pertains to the Global North (Pellow 2000).

While consideration of land use and production practices is critical for discerning the place-based politics of Iowa, this dissertation resists the facile conflation of "agricultural" with "rural," which problematically reduces the holistic humanity of rural areas to a single economic activity. Rurality is frequently essentialized to agriculture, as in the polarized framing of the DMWW lawsuit by politicians and lawmakers, despite the fact that only 3 percent of non-metropolitan residents make their living from farming, ranching, fishing, or managing agricultural land (Ashwood and Bell 2016; Davis et al. 2023). Such ideas about rurality too often permeate institutional domains to reinforce patterns of environmental inequity and invisibilize the experience of rural citizens (Bray 2021; Pellow 2016). Against this, I develop an analysis of the material and symbolic social power held by agriculture in rural areas to disentangle productivist practices from broader questions of justice, access, and identity.

Challenging dominant economic logics of profit and accumulation, rural and agrarian peoples assert a moral economy based on traditional and cultural values[11] (Scott 1976, 1985; Thompson 1971; Wolford 2005). This perspective aligns with Polanyi's (1944/2001) theory of the double movement, which describes spontaneous and protective countermovements against the dictates of the market system resonates with contemporary forms of resistance in agriculture[12]. This theory has been used to explain federal farm policy dynamics in the twentieth century and articulates with grassroots efforts to challenge agroindustrial power and pollution (Graddy-Lovelace and Diamond 2017; Marquez, Ishii-Eiteman, and Schafer 2020). Importantly, resistance is variegated and context-dependent, emerging both within and against hegemonic structures, which condition the forms that

[11] Studying the collective protests of 18th-century England, Thompson located the "riots" as protective reactions based on customary notions of social justice and traditional rights, in contrast to the prevailing view of these "rebellions of the belly" as erratic, fitful and spontaneous (Thompson 1971). The "moral economy of the poor," as Thompson understood it, derives from a consistent, consensus view of social obligations to ensure the baseline consumption needs of the population are met, particularly in times of dearth. The shift to "free" market practices challenged social norms, fomented resentment, and prompted popular action. James C. Scott built on this concept to untangle the agrarian political resistance in Southeast Asia. Economic and political changes in the colonial era, largely dependent on models of profit maximization, breached peasants' traditional arrangements of social reciprocity (Scott 1985, 1976). He documented the everyday efforts to resist the imposition of new ideologies that violate the traditional subsistence ethic. I draw particular inspiration from Wendy Wolford's understanding of "moral economy" as moral arguments or ideologies deployed by both dominant and subaltern groups to define the optimal organization of society, including how resources like land and water ought to be distributed (Wolford 2005). Chapter 3 explores these moral arguments and ideologies through the lens of mythology to interpret the current configuration of farming practices and responses to water quality crises in Iowa.

[12] Karl Polanyi's (1944/2001) *The Great Transformation*, a cutting critique of the myth of the self-regulating market and an economic history of modern civilization, provides an enduring framework for understanding social responses to capital's attempts to subsume socio-ecologies under the order of the market economy. This utopian project is met everywhere it is attempted by reactionary movements to protect social functioning, which Polanyi dubs the "double movement" (Polanyi 1944/2001, 79). As the pernicious effects of a market-controlled economy — with its reliance on the fictitious commodities of labor, land, and money — threaten to destroy "the human and natural substance of society," a protective response is guaranteed (Polanyi 1944/2001, 3).

dissent may take (Carney and Watts 1990). I draw on these insights to situate the struggle for clean water as rural Iowans resist and adapt to the contemporary landscape of extraction.

Historicizing Contemporary Crises

Both critical agrarian studies and political ecology emphasize historical scholarship to situate the unique spatial, structural, and ideological patterns of U. S food and agriculture in the nineteenth and twentieth centuries[13]. Many historical (and ongoing) processes, including industrialization of agriculture and farm consolidation, shape the contemporary material and discursive landscape of Iowa (Heffernan 2000; MacDonald 2020). A historical perspective provides contextual understanding of the imbricated ecology, social history, and geography of the American farm, exposing the roots of contemporary contestations over clean water in perennial narratives of expertise, efficiency, and security (Gilbert 2015; Graddy-Lovelace and Diamond 2017; Kloppenburg 2004; Lockeretz 1997).

Of particular historical importance for Iowa is the memory of the 1980s farm crisis, which has had profound and lasting effects on Iowa's agricultural communities (Davidson 1996). Marked by plummeting land values, soaring debt, and widespread foreclosures, over a quarter of the state's farms were lost in the span of a decade (Riney-Kehrberg 2022). This period of economic hardship not only devastated farm families financially but also took a significant psychological toll, contributing to a mental health crisis wrought by severe stress and a deep sense of shame over farm loss (Davidson 1996; Dudley 2000). The crisis's legacy endures, prompting some to ask whether it ever truly ended given that many rural communities continue to grapple with chronic economic insecurity and lingering emotional scars (Riney-Kehrberg 2022). Debt and instability are unfortunately now regular features of farming, influencing and exacerbating interconnected challenges of agricultural sustainability and social resilience.

Another key history that deserves special attention for understanding the context of modern capitalist agricultural production in Iowa is the Green Revolution (Harvey 2017). The World Food Prize Hall of Laureates, a museum adorned with bronze stalks of wheat and corn and featuring a prominent sculpture of "father of the Green Revolution" Norman Borlaug, sits both literally and figuratively at the center of the state (C. C. Mann 2018). A robust body of scholarship has focused on the global shadow cast by this era, as skyrocketing yields and technological developments coalesced with geopolitical imperatives to facilitate expansion and export of U.S. agricultural products and practices[14] (Cullather 2013; McMichael 2001; Patel 2013; Perkins 1997; Shiva 2016; Weis 2010). In the chapters that follow, I emphasize the historical importance of the Green Revolution to comment on the enduring local impacts of the agrarian change it shepherded — the entrenchment of Iowa in a global industrial maize complex (Chapter 2), the productivism branded as humanitarianism that motivates ever-increasing yields (Chapter 3), and the dominant paradigms of science and technology that contour environmental governance (Chapter 4).

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[13] Scholars have chronicled, for instance, the expansionary drive of American society that led to the Dust Bowl in the Southern Plains (Worster 2004), the railroad's role in the entwined urban–rural remaking of the Midwest (Cronon 1992), and the quest for control over water in the arid West (Reisner 1987).

[14] While the Green Revolution emphasized the critical importance of irrigation abroad, in Iowa a different technological approach to water management, subsurface farm drainage, facilitated productivism and the industrialization of agriculture.

I draw on these theoretical fields to offer new insight into key tensions I identify in Iowa amid the unfinished project of capital, which continues to reconfigure rural livelihoods and landscapes. The first tension relates to the disjuncture between the reality and imaginary of the independent yeoman farmer in Iowa. Those fortunate enough to own farmland in Iowa today are the beneficiaries of stolen Indigenous territorial land and decades of federal support. Most farmers in Iowa, however, do not own their own land (USDA 2023) and those who do are often saddled with debt (Burchfield et al. 2022). The overwhelming majority of the landscape in Iowa is privately owned, with most of it is in farms[15], and yet the agency of the individual farmer operating in the state is limited by market structures, federal and state policy mechanisms, and cultural capital (Burton 2004; Hendrickson and James 2005; Jackson 2008; Rissing 2021). This tension is reflected in urban-rural rhetorical divides that essentialize rural identities to agricultural production, further complicating the position of farmers and fracturing potential for collaboration. It is also exemplified in contradictions between the moralistic motives of farming to feed the world and the reality of industrial commodity production, where state and corporate-led efforts foment capitalist agrarian transformation. I engage with this tension by shifting the inquiry to capitalist practices, rather than individual farm-level behavior, to situate the policy and discourse of agribusiness in the lives and livelihoods of Iowans.

A second tension stems from the dramatic yet covert physical transformation of the materiality of Iowa. The banality of the vast fields of monocropped corn and beans that blanket the state, which themselves rely on an artificially produced reconfiguration of the state's hydrology, is routinized to a point of escaping notice (Swanson 2017). The uniformity and homogeneity of the landscape, such that you can drive for miles without seeing a single tree in a biome that was once an oak savannah, belies the complexity and embedded techno-political interventions that constructed the contemporary scene. It is in this banality that a silent crisis that threatens the health and safety of all Iowans has been forming, created by mutually constitutive processes within and well beyond the bounds of the state. To understand the ruination of the Anthropocene and envisage feasible alternatives for Iowa, we must look past the lush rolling fields to see the entangled formations of capital that have produced this place (Hart 2004).

These tensions suggest cracks in the logics guiding policy and practices, and from them emerges a set of related questions: First, how is the meaning of a shared resource negotiated amid competing claims coming from different positions of power? Second, how do contemporary socio-ecological contestations articulate with historical political-economic processes in the global agri-food system? Finally, how do materialities, social norms, and governing institutions intertwine as landscapes and livelihoods are simultaneously transfigured? Drainage, both as a physical infrastructure and a symbolic process, provides a critical entry point for exploring these questions and explaining the persistence of nitrate pollution in Iowa's contemporary capitalistic landscape.

Dimensions of Drainage

Throughout the chapters of this dissertation, I draw on a metaphor of subsurface *drainage* to help explain the imbrications of social and material dynamics provoking conflict in Iowa. Metaphors allow geographers (and other scholars) to make changing conditions legible and spark imagination,

[15] The fact that the overwhelming proportion of land in Iowa is used for agriculture has important implications for how power works in the state, as I will document in Chapter 4. Further, most of this land is privately held and used to produce commodities, tying farmers' livelihoods to global market dynamics (Farber 2018).

prompting new opportunities for dialogue and imaginaries for the future (Coddington 2021; Kearns 1997). A metaphor can function as an analytical tool, condensing polyvalent processes into a single concept. Drainage, as a metaphor, connects the hydrological transformation of the Iowa landscape wrought by extensive subsurface agricultural drainage with the extractive capitalist practices that are hollowing out rural communities. Interrogating the ideological, institutional, and technological infrastructures underpinning the politics of water quality in Iowa, I find drainage useful for a several reasons.

First, drainage reflects the *processes of extraction* at play in the Iowa landscape. Through physical, subsurface drains underlying Iowa's farm fields, which themselves are connected to ditches and channelized streams, water escapes the farm gate, carrying nutrients and topsoil. More than water, however, flows off Iowa's farm fields. Efficiency in draining water off fields mirrors the efficiency through which highly differentiated, input-dependent agriculture has drained local communities of people and financial resources. As commodity agriculture has consolidated across the landscape, rural areas have faced numerous losses. Among my participants, the most cited concerns (aside from water quality) included the loss of schools, hospitals, churches, and young minds from small towns across the state (Edelman 2021; Halawith 2022; Reding 2009; Swayne 2023; Vujicic 2016; Wing et al. 2008).

Second, drainage evokes *instruments of enclosure* seen throughout agrarian transformation (Kloppenburg 2004; Montenegro 2018; Thu 2001). As I argue in Chapter 2, land that has been tile-drained, or "improved," is locked into intensive cultivation, foreclosing alternative uses for the land. Farm drainage is a costly investment, borne primarily by those with means, and subsequently increases land values, which contributes to ongoing cycles of debt and difficulty accessing land. Similarly, structural constraints and systemic barriers underwrite maintenance of status quo productivism. These barriers can feel monolithic to individual farmers or residents, reinforcing intensive agricultural practices and limiting the adoption of more sustainable or diverse land uses.

Critically, drainage occurs underground, often invisible until it breaks. The *subterranean* domain of drainage helps us understand the subtle but powerful role of cultural discourses and social institutions that have stalled progress on water quality improvements and hollowed out rural communities. The hidden nature of drainage systems, operating silently beneath the surface, parallels the unseen forces that shape rural life. A subsurface system of pipes and channels guides the flow of water beneath farm fields, just as entrenched societal norms and policies direct the flow of resources and opportunities. The invisibility of systems makes them easy to ignore, facilitating extraction and enclosure. This is, until a problem arises. Crises reveal their presence.

Compounding each of these aspects of drainage is *intensity*[16]. Where once drainage was confined to wet spots here and there, increasingly drainage is being installed in what is called "pattern tiling" extending across the landscape. This immense scale has transformed the hydrological cycle, speeding the movement of water across the region. The widespread adoption of farm drainage has not only intensified agricultural productivity but also significantly altered regional water dynamics, exacerbating issues of nutrient runoff and water quality. As drainage systems expand and intensify, they reflect the increasing scale and speed at which rural communities are experiencing change.

[16] The scale and intensity of commodity production in Iowa is also why I use the term "industrial," following Henke (2008), to describe the agriculture practiced there.

Through this metaphor I draw attention to the entwined technological, ecological, and social dynamics governing water quality. Any attempt to meaningfully address water quality requires explicit and simultaneous consideration of the historical material and discursive projects at play on the landscape. Thinking through the metaphor of drainage can make visible unseen infrastructures and ideologies, highlighting the complex interactions and power structures that condition socio-environmental outcomes.



Figure 7. Abandoned corn crib in a field of soybeans in Grundy County, Iowa. Photograph by author, June 2021.

Listening, Witnessing

This dissertation is grounded in repeated, in-depth ethnographic fieldwork and archival research in Iowa. Between 2021 and 2024, I spent nearly 10 months, across eight trips, in Iowa listening to farmers and residents tell me the story of Iowa agriculture in their own words. I employ the classic tools of critical ethnography — in-depth interviews, participant observation, and direct observation — to understand the messy and relational social world of agrarian capitalism in the Iowa prairie (Hart 2004). I triangulate the qualitative data gathered through my fieldwork with contemporary scholarly literature on Iowa farming and gray literature including state and federal government reports, policy briefings, legal reviews, and non-governmental organization (NGO) white papers.

Recognizing that agrarian landscapes are intimately connected with global economic processes, I focus on the contingent and situated expressions of broader agri-food system trends as they impact the people and ecologies of my field site (Goodman and Watts 1997). I employed Burawoy's (1998) extended case method to help me examine these local manifestations of macro-level processes. This methodological approach allows for thick detail rooted in the everyday experiences of Iowans, while

remaining informed by theory (Gibson-Graham 2014). It also allows me to explore multi-scalar processes, evaluating local particularities alongside predictable contradictions of capital.

Archives provided documents on early agricultural drainage and the progression of agricultural groups in the state and gave me a contextual understanding of the history of the Des Moines Lobe. I pored over letters among drainage engineers, Farm Bureau bulletins, Extension publications, and glossy photographs of agricultural machinery in the first half of the twentieth century, most of which are not described in this dissertation but nonetheless helped ground my analysis. I reviewed oral histories at the Iowa State Historical Society that portrayed the state of farming in the early twentieth century. These historical reference points prepared me for the representations of values, constraints, and loss I would hear repeatedly in interviews. I was new to archival work when I began this project and was assisted by the archivists at the Iowa State Historical Society in both Des Moines and Iowa City and the Iowa State University Special Collections in finding material relevant to the histories of agricultural drainage and political subject-making in Iowa.

Much of the empirical evidence I present in this dissertation was collected in *interviews*, which were essential for orienting myself within the messy politics of water quality and for meeting agricultural stakeholders across a range of perspectives. In total, I conducted ninety-three in-depth, semi-structured interviews with farmers, rural residents, and key informants. These included forty-nine interviews with farmers (eight women and forty-one men[17], all between the ages of 35 and 75). I interviewed twelve extension officers; fourteen representatives of community groups, including Iowa Citizens for Community Improvement (ICCI), Great Plains Action Network, and Iowa Environmental Council (IEC); and fifteen representatives or affiliates of agricultural organizations, including the Agribusiness Association of Iowa (AAI), Iowa Agriculture Water Alliance (IAWA), Iowa Farm Bureau (IFB), Iowa Pork Producers Association, Iowa Soybean Alliance, Iowa Corn Growers Association, Iowa Farmers Union (IFU), and Practical Farmers of Iowa (PFI). I also interviewed eighteen Soil and Water Conservation District (SWCD) commissioners, current and former staff at the Natural Resources Conservation Service (NRCS) and the Iowa Department of Natural Resources (IDNR), employees and leadership at drinking water utilities, conservation consultants, and former county Board of Supervisors members. These categories are not mutually exclusive.

I employed a purposive sampling frame to stratify my sample for a diversity of characteristics and positionalities of water users and agricultural stakeholders. Many of the first farmers I met were introduced to me through Iowa State University's Extension and Outreach (E&O) and Iowa Learning Farm program. This group of farmers, as might be expected by their connections and involvement with E&O, was more engaged in conservation than the average Iowa farmer, so I reached out to contacts met through farm management companies (Hertz and Farmer's National) and through the IFB to ensure I was connecting with a representative array of Iowa farm operators. In the end, less than half (n=22) of the farmers I interviewed used cover crops. Most of the farmers I interviewed (n=38) owned at least some of their own land. Of those, most still rented additional

[17] Although Iowa's rural areas are rapidly diversifying (more so than some urban areas), nearly 85 percent of Iowans identify as white according to the most recent census. That percentage is even higher among farmers because of historical legacies of systematic racism and exclusion. In this context in Iowa, identifying someone by any other racial identity would be too revealing. To protect the anonymity of my participants, I have chosen not to mention race (U.S. Census Bureau 2024).

acres for their farming operations. To protect the identity of my participants, I use pseudonyms throughout this dissertation.

As a scholar embedded in the social world I study, I treat the interview as a dialogue rooted in theory and an opportunity for respondents to tell their story about themselves (Bourdieu 1996). My process for conducting semi-structured interviews is grounded in feminist practice to foster conversational and interactive discussion (Longhurst 2009). Interviews were primarily conducted at the participant's place of work — in offices or on farms. Four interviews were conducted via Zoom. Interviews lasted 1–2 hours and were usually held one-on-one, but in eight interviews the farmers their spouse were present. I asked participants about their relationship to farming, their farming practices (if applicable), and what they saw as the most pressing issues or exciting opportunities. I also asked questions about the DMWW lawsuit and what other information sources I should be seeking (see interview guide in Appendix 1). Interviews were audio-recorded with permission from the participant.

In addition to formal interviews, I met people in coffee shops, at taverns, and at agricultural shows and equipment retailers. Because the focus of my study was drinking water, everyone I met in Iowa had some stake in the research. I found that even when I was speaking with people who did not farm, they usually were not too far removed from farming: their cousin now farmed the family's land, or their dad had sold his cattle when Iowa Beef Processors, Inc., was bought out by Tyson Foods, or they had worked in meat packing before an injury forced retirement.

Iowans are famously nice and throughout my time in the field I was regularly invited into the homes of farmers and residents. Through these deeply personal interactions I came to know my field site in a new and intimate way. Many times, these contacts had suggestions for farmers or organizations to whom I should reach out. If a name was suggested multiple times, or if including them would increase the diversity of my sample, I asked for a connection.

Interviews and informal connections frequently led to invitations into spaces where agricultural stakeholders and water users interacted with one another. I also engaged in *participant observation* to immerse myself in the discussions over water quality and agricultural practice and to witness the subtleties and complexities of social interactions in person (Geertz 2005). I attended over a dozen field days hosted by PFI at member farms as well as six IFB events, five of which were targeted at Young Farmers. I also attended eight community meetings in the Des Moines Lobe where the topic of discussion was related to water quality. At all these events I identified myself as a researcher, participated where appropriate, and kept detailed notes about the content and emotional valence of conversations.

All interviews and fieldnotes were transcribed and digitized weekly. Data were classified based on their attributes (e.g., type of participant, location, data collection method). Upon returning from the field, I analyzed all materials for emergent themes[18]. When coding, I organized materials into categories and highlighted relevant parts to determine broad schema and begin identifying codes. Subsequently, my data were coded and analyzed in the MAXQDA software. A randomly selected subset (n=10) of the interviews was coded by research assistants to check my coding for bias and increase reliability of the analysis. My research received Institutional Review Board approval from

[18] More detail on the themes specific to each chapter and the contradiction it explores, as well as the gray literature I draw from, are included in that chapter.

the University of California, Berkeley. Preliminary fieldwork was conducted under protocol #2021-04-14266 and continued fieldwork was conducted under protocol #2023-04-16276.



Figure 8. Photograph of the author learning the names of prairie plants at a field day in July 2023. Photograph courtesy of PFI.

Structure of the Dissertation

Over the course of the following three chapters I argue that a confluence of historical, cultural, political, and ecological processes has created the current water quality crisis. I depict the development of the slow crisis of nutrient pollution in Iowa's waterways, scaffolded by technical, discursive, botanical, and institutional construction of the modern landscape.

In the first paper (Chapter 2), I argue that farm drainage is a political technology as much as an agricultural one, enclosing the future of the landscape for intensive cultivation and entrenching private property relations. This chapter charts the hydrosocial history that has produced the current landscape of Iowa and demonstrates the intrinsic bundling of land and water in Iowa, such that any struggles to control water are also necessarily territorial contestations over land (Boelens et al. 2016; Swyngedouw 2009). I document state-capital imperative that has made and remade the Iowa landscape, with a particular focus on development of the industrial maize complex and hydraulic reordering via agricultural drainage. I begin with a brief discussion of the geological formation of the Iowa prairie and the first peoples who hunted, fished, and farmed in this landscape, then recount the historical parade of state interventions that have privileged private property relations and their

impact on water governance. I enumerate the environmental amenities sacrificed in the state as a result of extensive draining, including loss of prairie, agricultural diversity, wildlife, meandering rivers, and, of course, clean water. In attending to this history, I explicate the critical role of an unseen infrastructure in producing the agroindustrial landscape of modern Iowa.

I return to the DMWW lawsuit in the second paper of my dissertation research (Chapter 3) as I try to understand the discourses that shape how Iowans responded to the conflict. Through interviews with row-crop farmers and stakeholders in Iowa, I uncover (three) interlocking myths that legitimate industrial agricultural production practices to expose underlying power structures and political dynamics. I begin by conceptualizing a theory of myths as socially constructed ideas, laden with ideological functions, that are naturalized to perpetuate a particular arrangement of social power (Barthes, Lavers, and Barthes 2006). I argue that the contemporary cultural paradigm guiding the policies and practices of Corn Belt agriculture hinges on a series of mythologies about the roles and responsibilities of farmers in global food provisioning and their historical relationship with nature. Specifically, these myths extend and reinforce productivist agricultural approaches in lieu of diversified agroecological alternatives, which ultimately forestalls action on growing environmental and public health catastrophes. By naming each myth, I aim to expose and dispel the contradictions inherent in its representation of reality to strip it of ideological function. This paper was published in the *Journal of Rural Studies* (Hall 2024).



Figure 9. Corn crop in Johnson County in July 2023. Despite the common saying "knee high by the Fourth of July," corn is usually 8 feet tall or higher by the holiday. Photograph by author.

In the third paper (Chapter 4), I confront a key epistemic dimension of nitrate pollution: you cannot see, smell, or taste nitrates in water. In this context, the production of data becomes critical, shaping how the state both assesses and addresses nutrient runoff. I demonstrate how in Iowa the

production of knowledge is embedded in agroindustrial interests, connecting a recent political controversy over the status of "progress" in the years since the introduction of the NRS with historical attempts to discredit or defund knowledge that does not conform. I argue that the power relations governing water engage in the strategic cultivation of doubt, confining the making and use of knowledge to authorized experts and ensuring continued extraction and production. By delegating water quality monitoring to an agribusiness association, the state contributes to elevating their partial knowledge for the sake of accumulation. This comes at the expense of embodied knowledges that may reveal an alternative account of degrading water, which could prompt regulation and threaten the economic viability of agroindustry.

Through these cases, I document the contentious, slippery, and relational politics of water quality in Iowa. I contribute an in-depth examination of a capitalist agrarian landscape to situate the local socio-ecological repercussions of a global agri-food system, demonstrating that struggles over water are born of the past and embedded in contestations over the future of Iowa.

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Chapter 2

'Corn Doesn't Like Wet Feet': Invisible Infrastructure and the Draining of the Iowa Prairie

"People don't really know, but, in this part of the world, we are highly dependent on drainage."

Ron L., Story County, IA, June 2021

In July of 2023 I attended CORNival, local festival in Altoona, Iowa, celebrating 100 years of the miracle of hybrid corn. The Des Moines suburb was home to the first field of hybrid corn ever grown and marked the anniversary with an installation of fifty 6-foot-tall statues of giant ears of corn decorated by local artists. Unveiled on the Fourth of July, following a patriotic parade of sports teams, candy tossing, and antique tractors, the celebration was a fitting expression of the triumph of the "botanical bastard" that reigns supreme over the landscape of Iowa (Warman 2003). Having spent a considerable amount of time in Iowa, I found the corn iconography exalted at this festival to be nothing new. Corn imagery is, appropriately, closely associated with the state of Iowa, which was instrumental in ushering in an era of scientific breeding and now leads the nation in production of the crop. Walking through the Des Moines or Cedar Rapids airports, for instance, one can find countless tchotchkes of all varieties featuring the plant: keychains, hats, onesies, magnets, stuffed dolls, so that you can bring home a piece of Iowa's claim-to-fame. Beyond the gift shop, the story of corn is still hard to miss. The landscape is blanketed with a golden carpet, often cropped right up the edges of homes in small towns and suburban developments alike. Huge elevators filled with the dried grain tower over communities like cathedrals of the agricultural age, standing as monuments to the region's agrarian devotion. Less well known, outside of farming communities at least, is the story and importance of agricultural drainage, working beneath the surface to ensure corn's dominance over the Iowa prairie. This is that story.

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"Corn doesn't like wet feet," according to the familiar farm saying. This simple adage, frequently relayed to me by farmers and urban residents alike, illuminates the dramatic hydro-ecological transformation of the state of Iowa wrought by corn maize, *Zea mays* (See Figure 10). Highly sensitive to excess moisture in the soil, particularly during the early stages of growth, corn yields suffer when the plants stand in water (Bailey 1909). Corn's political and economic importance grew across the nineteenth and twentieth centuries as more and more land across the Midwestern United States was devoted to growing the grain. Corn production was simultaneously a cause and a consequence of draining 70 percent of the wetlands across this landscape. In Iowa, pursuit of ever higher corn yields led to extensive drainage "reclaiming" over 95 percent of the state's wetlands (McCorvie and Lant 1993).

Many scholars of Iowa argue that it is the most human-modified state in the U. S. because of the dramatic loss of tallgrass prairie across the state and the intensive agriculture that envelops the landscape (e.g., Mutel 2022; Swanson 2017). Only 2 percent of Iowa's pre-settlement landscape remains unaltered today (Mutel 2008). As farm fields grew larger through the twentieth century, yields grew as well and drainage networks expanded across the state. Today a typical Iowa farmer grows carbohydrate-rich yellow dent field corn, primarily for livestock feed, export to foreign markets, and use in ethanol, in rotation with protein-packed soybeans, on ever-larger parcels surrounded by straightened streams and drainage ditches. This has left little room for the native biodiversity or wetlands that could naturally absorb excess nutrients. In tandem, the number of farmers has dropped precipitously, hollowing out rural communities.

Using the framework of hydrosocial territory, defined as a politically produced space where water and social power mutually constitute each other, this article documents the historical hydrosocial processes that have made and remade agro-industrial Iowa (Boelens et al. 2016; Linton and Budds 2014). The contemporary landscape bears the palimpsest of ideologies, enclosures, and contradictions forged in the early days of Iowa's settlement. This history reveals that the concealed and naturalized boundaries between land and water were politically constructed, with enduring socionatural significance (Lansing 2009; Swyngedouw 1999). Maize plants and drainage tiles stand out as critically entangled physical and social actants shaping the modern capitalist prairie. Unseen subsurface agricultural drainage facilitated intensive corn production, which in turn required extensification of drainage.

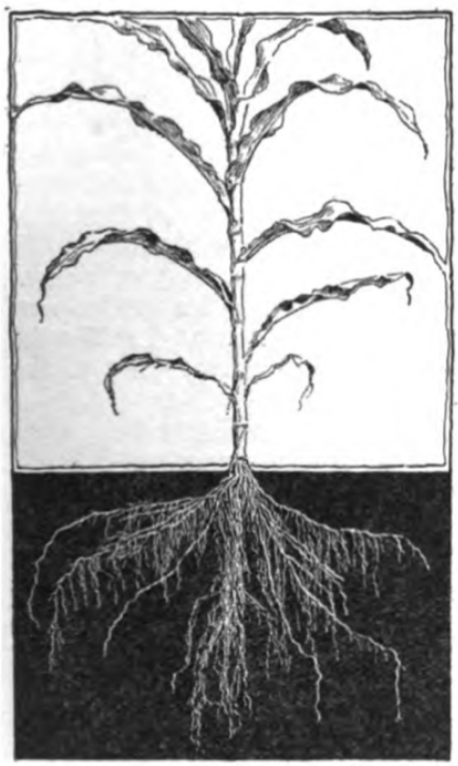


Figure 10. Root system of a corn (Zea mays) plant. (Bailey 1909)

Land, water, and botanicals are entangled with capital, infrastructure, and governance in this manufactured geography, constructing a hydrosocial territory that continues to condition Iowans' daily lives and foment socionatural contestations (Castree 2008; Swyngedouw 2009). Although the crops are grown and systems installed on privately owned farms, the dynamic interplay of corn maize and agricultural drainage was facilitated by a series of federal land grants and cooperative institutions. The immensely productive agriculture of the tile-drained landscape was made through public intervention and yet private property ideology looms large on the landscape in the interstices of the closely cropped corn plants that blanket the state, perpetuating cycles of debt and entrenching capitalist agriculture.

In what follows, I trace the industrialization of corn maize in Iowa, the technical and social infrastructure it required, and the history of state land distribution programs that transfigured the landscape. I provide an account of the construction of Iowa's agrarian landscape, from deglaciation through the post-war industrialization of farming, with a particular emphasis on the era between 1870 and 1930, when a vast network of drainage tile was installed across the state. This largescale subterranean infrastructure project relied on a combination of labor, technology, and capital and necessitated collaboration and government support. I juxtapose this history with the agro-

industrialization of corn, which thrived in the newly drained landscape and reinforced technohydrological transfiguration. Working hand-in-glove, capitalist farmers and state institutions drained the waterlogged frontier, ultimately enabling corn's conquest and fortifying Iowa's position in the modern global agrifood system. From this perspective, persistent nutrient pollution emerges as the result of a specific confluence of sociopolitical institutions, hydro-ecological relations, and the development logic embedded in each.

This chapter argues that Iowa's contemporary agro-industrial landscape was produced by subsurface drainage and enabled by public institutions for private accumulation, with enduring consequences for social and ecological relations. The state-capital imperative to dry out the Iowa prairie radically transformed the landscape, entrenching private property relations, restricting water governance, and degrading the ecology of the state. Today, Iowa agriculture is impressively productive in terms of commodity volume, largely facilitated by drainage infrastructure. It is also, however, inherently leaky with respect to nitrates and it has come at the cost of the native prairie, agricultural diversity, wildlife, meandering rivers, and, of course, clean water (David, Drinkwater, and McIsaac 2010; Hatfield, McMullen, and Jones 2009).

Methods

This research is the result of archival investigation and in-depth interviews in Iowa between 2021 and 2024. There is, unfortunately, no centralized database on where, when, and by whom agricultural drainage was installed on private land. As a result, I relied on a mix of data sources to derive the arguments I present in this paper. First, I reviewed historical documents at the Iowa State Historical Society Archives (with special attention to the State Drainage, Waterways and Conservation Commission records) and Iowa State University's Special Collections archive, which contains records on agricultural engineering, swampland surveys, and historical litigation around drainage. Through these collections, I reviewed extensive correspondence between the chief of drainage investigations, C. G. Elliot, and county commissioners between 1902 and 1909. I combed through reports released by the Iowa State Department of Agriculture (before it became the Iowa Department of Land Stewardship and Agriculture) celebrating 100 years of statehood by reviewing the progression of crop production in the state. I also reviewed newspaper clippings from this era across the Des Moines Lobe where farm drainage was reported on. The following arguments also draw from historiographies of Midwestern drainage projects across the Corn Belt. Together, this material provided a window into institutional priorities, popular framings, and political contestations around water management projects in the early reclamation era. Finally, the 1932 Census of the United States Drainage of Agricultural Lands Report allowed me to triangulate this material with statistics and trends on farm drainage in the state of Iowa as well as specificities of drainage law (U.S. Bureau of the Census 1932). As part of a larger dissertation project, I also conducted more than ninety semi-structured interviews with individuals from state and local government agencies, environmental organizations, community groups, and agricultural producers. Primary interview data with current or retired tile installers, multigenerational farmers, and agricultural historians in the state helped to contextualize historical documents and inform my analysis.

Cultivating the Tallgrass Prairie

The rich soils of contemporary Iowa were formed following the glacial recession[1], which left behind a vast landscape of prairie interspersed with marshes and shallow lakes (Bishop, 1981) (See Figure 11). For thousands of years before European settlers arrived, the tallgrass prairies, oak savannahs, and sedge meadows were home to the Oneota peoples — ancestors to the Oto, Winnebago, Missouri, and Ioway (who lent their name to the state) tribes — who regenerated the landscape with fire. The first inhabitants of the landscape hunted, fished, and practiced cultivation, including planting and harvesting of corn, which then as now provided reliable, durable, and storable food calories (Mutel 2008). Regular burnings maintained the prairie grasses in order to ease travel, increase visibility, control pests, clear woodlands, and nurture vegetation to attract game animals for hunting (Mutel 2022). The early Indigenous populations cleared lands for gardens and villages, shaping and reshaping the composition and distribution of plant communities across the region through selective cultivation of domesticated varieties. The "black gold" underlying modern Iowa's incredibly productive agriculture is in part a result of their actions.

After Columbus's arrival in the New World, conflicts with European immigrants pushed Indigenous communities westward while diseases decimated their populations. The first European settlers encountered a world of abundance, seemingly designed for cultivation with soils so rich they required little to no fertilization (Mutel 2008, 14). The territory was "opened" to pioneer settlement in 1833, following the euphemistically named "Black Hawk Purchase." Less a purchase than a punishment for violating a treaty they misunderstood, this action forced all native inhabitants to vacate their homelands (Mutel 2022). Settlers moved quickly into the emptied landscape, attracted by reports of the favorable climate and soils, both of which made the region well-suited to agriculture. Cadastral surveying was completed a few years later, in 1836, recasting the tallgrass prairie and oak savannahs into a gridded extension of eastern economies.

[1] The most recently ice-covered area, the Des Moines Lobe, stands out as a uniquely fertile and flat watershed with poor surface drainage. One of the most prized agricultural regions in the country, it is also the watershed at the center of the Des Moines Water Works (DMWW) lawsuit. Because of the intensive agriculture and extensive drainage in this area, it is arguably the region most in need of conservation practices. However, the rich black gold, formerly thick muds made farmable by drainage, is still the area most subject to tillage and sports the least amount of cover crops — a tragedy, but a fundamental reality relayed to me by several farmers who have spent all their lives in the area.



Figure 11. A re-established prairie in central Iowa. Photo by author, July 2023.

With the land depopulated of its native inhabitants, the Federal Land Ordinance (of 1785) subdivided the prairie commons into private holdings, promoting individual ownership and settlement for European settlers, who rapidly undertook extensive conversion of the tallgrass prairie into agricultural farmland. Settlers began cultivating grains including corn, wheat, and oats, along with other vegetables and hay, which grew well in the moist, nutrient-rich, and well-aerated prairie-derived soils. Though the assortment of early crops was considerably more diverse than what is grown today, the introduction of imported plants and livestock "superimposed a new biological regime upon the land" and set the stage for the continued transmutation of the ecology of the state (Mutel 2008, 101).

The privatization of land holdings, facilitated by colonial politics that privileged European "improvements" over Indigenous practices, laid the groundwork for a culture in which property rights reign supreme. Iowa achieved statehood in 1846, on the heels of another significant wave of land enclosure via the Federal Swamp Lands and Homestead Act of 1865. Distribution of prairie lands into private hands was a critical first step in establishing the modern agricultural landscape of Iowa. But before the newly titled fields could be tilled for cultivation, they needed to be *tiled* (See Figure 12).

'Land made good': The Era of Reclamation and Improvement

"All the fields here are tiled to make them farmable. And we're not going back to not tiling," Rick (IA608), a farmer in Badger, Iowa, told me as we walked through his field of corn drying on the stalk in anticipation of the upcoming harvest. Looking out at the intensively cultivated lands in

central Iowa, it is easy to forget about the subterranean pipes lying beneath the root layer, hidden from view. Occasionally, the metallic shimmer of a tile-drain outlet appears in a drainage ditch along the side of the road, water trickling out slowly but steadily, and I am reminded of the underground tile crisscrossing across the landscape.

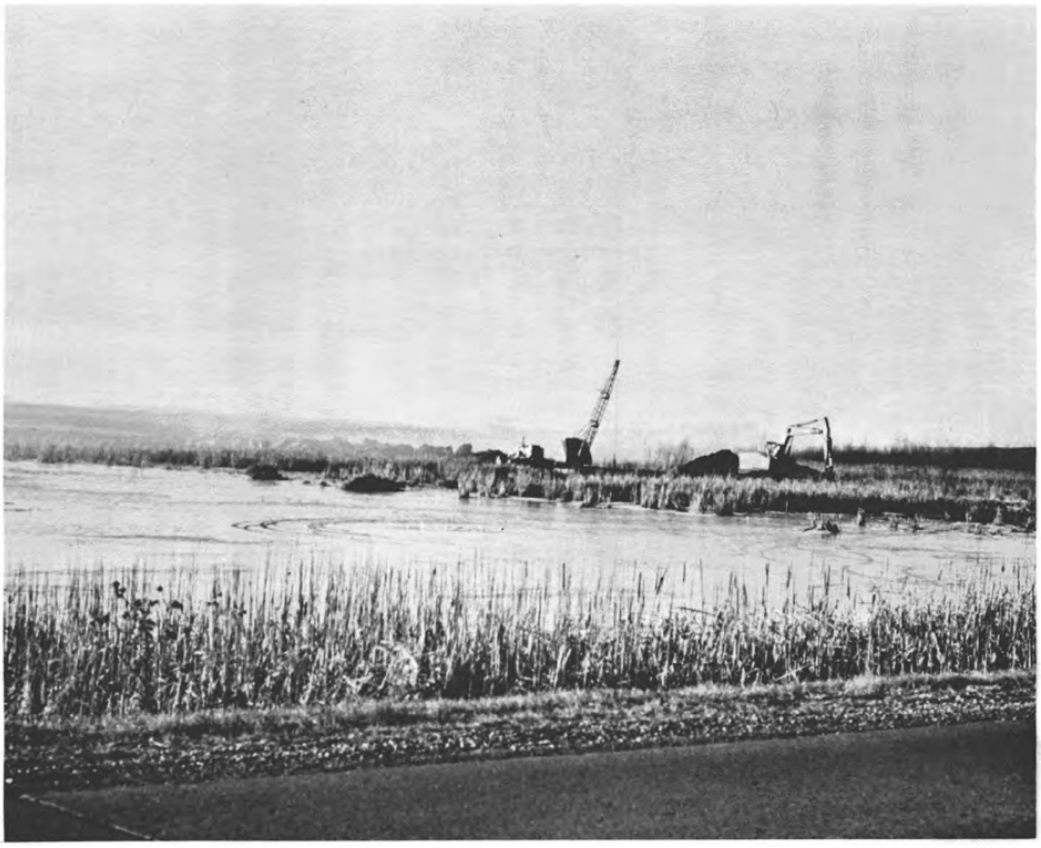


Figure 12. Prairie marsh being drained by construction of drainage ditch (Bishop, 1981)

Although agricultural drainage frequently doesn't receive the same level of scholarly or popular attention as irrigation in the arid and semi-arid West, the water management programs in the humid Midwest have undoubtably shaped the course of state and national development (Howe 2019; Pisani 2000). By 1920, over twice as much land had been "improved" by drainage than by irrigation (34 million more acres) (Carlson 2010b). Aided by federal policies, state-sanctioned institutions, and a particular idea of land, drainage arrived in the Iowa prairie in the late nineteenth century, forever changing the ecology and economics of the region.

The first subsurface drainage was hand-lain, using pipes made from clay (akin to terra cotta roofing tiles, which is why the practice is called tiling). Like those who carried heavy chains through the tall prairie grasses to mark out the cadastral grid that delineates Iowa, early settlers working with simple hand shovels remade the region into one of the most productive agricultural areas in the world. In many cases, the prairie was likely already broken by the plow, yet carving out miles of deep trenches in the dense black soil and laying the heavy tile would have still required tremendous effort. The work was back-breaking -— teams of immigrants hand-dug ditches in the humid heat of mid-summer, when the clay soil was dry enough allow digging (Imlay and Carter 2012). Using a ditching plow, workers cut a deep and narrow trench, then one at a time carefully placed the cylindrical clay tiles (see Figure 13).



Figure 13. Hand-installation of tile drainage in Iowa. Photo courtesy of Iowa State Historical Society.

Over 7 million acres of the wettest region of the state was drained by hand this way in the early 1900s (McCrory 1928). Concrete tile and mechanical tiling equipment wasn't available until after World War II; plastic rolls of PVC tile arrived in the 1970s (IA157). Most clay tile has been replaced in the modern era by plastic perforated pipes installed in intricate patterns across fields, but some of the original tiles remain. In much of the state, there is a dearth of records of where clay tile was installed because it was done on privately owned land. A technology whose presence is frequently notable by its absence or malfunction, you often find it only when it breaks, either from age or the increasingly heavy machinery employed on agricultural fields[2].

An Empire in the Swamp

Before the first drainage ditch was dug, the dramatic transformation of the Iowa landscape began in the minds and imaginations of the young nation's settlers (Pisani 2000). To Midwesterners in the late nineteenth and early twentieth centuries, notions of progress and improvement meant "reclaiming for settler farmers what nature had made unsuitable for agriculture" (McCorvie and Lant 1993, 25). As discussed in more detail in Chapter 3, conventional agriculture today relies on a valorization of land in terms of its productive potential. By any name, marshes, fens, wet meadows, or prairie potholes were seen as inferior and considered symbols of moral depravity in their unsuitability for cultivation. Popular imagery portrayed the prairie swamp as dangerous, forbidding, and, worst of all, unproductive (Urban 2005). Accordingly, surface water removal through drainage was seen as "enlightened land stewardship" for health and prosperity (Carlson 2010a, 5). Hopeful farmers

[2] This happened on my family's farm in 2021, revealing tile installed two generations back.

quickly adopted nascent drainage technologies, from the mole drain to simple open ditches, to overcome the menace posed by wetlands[3] (Lindsey 1860).

While public attention has predominantly concentrated on water resources in the West, the federal government has been less myopic in its attention to water management and was heavily involved in transfiguring nature in the humid half of the United States (Carlson 2010a). The prevalence of drainage was advanced by federal policy in the form of the Swamp and Overflowed Lands Acts of 1849 and 1865, which ceded all federally owned swamp and overflowed lands to fifteen states in the Midwest and Southern United States (Bogue 1951). Through these acts, the newly formed State of Iowa was granted nearly one million acres[4] of public domain wetlands for reclamation and conversion into arable land (Bishop 1981). After being granted to the states, this land was turned over to counties for distribution to individuals. Fraud and corruption was extensive in this process because county commissioners sold the land to themselves or close family members for nominal fees (Bishop 1981; Bogue 1951). Those willing to purchase the swampy lands were frequently well-capitalized residents or investors who either sought a quick investment opportunity to resell the land or intended to acquire largescale acreages that could be used for tenant farming.

Three primary reasons motivated Congress to enact the Swamp and Overflowed Lands Acts: rescuing worthless lands to make them useful and "good," mitigating unsanitary conditions (malaria), and enhancing the value of the land for readier sale of overflowed and adjoining parcels. Public health campaigns that were focused on the inherent danger of miasma from swamps and wetlands stigmatized the landscape and impelled reclamation efforts, providing cover for what some consider to be the true motivation: profit[5] (Carlson 2010a).

Although there is a dearth of records of early drainage, federal government inquiries into the extent of drainage document a consistent attention to the economic benefits of drainage as the infrastructure became a capitalized factor in land values (Iowa State Drainage, Waterways and Conservation Commission 1911; U. S. Bureau of the Census 1932). Until technology advanced, the Swamp Acts alone were not enough to directly result in widespread drainage (McCorvie and Lant 1993). However, the legislation represents well the dominant view of these pestilential landscapes and the general campaign for improving them. Critically, the Swamp Land Acts turned drainage into a state priority.

The Homestead Act of 1865 furthered drainage of the Midwestern prairie through another redistribution of public lands into private hands. Following the Homestead Act's passage, new arrivals to Iowa, like earlier settlers, claimed and fenced off parcels of land, converting previously communal or open-access land into privately owned agricultural properties. Sales of newly available, "unimproved" land helped wealthy landowners consolidate their holdings (Imlay and Carter 2012; Pisani 2000). Privatization facilitated more intensive cultivation, which required drainage.

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[3] James C. Scott presents a different view of wetlands in *Against the Grain*, highlighting their abundance of resources as a source of subsistence and refuge against early states (Scott 2017).

[4] The states themselves defined which lands were "swamp" and claimed more than triple what the General Land Office had estimated in their land surveys (Mutel 2008; Schwieder 1996).

[5] Improvement has long been associated with profit. In medieval England, the verb "to improve" meant to produce a profit off of land, often by enclosing commons and using them for agriculture (Li 2007).

How Drainage Works

Drainage is accomplished through the installation of subterranean pipes buried approximately 1 meter below the soil surface. Excess water trickles through the soil into perforated plastic tubing or clay tiles and is carried off by gravity into drainage ditches and catchments that feed into streams and rivers (See Figure 14). This artificially lowers the water table, preventing water from collecting into ponds in surface depressions or saturating the soil root zone. Drainage offers several benefits to agricultural land management, including improved soil aeration, reduced waterlogging, enhanced soil structure, and an extended growing season, all of which contribute to higher crop yields (Helmers et al. 2007). Importantly, it can also confer significant risk because water-soluble nitrates applied to the soil quickly and easily enter surface water sources and speed downstream.

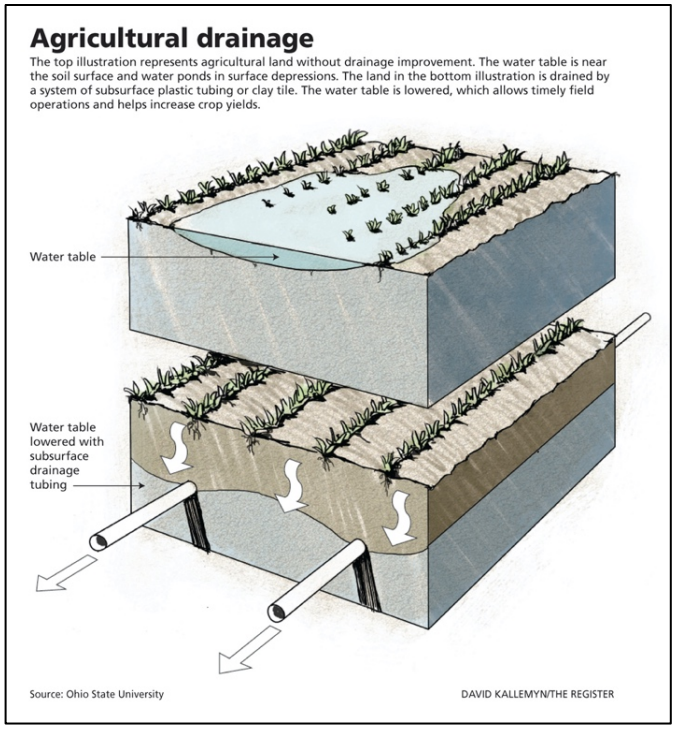


Figure 14. Illustration of agricultural drainage.

In modern pattern tiling practices, tile drainage is installed at a uniform depth and pipes are spaced across the field 80, 40, or even 20 feet apart in intricate patterns of parallel piping that follow the land's contours. Mike, a retired tiler, told me that as a general rule, "tile should drain an area about 20 feet wide for every foot of depth, meaning a tile put in at 4 feet should drain 40 feet each way from the tile, or an 80-foot swath, but the deeper the tile, the longer it takes for moisture to reach it and drain away" (IA602). His neighbor Bill, a pork producer who has lived in the Des Moines Lobe his whole life and introduced us, added, "That's a good thing if you care about water quality" (IA157). Depending on soil characteristics, weather dynamics, and economic motivations to increase yield, farmers may be tempted to install tile lines closer to the surface, resulting in a greater density of subsurface pipes and a faster conduit for dissolved nutrients to enter waterways. One resident of the Des Moines Lobe told me, "The land around here is so flat and so this incredibly intense agriculture is underlain by incredibly intense drainage" (IA386). Indeed, the Des Moines Lobe is the epicenter of agricultural drainage in the state, but the yield bumps gained by increasing the density of tile on farms is catching, and, according to John, "pattern tiling [is] spreading beyond the Lobe" (IA602).

Capital and Cooperation

Constructing Iowa's modern landscape required immense sums of capital. Many farmers I visited spoke with pride over the remarkable infrastructural triumph that is drainage. Others spoke with hints of regret. More than a few farmers and agricultural professionals summarized the era of reclamation by way of comparison with another significant engineering effort:

> Iowa's investment, as a whole, to create the original drainage districts that we were putting in place … was about equal to the entire United States' investment to build the Panama Canal. (IA188)

The New York Times reported in 1910 on this remarkable, if unknown, association, stating that the drainage improvements in Iowa had come very close to the total expense of the Panama Canal[6]. The newly reclaimed lands were some of the most valuable in the world creating a one of the "richest agricultural States in the world" (New York Times 1910; see Figure 15).

In a presentation to the State Agricultural Society in 1882 titled "Tile Draining on Farms," J. G. Brown declared "There is no question that enters so largely into the success of agriculture as the subject of this paper" (Brown 1882). He continued:

> The importance of drainage is illustrated by the large amount of money that is expended by individuals, and the combined capital of large land owners [sic], and by the aid of public money in many instances, in reclaiming wet land, and bringing it into subjection, and under the influence of plow and harrow.



PAYING $307,000,000 FOR IOWA DRAINAGE

Private Owners of Farms to Spend All But $60,000,000 of the Sum.

TO RECLAIM SWAMP LANDS

Values Will Be Increased Millions of Dollars, Making the State One of the Richest for Agriculture.

Special to The New York Times.

BURLINGTON, Iowa, Sept. 22.—So quietly that the fact has not become known widely, Iowa farmers have been arranging for drainage improvements in their low lands at a cost that will come within $55,000,000 of equaling the expense of building the Panama Canal. The general public has little conception of the extent of the enterprise which will increase the value of Iowa lands by millions of dollars.

The total expenditures now planned in Iowa in these improvements is figured at $307,000,000. This service will result in reclaiming thousands of acres of the most valuable land in the world, and carry out in good measure the policy urged by James J. Hill of making every use possible of the swamp lands of the West. Much of the work has been started already in the various river counties in the State, and some of it has been finished. When completed Iowa will be among the richest agricultural States in the world.

Figure 12. The New York Times *article, published September 23, 1910.*

As the *New York Times* article noted, much of the enormity of this sum was spent by private landowners[7]. Brown's comments, however, highlight the importance of collaboration and coordination in achieving widespread drainage across Iowa. Although documentation of who paid what for drainage installation is difficult to track definitively, the cost of draining the wetlands for agriculture was not entirely borne individually, nor was it spread evenly across landholders, at least initially. Small holders could seldom afford the expense of draining on their own. Drainage was an economic engine, and thus of considerable state and national interest. In addition to the increases in land values and agricultural production, capitalization in the tile manufacturing and laying industries highlights the crucial role of drainage in rural economies (McCrory 1928). The federal government was invested in facilitating drainage, and the USDA Agricultural Stabilization and Conservation Service (ASCS) helped subsidize wetland drainage by sharing the cost of tiling until at least 1956 (McCorvie and Lant 1993).

Further, the early methods of private drainage were prohibitively expensive, which meant that agricultural drainage was initially only undertaken by large landowners who had sufficient capital to

[6] While much of the wettest regions of the state had been drained by 1910, drainage would continue for decades more, with new drainage installation occurring through today.

[7] Farmers frequently reminded me of this expense, which many still feel: "My dad and my great uncle and my brother just have spent, I don't want to know how much money putting in tile drainage trying to dry out that spot" (IA078). This farmer spoke with exasperation of the seemingly never-ending battle with the wet prairie, attempting to eke out another few bushels on a chronically wet spot.

invest in the emerging technology. Large landholders benefitted from federal and state programs that provided cheap land. To make a project worthwhile, and to avoid legal troubles with downstream neighbors who might be unhappy receiving the excess flow, wealthy landowners drained thousands of acres at a time (McCrory 1928; Sayre 2000). Wealthy landowners and farmer-capitalists pioneered improvements in drainage technology, gradually bringing the cost of both manufacturing and installation down.

Private enterprises had laid the groundwork for effective drainage, but it quickly became clear that a collective approach to drainage was necessary, and landowners demanded assistance from the state to complete this work (Pisani 2000). Effectively draining the wet prairie lands required widespread cooperation. The State of Iowa achieved this in 1873 with legislation that authorized the formation of drainage districts. Districts operate as special-purpose governments with the power to levy taxes and invoke eminent domain in service of removing surface water. Creation of a drainage district established a legal mechanism for removing wetlands for cultivation, justified by the imperative for "public welfare" through agricultural cultivation (McCorvie and Lant 1993, 31).

An individual drainage district was typically formed by a group of landowners who petitioned their county board of supervisors and the district was managed by a board of trustees, often appointed by the supervisors. These cooperative institutions, which blurred the lines of public and private governance, were integral for construction and continue to oversee maintenance of drainage infrastructure including ditches, tiles, and levees. District commissioners collected the necessary capital for widespread drainage through fees assessed to landowners based on their expected benefit. With the legal power of eminent domain, they oversaw efficient and coordinated drainage of huge swaths of land "often incorporating several townships, whole counties or watersheds" (McCorvie and Lant 1993, 35). McCorvie and Lant argued that more than federal disbursement of land or technological innovation, the organization of drainage districts was essential in transforming waterlogged areas into the rich core of the U. S. Corn Belt. Once established, districts were difficult to dissolve and most that were established in this era continue to exist, which some contend serves as a significant barrier to wetland restoration (Bishop 1981).

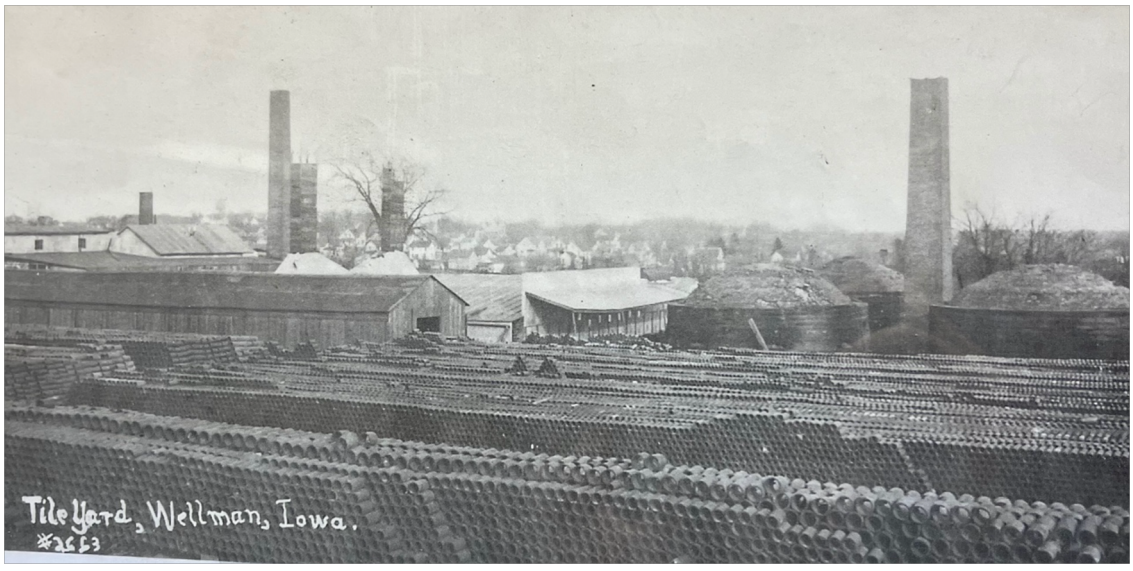


Figure 16. Ceramic tile factory in Wellman, IA. Photo of display at Wellman Historical Society, taken by author in March 2023.

Drainage was (and is) propelled in part by the need for the owners of capital to increase it, which in many cases has meant that subsurface drainage extends beyond wet areas of the prairie. By the end of the nineteenth century, smaller landowners and farmers were able to access (relatively) cheap drain tile produced locally (Urban 2005) (See Figure 16). Around this time, proponents of drainage began to extoll the virtues of underdrainage for dry land, encouraging the creeping expansion of drainage beyond the prairie potholes of central Iowa. "Drainage not only helps such land in wet years but it helps them in dry years as well," a Missouri Valley paper boasted (Missouri Valley Times 1904). A Keokuk publication agreed a few years later that "Quite a number of farmers have proved that [tile drainage] also benefits land that's dry and hard" (The Daily Gate City 1916). Then, as now, many farmers feel that "all prairie is wet prairie" (Prince 1997; IA200). According to the USDA's 1930 Census of Drainage, over 85 percent of the drainage-improved lands in Iowa were already farmed before they were drained, suggesting that often the objective was to increase productivity and profit on dry land rather than to reclaim wetlands for cultivation[8] (U. S. Bureau of the Census 1932).

Extensification of drainage frequently reinforced agrarian class structure through the persistence of regressive land tenure systems (Imlay and Carter 2012). Wealthy landowners drained the prairie, then brought in tenant farmers who worked the fields growing oats, wheat, and corn (Bogue 1951; Sayre 2000). On tile-drained land, leases were shortened to annual agreements and sharecropping was replaced by monetary payments to safeguard the landlord's income in case prices fell. Immigrant communities were frequently forced to cede controlling interests in drainage districts to banks and absentee owners; large-scale land-holding increased alongside rates of tenancy (Imlay and Carter 2012). Banks and speculators procured large tracts of land, installed drainage, and then sold the improved land on credit, leaving those who could afford to purchase the subdivided plots saddled with debt (Sherman 1924). As in the arid West, the costs of water management in Iowa meant that the "family farm gave way to agribusiness" (Pisani 2000, 478).

Entwined functioning of the state, capital, and technology transmuted Iowa's hydrosocial landscape into its contemporary form. The privatization of the Iowa prairie and the state-facilitated capitalist expansion of drainage enabled accumulation by naturalizing and locking in artificial boundaries of land and water, with significant social and ecological implications. Between 1850 to 1930, more than 70 percent of the wetlands of the Midwest were drained out of existence and in their place the grain farming that earned the Corn Belt its nickname solidified (Pisani 2000). Corn now reigns supreme in Iowa, placing the state at the center of a global food regime. In the next section, I briefly summarize the mutually reinforcing history of this plant before turning to the social and ecological consequences of its ascendency in the drained prairie.

A Culture of Corn

As tile drainage proliferated well beyond the prairie potholes of the Des Moines Lobe, technological advancements and political economic pressures were reshaping agriculture (Friedmann 1992; McMichael 2009). The development of hybrid corn led to dramatic intensification of corn cultivation.[9] With the help of newly available synthetic fertilizer produced in the Haber-Bosch

[8] Outside the swampy bogs of the Des Moines Lobe, as mechanical tiling and lower-cost tile options became available, landowners were able to install drainage extensively without the creation of cooperative districts. As a result, there are no centrally managed records of where drainage tile exists in most of the state.

[9] Hybrid corn is the result of crossbreeding two genetically distinct strains for desirable traits (Kloppenburg 2004). The offspring of this crossing display a notable hybrid vigor, such that the progeny is frequently sturdier and returns higher

process, corn yields nearly doubled in the span of two decades, encouraging farmers to grow more of the water-sensitive crop (USDA 2018). The cost of this miraculous increase, however, was felt acutely. Farmers could no longer save seeds because the hybrid varieties lose their vigor after a single harvest. Instead, farmers were (and are) forced to purchase new seeds each year, as well as the fertilizer needed to sustain high yields. The true beneficiaries of the publicly funded agricultural research and development that produced hybrid corn, it can be argued, are private seed companies, including Henry Wallace's Des Moines-based Hi-Bred Corn Company, now known as Pioneer (Kloppenburg 2004).

Iowa had been growing corn — both for human consumption and for livestock — well before the miracle of hybrid corn, along with wheat for the state's hundreds of flouring and grist mills, and oats for horses. Wheat production declined due to ratcheting pest pressures and land prices by the end of the nineteenth century (Swisher 1961; Warman 2003). As the frontier was opened to settlers in nearby states, land elsewhere was relatively cheaper than the drainage-improved fields of Iowa, and wheat production moved west. Oat production remained steady through World War II, until the industrialization of the Corn Belt replaced animal traction with tractors powered by internal combustion. Just as genetic innovations in the form of hybrid corn began to dominate the landscape of Iowa in the early part of the twentieth century, technical innovation in the post-war era intensified agriculture, underwriting ever-increasing production of corn (Friedmann 1992). Iowa was quickly becoming a "land of corn, and more corn" (Swisher 1961).

The new agriculture resulted in dramatic increases in production per laborer through intensive use of mechanical and chemical inputs, which further supported the growth of off-farm input suppliers and agribusiness capital. Corn, which was grown in dense and neatly ordered rows, fit well with mechanized approaches to farming and in turn agricultural equipment was frequently designed specifically for corn cultivation (Warman 2003). Machinery grew larger, becoming more efficient and more versatile. Chemical herbicides, widely available after WWII, and insecticides also became essential inputs in farming around this time. Labor savings from the innovations in agriculture steadily led to larger fields on fewer farms, which increasingly specialized in crops because they no longer needed the manure nor the motive power of livestock. To many toiling farmers, this was a welcome relief. As one fourth-generation farmer told me:

> The first thing my dad did when he got home from the service was he sold the dairy cows, he sold grandpa's herd. I've been grateful to him ever since then. And then when my brother and I went off to college, he sold his hogs and cattle he was raising, 'cause no one had the labor supply. And, well, we've been all grain ever since. (IA754)

Others, reflecting on the old ways and marveling in the gift of technology, told me: "I don't know much about this, but I don't want to go back the way it was" (IA608). As Rick remarked in his field of Hi-Bred field corn, tile-drained agriculture, with all its supporting technologies, is here to stay.

These mechanical, chemical, and genetic developments coincided with a governmental push for increased grain and oilseed cultivation as part of a geopolitical agenda to stabilize food supplies

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yields than either of the parents (hybrid yields could be over 100 percent higher than conventional varieties). The impact of hybrid corn was dramatic and wide-ranging: by 1941, more than 90 percent of the corn being grown in Iowa was hybrid (Warman 2003). Prior to the adoption of hybrid corn, open-pollinated varieties were yielding about 26 bushels/acre. Since then, with widespread adoption of the "double-cross inbred-hybrid corn" yields have grown about 2 bushels/acre each year. Today Iowa's average yield is over 200 bushels/acre (USDA 2023).

during war, provide sustenance for a growing industrial workforce, and strengthen trade relations with foreign economies[10] (Eddens 2019; Friedmann and McMichael 1989). Instead of traditional agricultural supply control programs, the federal government implemented programs designed to increase commodity production, in a moment that was embodied by Secretary of Agriculture Ezra Taft Benson famously compelling farmers to "get big or get out" (Rosenberg and Stucki 2017). Iowa's farms were increasingly internally specialized, governed by world-prices, and dedicated to producing industrial commodities (Friedmann and McMichael 1989; Lobao and Meyer 2001; Weis 2013). Structural changes both domestically and abroad were reforming the global food system, and Iowa's large tile-drained fields of corn, cropped in rotation with soybeans, became entrenched in a transnational maize-oilseed-livestock regime (Friedmann 1992; Weis 2013). A third-generation farmer in the Des Moines Lobe described the changes his family has seen in farming:

> A hundred years ago around this house there were sugar beets grown and my grandfather as a kid, a Russian immigrant from during World War I, they were fleeing Europe, would pick the sugar beets. And my grandfather would take beets by horses and a wagon and take them into the Whaley Sugar Factory, which was in town. We can still grow sugar beets here. But we don't because the nearest sugar beet factory's about 250 miles away in the Red River Valley. (IA608)

Several other farmers reflected similar sentiments, noting that Iowa's rich, fertile soils *could* be used to grow many different crops. But Iowa today is firmly rooted within an industrial maize complex. Infrastructure for other commodities has fallen away as farms consolidated and specialized. Livestock has moved indoors, leaving more room for the vast fields of corn and soy that feed them. In many ways, the dedication to maize has paid off: the state leads the nation in production of the golden grain.

The Landscape of Capitalism

In many other ways, however, the culture of corn has had far-reaching ramifications. Robert Sayre, in an essay titled "The Landscape of Capitalism," relayed the history of capitalist accumulation and development in the Iowa prairie, concluding that "even more than with plowing and fencing, the economic gain [of tile drainage] was an ecological loss" (Sayre 2000, 121). Corn's conquest of Iowa, abetted by extensive drainage, has been undeniable, but it has come at the expense of an ecologically diverse and complex natural system. Corn now covers more than half of the cultivated land in the state in any given year, almost always in a 2-year rotation with soybeans, such that the two together dominate the landscape in monocropped uniformity (see Figure 17) (USDA 2018). The development logic spurring privatization and drainage have eroded access to public lands such that the state now ranks either 47th or 48th in public land availability, with more than 97 percent of the state's land area in private hands, with the overwhelming majority of this land being farmed (Murphy 2023).

[10] The development logic that underwrote 'improvements' in domestic agriculture trickled into geopolitics, as productivism was rebranded as humanitarianism (Buttel 2005; McMichael 2009).

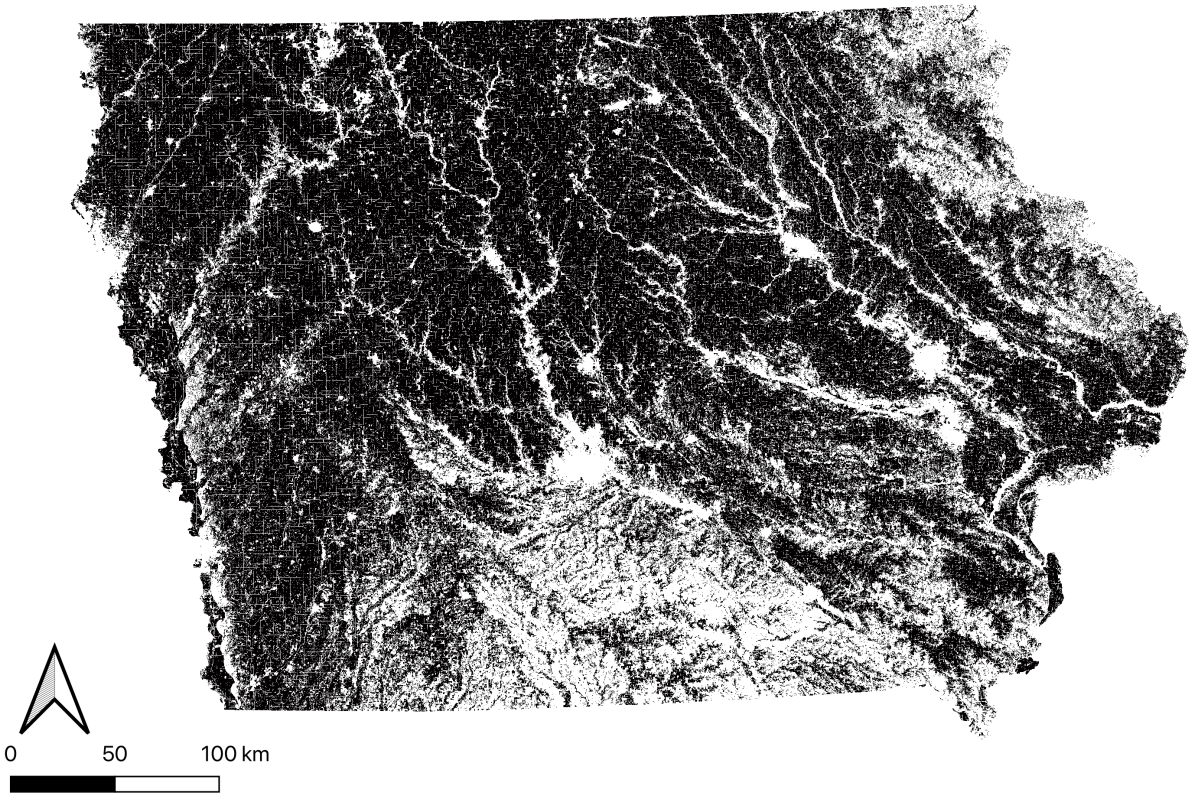


Figure 17. Corn and soybeans grown in Iowa in 2023 are shown in black, covering about two-thirds of the state. Map by author; data sourced from Cropscape Data Layer.

The wet prairie that settlers encountered upon their arrival in Iowa was transformed in the span of decades, creating a reordered landscape of rectilinear streams and tile-drained farms. Today, less than 0.1 percent of the native tallgrass prairie remains (FWS n.d.), primarily lost to row-crop cultivation. More than 95 percent of the state's natural wetlands have been drained (Bishop 1981). Streams were straightened, shorting the total mileage in the state by half (McCorvie and Lant 1993) (See Figure 18). These watercourses were squared up to make fields easier to farm. As a result, their flow rates increased, causing them to carry more sediment and soil-bound nutrients off farm fields to downstream lakes and rivers. In addition to contributing to nutrient pollution, the destabilized flow regimes caused by stream channelization have annihilated aquatic habitats, leading to dramatic declines in fish, amphibians, and water fowl[11] (Ballard, Jones III, and Janke 2021; Gallant et al. 2011; Mitchell et al. 2022; Mutel 2022).

[11] Before they were drained for agriculture, roughly 25 percent of migratory fowl in North America used the wetlands of the Midwest in their annual migrations (Pisani 2000, 479). Conservation organizations are now deeply engaged in campaigns to rectify the loss of this important habitat by creating bird sanctuaries and migratory refuges.



Figure 18. Straightened tributary of the Iowa River in Albion, IA. From this satellite photo one can make out the stream's original meander. Photo from Google Earth.

The new corn-centric biological regime has resulted in negative impacts both locally in Iowa and much further downstream (David, Drinkwater, and McIsaac 2010). Hybrid corn is notoriously nitrogen (N) hungry and requires huge amounts of fertilizer, whether synthetic or organic (Ribaudo 2011). Ready availability of externally derived fertilizer and an economic environment emphasizing cash cropping means that most fields are left bare over the winter, allowing the highly water-soluble nitrate-N to readily leach through soils and run off (David, Drinkwater, and McIsaac 2010; Hatfield et al. 1999; Hatfield, McMullen, and Jones 2009). Together, tile-drained fields and monocropped corn create an inherently leaky system (David, Drinkwater, and McIsaac 2010). The extensive subsurface of artificial drainage installed across Iowa's former wetlands ensures that N-laden water from fields speeds into Iowa's streams, lakes, rivers, and, ultimately, the Gulf of Mexico (Blesh and Drinkwater 2013).

Conclusion

The landscape of Iowa today is a product of the biophysical and cultural, of the material and political, of nature and society. In this hydrosocial territory, the materiality of drainage infrastructure foregrounds the frictions among social practices, environmental processes, and structural forces. The considerable labor and capital invested in drainage systems across the Midwest are often overlooked, particularly by those outside of farming. And yet tiles, often installed decades ago, continue to operate quietly beneath the surface of farms across the state, sometimes even escaping the awareness of those managing the land.

I suspect that part of why drainage remains relatively underexamined when compared to water management paradigms in the West is because installation of agricultural drainage does not serve to differentiate the landscape. On the contrary, drainage enables increasing uniformity (Hewes and Frandson 1952). The oak savannah, once dotted with small ponds and marshes and scattered with

timbers around meandering streams, becomes a cultivated field, likely growing the same crops as the field adjacent to it, and indistinguishable from land that may have once featured starkly different natural drainage conditions. The water regimes of lands east of the Hundredth Meridian have been equally reordered as those to the west, if not more so (Pisani 2000). While tile drainage itself may be difficult to observe, the effects of the silently trickling subterranean infrastructure are significantly less subtle. As McCorvie and Lant contended, "[the] Corn Belt seems less an accomplishment and rather more of a massive environmental insult" (1993, 23).

During the era of reclamation, farm drainage was frequently framed as inherently in the interest of the common good, and yet the economic gains of widespread drainage were never evenly distributed across the population. An example of continuity despite ecological transformation, the draining of Iowa's prairie initiated cycles of debt among family farmers and engendered ubiquity of private property relations. Wealthier landowners and owner–operators benefitted at the expense of small and tenant farmers, accumulating more capital that could be further invested in land acquisition, drainage, and agricultural production. The trends seen in the early days of agricultural drainage in Iowa carry through to today as a debt-saddled agriculture simultaneously hardens and hollows the private-property regime. While most farms are still owned privately, there are fewer of them, forcing many people to find work elsewhere (USDA 2018). Rural residents remarked on this frequently, telling me: "I see increased consolidation. I see fewer bigger farms, and that's bad for main street" (IA608). The impact of successive ways of consolidation was often cited as a top concern in my conversations with Iowans. "That sense of community is, is being lost as we get bigger … that people part of it is gone. When we become larger like that, it's all about the bottom line" (IA859). And yet, the ideology of private property remains strong in the face of growing environmental degradation and social dislocation[12].

I suggest that drainage is a critical component of ongoing enclosure and accumulation on the landscape. As Rick and many other farmers explained to me, land that has been tile-drained is, at least in the near term, locked into commodity production. Once drained, land values increase, such that any other utilization becomes impossible to justify for the owner, even those with significant capital. Historically, drainage played a key role in enclosing the region's resources following appropriation and privatization of Indigenous lands, allowing that landscape to become the agro-industrial monolith it is today. The increased value of tile-drained farm fields helped to entrench systems of private property and commodity crop production, foreclosing alternative agricultures. Having been drained and locked into private land tenure, the possibilities for federal oversight of Iowa's former wetlands were similarly restricted, contributing to persistent water degradation.

Given its significant social and ecological effects, drainage deserves more recognition among the catalogue of technological innovations born in Iowa that are now indispensable tools of modern farming — the McCormick reaper, Hart-Parr tractor, and Pioneer Hi-Bred seed. Extensive drainage, enabled by interactions of state, capital, and technology, empowered agro-industrial production in Iowa. Drainage systems (the physical tile together with the governing infrastructure) mitigated the soggy geography of the wet prairie and facilitated the cultivation of corn on a large scale. This history has important ramifications on contemporary socionatural power relations, patterning

[12] I discuss this ideology and how it has shaped the state's response to growing nutrient pollution crises, elsewhere (Hall 2024).

resource distribution and engendering ongoing conflicts over the meaning and values of the agrarian landscape.

This chapter has told the story of Iowa through the lens of technical, botanical, and social infrastructures. I have explored the dialectical relationship between nature and the state, and between physical and social structures in the waterlogged frontier. Drainage is imbricated with dominant paradigms of private property, productivism, and extractivist orientations toward nature that continue to shape the material and ideological landscape of agriculture in Iowa. This influence can be subtle, literally working beneath the surface to condition social and hydrological processes, but has critical impacts on the distribution of environmental harms both in the state and beyond. Without an understanding of the state and capital interventions that constitute the hydrosocial history of drainage, the socio-ecological repercussions of its extensive installation are concealed as well.

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Chapter 3

Cropaganda:
Mythology of Corn Belt Agriculture

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Abbreviations

CWA	Clean Water Act
DMWW	Des Moines Water Works
IDALS	Iowa Department of Agriculture and Land Stewardship
IDNR	Iowa Department of Natural Resources
IFB	Iowa Farm Bureau
N	Nitrogen
NRS	Nutrient Reduction Strategy

Abstract

Even as scholars have increasingly recognized the role of industrial agricultural practices in contributing to non-point source pollution, drinking water in the Corn Belt remains perilously contaminated with excess nitrates, which pose a significant risk to human health and the environment. A recent lawsuit filed by the city of Des Moines, Iowa, against three upstream counties over chronic nitrate pollution sparked heated debate around the roles and responsibilities of agricultural production. Drawing on Barthes' theory of mythology, this paper explores how three core myths influence agricultural management paradigms and practices that contribute to the water quality crisis in Iowa and shape how key stakeholders have responded to the crisis. This chapter relies on ethnographic data to explain agricultural nitrate pollution and the stalled progress on water quality improvement. Together these myths draw on post-enlightenment ideas of nature, security, and modernity to perpetuate productivist behavior, claim resources for conventional commodity agriculture, and impede widespread adoption of alternative agricultural practices. By identifying and interrogating each myth, I aim to reveal and complicate the inherent contradictions in its representation of reality to strip it of ideological function and, in doing so, cultivate opportunities to imagine and create an alternative system that benefits both people and the planet.

***Keywords*:** Agriculture; Agroecology; Mythology; Non-point source pollution; Productivism; Urban-rural divide

After over half a century of attempting to manage rising nitrate levels in drinking water sources, the water utility serving the capital city of Iowa filed a federal lawsuit against three upstream agricultural counties. In their 2015 suit, the Des Moines Water Works (DMWW) alleged that the drainage districts in those counties had violated federal standards set by the Clean Water Act (CWA), compromising the safety and availability of the drinking water for over half a million people living in and around the metro area of Des Moines. State policymakers, including the

governor and members of the legislature, amplified the urban-versus-rural framing of the lawsuit, fomenting bitter politically charged divisions. In response to the allegation that their management practices contaminate water, farm groups articulated their cultural and social role as "stewards of the land." Individual farmers echoed these sentiments, blaming urban water users for the increased nutrients and evoking their moral responsibility to "feed the world." Although the DMWW suit was ultimately dismissed by a federal judge, it created a nationally salient conflict and has since inspired two more lawsuits framed around the struggle over water resources in a heavily agricultural landscape.

This chapter explores the dominant discourse articulated by politicians, agricultural groups, and individual farmers in response to the DMWW lawsuit and the growing debate over water quality. Through interviews with row-crop farmers and stakeholders in Iowa, I uncover how three interlocking myths legitimate specific agricultural production practices that extend and maintain the non-point source pollution. I argue that the contemporary cultural paradigm guiding the policies and practices of Corn Belt agriculture hinges on mythologized roles and responsibilities of farmers in global food provisioning and their historical relationship with nature. Together these myths draw on post-Enlightenment interpretations of nature, security, and modernity; bolster status-quo productivist paradigms; and forestall action on growing environmental and public health catastrophes. Tracing the discursive heritage of the myths that engender the contemporary agricultural landscape yields insight into how normative discourses of farming and resource use function as socio-material levers for or against environmental progress.

Myths, in this analysis, are understood to be socially constructed ideas that have become normalized over time to perpetuate a particular arrangement of social power, typically in the interest of the dominant or ruling class (Barthes 1972; Nally 2016). By naming each myth, I aim to expose and dispel the contradictions inherent in its representation of reality in order to strip it of ideological function. Myths, as human creations, can be destroyed. Demythification interrupts their power and may ultimately offer opportunities to imagine and create an alternative system that benefits people and planet. To this end, I rely on ethnographic data from interviews to reveal the underlying power structures and political dynamics at play in the debate around drinking water contamination in Iowa.

This chapter continues with a section conceptualizing myth. Following that I briefly review the agronomic underpinnings of Iowa agriculture to contextualize the origin and progression of both the present water quality conflict and the ideological reactions it has engendered. Before turning to the myths themselves, I review the qualitative methods used to build my argument. Finally, I document the contemporary forms of three core myths and the incongruous claims upon which they rest. I conclude with a discussion of how these myths perpetuate productivism, legitimate claims to land and other resources, and impose a position of power for conventional grain and livestock farming practices above agro-ecological alternatives.

Conceptual Background: A Theory of Myth

Roland Barthes's *Mythologies* (1972) articulates a theory of myth through a semiological analysis of the propagation of myth in mid-twentieth-century France. A literary theorist, Barthes interrogated common narratives and mundane objects including steak-frites, cleaning products, and children's toys (Barthes 1972). His journalistic critique illuminates the everyday manifestations of culture and the metamorphic process whereby familiar refrains legitimate class interests. Barthes argued that

myths are not arbitrary but rather created with a purpose. Their construction is an ideological process. Myths naturalize cultural and social inventions through their repetition to support a particular set of power relations and social norms as dictated by dominant classes. Barthes contended that myths do not hide reality but rather distort it, abolishing complexity and contradictions along the way. As they are propagated, myths "empty" history to establish bourgeoisie worldviews as "evident laws of a natural order" (Barthes 1972, 139). Apparently neutral, timeless, and universal, mythology, as Barthes demonstrated, is actually political, historical, and contingent (Huppatz 2011). To Barthes, demythification is an essential act required to divest myths of their political purposes. As a first step in this process, Barthes sought to expose the passive and habitual consumption of myth through a critical reading of contemporary discourse.

I connect Barthes' concept of myth with the explication of narratives considered in Leach and Mearns' (1996) collection of essays *The Lie of the Land: Challenging Received Wisdom on the African Environment*. Leach and Mearns explored and problematized unfounded narratives, what the editors dub "received wisdoms," of environmental degradation. Drawing on Roe's (1991) theory of blueprint development, they demonstrated how received ideas are actualized into a cultural paradigm; more than a set of beliefs, narratives are a "blueprint for action" (Leach and Mearns 1996, 188). For Leach and Mearns, narratives are stories with implied premises and conclusions, simultaneously describing a problem and prescribing its solution. Narrative therefore functions as a rationale for policy and becomes embedded in institutional structures, with practical and material consequences. The essays in *Lie of the Land* illustrate the totalizing capacity of narrative: how narrative misrepresents and precludes alternatives; how local actors are ensnared in narrative propagation (though without much power to define it); and how corollary narratives, programmatic approaches, and technological apparatuses consume political imaginaries.

As forms of discourse, both narrative and myth represent power relations that may go unnoticed (Barthes 1972; Foucault 1981 cf. Leach and Mearns 1996). Narrative, however, in Roe's conceptualization, is more programmatic; it implies an objective and outlines a script for conduct (Roe 1991 cf. Leach and Mearns 2003). In this examination of the rhetorical devices that have emerged in Iowa's debate over water quality, I incorporate the programmatically purposeful concept of narrative into Barthes' concept of myth. Building on these frameworks, I understand myths to be socially constructed ideas that are naturalized into "truths" and guide policies, programs, and practices to align with political interests. In this form, the concept of myth may deepen political ecological exploration of how discourses are used to legitimate a narrow range of social behaviors and allowable human-environmental interactions. Next, I provide background on the agronomic context to which I apply this concept of myth.

Context: An 'Inherently Leaky' System

The Corn Belt is a geographic region in the Midwestern United States covering Illinois, Indiana, Iowa, Minnesota, Nebraska, and Ohio, characterized by vast production of *Zea mays L.* (corn) (USDA NAL 2021). Since 1850, this area in the upper Mississippi River Basin has been distinguished by the combination of corn cultivation and livestock fattening, alongside small grains farming in the cool season (Hudson 1994). In the post-war intensification of U. S. farming, agricultural production in the region narrowed significantly to a select few crops requiring increased reliance on purchased fertilizer inputs. Today the Corn Belt is defined by large and mid-size farms specializing in corn and soybeans. Both geographically and symbolically, Iowa is situated at the heart

of the Corn Belt. More than 90 percent of harvested cropland and over 60 percent of the state's overall land base annually is planted to monoculture corn or soybeans (USDA NASS 2018a).

Corn is the most intensive user of nitrogen (N) fertilizer in the United States, both on a per acre basis and in total usage (Ribaudo et al. 2011). In Iowa several types of N fertilizers are used, most commonly anhydrous ammonia and liquid manure from the state's 24 million hogs (IDALS 2023; USDA 2018b). Once land-applied, the added N converts to nitrate (NO_3), the form of the nutrient that can be taken up by plants. Nitrate-nitrogen is highly mobile in water and readily leaches through soils (Helmers 2007).

Conventional agronomic management in Iowa leaves fields bare over winter, allowing soluble nitrate-N to leach through soils and run off (David, Drinkwater, and McIsaac 2010; Hatfield et al. 1999; Hatfield et al. 2009). This issue is exacerbated by the extensive subsurface artificial drainage installed across Iowa's former wetlands, which speeds water movement from fields and leads to significant N leaching into Iowa's streams, lakes, and rivers (Blesh and Drinkwater 2013).

This *leaky* system has left more than half of Iowa's water bodies impaired with respect to nitrates (David, Drinkwater, and McIsaac 2010; Iowa DNR 2018)[1]. Nitrate pollution in Iowa has been recognized for decades as contributing to hypoxic conditions in the Gulf of Mexico and imperiling drinking water supplies (C. S. Jones et al. 2018; Robertson and Vitousek 2009). Health effects of nitrates include blue baby syndrome (methemoglobinemia) and increased risk of certain types of cancer[2] (Inoue-Choi et al., 2015; Ward et al., 2018).

The Iowa Department of Natural Resources (DNR) acknowledges that agricultural sources are responsible for more than 90 percent of the nitrogen entering Iowa's waterways (C. S. Jones et al. 2018). Along with the Iowa Department of Agriculture and Land Stewardship (IDALS), the DNR developed the Nutrient Reduction Strategy (NRS), a voluntary, incentive-based approach to reducing nitrogen and phosphorus loading in Iowa's waterways. However, despite these efforts, the number of impaired water bodies in Iowa continues to rise, spurring toxic algal growths and endangering local drinking water sources across the state (IEC 2021).

Faced with a lethargic progress on nutrient reduction goals, escalating treatment costs, and dwindling clean drinking water supplies, in 2015 the DMWW sought damages in a federal lawsuit to help pay for nitrate removal (Meinch 2015). Although the suit failed, it ignited statewide and national conversations over the political and ecological management of shared resources and the appropriate role of commodity agriculture. Since then, two similar lawsuits have been initiated in the state, highlighting the ongoing struggle over the meaning and territorial control of water in Iowa.

Mythology and Agro-ecological Transition

[1] All agricultural productions systems are "leaky" to some extent. The research reviewed here highlights that the specific agronomic practices in use in Corn Belt agriculture, in particular the temporal dynamics of bare fields in late winter and early spring, make this system significantly *more leaky* with respect to nitrates. I thank a reviewer for helping me elucidate this distinction.

[2] The current drinking water standard of 10 mg/L of nitrate-nitrogen was established in 1962 to protect pregnant women and young children from acute effects of nitrate pollution (Brender et al., 2013). Increasingly, the long-term impact of chronic nitrate pollution is understood to be carcinogenic, leading some to call on the U. S. Environmental Protection Agency (EPA) to reduce the allowable nitrate level in drinking water sources (Weyer et al. 2001).

This chapter develops mythology as a theoretical tool to interrogate the persistence of chronic nitrate pollution in the Corn Belt. Farmers embedded in this system are subject to socially circulating discourses as they face dual pressures to continue producing agricultural commodities while also limiting their environmental nitrate contributions. This analysis aims to extend the robust literature on nutrient-related water-pollution in the Midwestern United States, which has largely centered farmer identities and structural constraints, through an attention to the mythic discourses that reproduce and reinforce individual actions.

Assessments of what motivates or deters adoption of agro-ecological practices that could reduce agricultural N runoff have often focused on operator characteristics and values, though commonly without much interpretive success. In a 2008 meta-analysis, Prokopy and co-authors reviewed fifty-five studies and found no consistent explanatory factor for agricultural best management practice adoption (Prokopy et al. 2008). Many scholars have similarly evaluated farmer behavior by surveying individuals' attitudinal dimensions across profitability and stewardship identities (e.g., Arbuckle 2013; Chouinard et al. 2008; McGuire, Morton, and Cast 2013; Reimer, Thompson, and Prokopy 2012; Thompson, Reimer, and Prokopy 2015). There is a tendency in the literature to highlight individual characteristics, even while recognizing that farmer choices are made within a constellation of broader cultural, social, and economic factors (e.g., Reimer et al. 2014). Myriad barriers, constraints, and systems "lock-in" impact farmers' willingness or ability to implement on-farm management changes that could improve water quality. In the Corn Belt, Mortensen and Smith (2020) argued that a pernicious feedback cycle of "simplification forces" perpetuates the continuation of the current system of large-scale monoculture (2). These barriers act both at the field level and more broadly in restricting individual actions, regardless of environmentally aligned farmer attitudes (Baur 2020; Blesh and Wolf 2014; Roesch-McNally et al. 2018).

Other scholars have investigated how discursive strategies come to naturalize or legitimate industrial agricultural production systems through the lens of social symbolism, ideological frameworks, and narrative themes (e.g., Burton and Wilson 2006; Shipley, Steward, and van Riper 2022). Examining farmer behavior through a culture of "productivism," Burton (2004) looked to the symbolic meanings associated with farming practices, including ever-increasing yield and general field tidiness, that entrench farms in utilitarian agriculture. My investigation takes up Burton's call to recenter analyses within cultural logics, in addition to macro-economic factors, though with more attention to the "language of farming" (212).

Houser et al. (2020) explored how farmers respond to disruptive crises, such as legal conflicts around water quality, and participated in the reproduction of the "industrial [capitalist] agricultural system" (985). They found that farmers hold three primary ideological positions — agrarianism, market fundamentalism, and techno-optimism — through which they shift the blame for environmental outcomes away from agricultural practices. Midwestern farmers express conviction that technology and market forces will provide solutions without requiring significant systemic changes. The concept of myth advanced here engages with the theory of "discursive repair" elaborated by Henke (2008) and Houser et al. I extend their work to emphasize the political valence of discursive strategies that reproduce agricultural–environmental disasters and rhetorical frames that are especially prevalent in Iowa.

Mythological analysis incorporates into a single framework much of the ideological, symbolic, and structural properties explored in the existing body of scholarship on impediments to an agro-ecological transition. Myths, as politically influential and repetitive modes of discourse that are rich

in symbolism, highlight the socially circulating cultural forms that are invoked in response to perceived challenges and the power they hold in perpetuating system stasis. In this paper, I employ mythology to identify the political meanings attached to oft-repeated cultural beliefs and restore the nuance they obscure. As a theoretical tool, myth builds on the literature reviewed here to dismantle and denaturalize the tropes embedded in individual actions and institutional practices.

Methods

This chapter develops an ethnographic analysis to understand the on-the-ground perspective of Iowans around this conflict (beyond stylized media portrayals, politicians' statements, and agribusiness press releases). Over the course of 6 months in 2021 and 2022, I conducted more than fifty-five semi-structured interviews with farm operators[3] (n=38) and agricultural conservation professionals (n=17) within the Des Moines Lobe in Iowa. Interviews were conducted one-on-one between researcher and participants. Almost all interviews were done in person and on-farm, when applicable. A small handful were conducted over the phone. All interviews were audio-recorded with permission from the participant.

Initial interview participants were recruited through the author's pre-existing network of farmers, farm managers, university extension agents and other conservation professionals, and subsequent network sampling from initial contacts. Research participants were also selected using a purposeful sampling method to account for differentiations across gender, marital status, age, and farm size. The majority of the farmers interviewed were white, English-speaking males who had been farming for more than 15 years, which coincides with the demographics of the farming population in the Corn Belt more generally. Most grew corn and soybeans (n=36), although a few also had contracted hogs. I sought out farmers who grow vegetables and other specialty crops (n=2), which they marketed through community-supported agriculture markets, and ranchers who raise pastured beef cattle (n=1) for local customers. The conservation experts and stakeholders interviewed were also white and English-speaking, though this group included more women. This group included extension agents, environmental engineers, former state representatives, and community activists involved in water quality improvement efforts.

All participants were asked to share how long they had lived in Iowa, their relationship to farming, and what they perceived to be the most pressing issues in the state. Participants were asked whether they were familiar with the Des Moines Water Works lawsuit and if so, what they thought about the lawsuit then and now, whether they discussed it with peers, and what they had heard about the suit. Farmers were also asked information about the practices they use in their operation. Finally, participants were asked to share what they were optimistic about in Iowa and in agriculture. I asked follow-up questions to clarify participants' responses, ask them to expand on a comment, or to pursue a line of inquiry brought up by respondents, when necessary.

Interviews lasted between 42 minutes and 3.5 hours. Following completion, interviews were transcribed by the author and analyzed using MAXQDA software. Coding focused on how participants discussed the severity and proximate causes of water quality, as well as the roles and

[3] The term "farm operators" indicates individuals who are engaged in regular on-farm activities. Some members of this group would reject my use of the word "operator," preferring to be called "farmers." For ease of comprehension, however, I use these terms interchangeably. These terms include both owner- and tenant-farm operators.

responsibilities of farmers. Although I was familiar with existing literature on farmer ideology and agricultural practices, I aimed to let main themes emerge from the data.

In addition to conducting interviews, while in Iowa I observed public events such as field days, workshops, and town halls where farmers, residents, researchers, and local leaders came together to discuss the topic of water quality. I also followed news reports from local media outlets and agricultural publications related to the DMWW lawsuit and water quality more broadly. Fieldnotes from these ethnographic experiences were also coded for thematic grouping. I situated my findings from field interviews and participant observation within the broader scholarship of agrarian change and political ecology to explore the material processes and cultural logics surrounding the issue of water quality in Iowa.

Results

Though it had been several years, every person interviewed remembered the Des Moines Water Works lawsuit. Participants recalled the lawsuit vividly, some with regret and others with reanimated anger. While most farmers noted that they didn't really believe that Des Moines would win[4], they asserted that they had found the legal approach to be disrespectful and unbefitting of the collaborative spirit of Iowa. Reflecting on the lawsuit, one farmer proclaimed "It was mean." Another told me, "I talked to some other farmers, and they wanted his head," referring to then-director of the utility, Bill Stowe, who led the legal action. A state conservation professional commented, "It was unfortunate, but at least it got people talking about the water."

In line with past work, both farmers and residents were aware of the problem of water quality, though many farmers did not believe that agriculture significantly contributed to the issue (see Houser et al. 2020). Farmers and residents drew on key narratives in responding to questions about the DMWW lawsuit and nitrate pollution. Next I illustrate the three most prominent myths that emerged.

Myth #1: Farmers are the natural, historical stewards of the land

As noted in the introduction, the federal lawsuit brought by DMWW was perceived by many in the state as an attack on rural livelihoods. In response, farm groups articulated their cultural and social identity as natural and historical "stewards of the land" (Comito, Wolseth, and Morton 2013; Masters 2016). In my interviews, farmers echoed this myth, situating themselves as the appropriate custodians of the public good and tapping into broad ideologies of nature and ownership. Many see their work as inherently, and historically, oriented toward environmental improvement. As one row-crop farmer in the Des Moines Lobe told me, "We're really the original stewards, and so, you know, we really care about [water quality], and we're doing it by keeping the land producing" (IA36). This farmer connected environmental stewardship with cultivation. When asked about the practices employed on his operation, another conventional farmer reflected that "We've always done conservation, it's just what we do. My family's been here since the 1800s and, and, so, you know, it's just how we've always done it" (IA15). These farmers felt that it was only natural, and historically

[4] The ultimate dismissal of the case may have influenced how farmers reflected on how threatening they perceived the lawsuit to be. Whether farmers truly felt safe from legal censure and liability at the time is not the focus of this paper but is worth exploring in future work as more lawsuits emerge pitting municipal stakeholders against agricultural interests.

precedented, that they fulfill the role of primary conservators of Iowa's common resources (See Figure 19).

Within a cultural "resource logic" that sees nature as needing to be tamed, disciplined, and made productive, this myth naturalizes the role of farmers as the primary agents responsible for the long-term care and environmental health of the landscape (Merchant 1980; Wenzel 2019, 148). This myth relies on a Lockean vision of row-crop farmers as having reclaimed the wild and economically worthless wetlands of pre-settlement Iowa into today's high-yielding, civilized agricultural landscape (Locke 1690 cf. Wenzel 2019). A farmer assured me: "I mean, this land, they're not making any more of it. But we've been here for generations, and, and farming is our livelihood. This is some of the best land in the world to raise these crops, so we have to, we have to make do" (IA62). Cultivation rescues an economically "wasted" landscape through title, enclosure, and productive improvement (Wenzel 2019). In Iowa, where the neatness of your rows is seen as a measure of your character, the productivity of your fields indicates the "moral fruits of [your] labor" (Comito, Wolseth, and Morton 2013, 287). Realizing the productive potential of the land requires regular human intervention, which, accordingly, the Iowa farmer is uniquely suited to manage.



Figure 19. Stewardship messaging at the Wells Fargo Arena in Des Moines, Iowa. Photo by author, January 2024.

Within "stewards of the land" mythology, property rights are assumed to guarantee care. Many of the land-owning farmers I spoke with repeatedly assured me that they would never "screw up" the resources "that make their living" (IA17). A row-crop farmer stated it like this:

> That ground out there is our factory. And we're going to do the best we can to make it as efficient as it can be. So, we're not going to purposely over-fertilize — we're going to try and make it as efficient as possible. Because that's what makes our livelihood, right? And so, to hear that, well, you know, they're abusing it, or they're, that's just ridiculous. (IA33)

Extension agents affirmed this commonly held conviction, telling me: "I hear from farmers a lot that farmers are the, are the best caretakers, because it's their land. And I do think farmers know their

land the best. … A lot of farmers think they're already doing all they can" (IA07). Another put it more simply: "It is our livelihood. We're not going to mess it up on purpose" (IA40). These comments reveal that ownership is presumed to incentivize environmental stewardship by ensuring long-term interest in the resource.

Many operators cited financial incentives as the main reason they engage in land conservation practices that could protect water quality. A row-crop farmer told me: "As a farmer, you're not going to go out and spend dollars, you don't want to put this stuff on the ground to have it wash away. You want that to turn into food" (IA18). A few counties away I was told, frankly, "I do conservation, from the beginning, as economics" (IA27).

The farmers I spoke with perceived the DMWW suit and unfolding conversation around water quality as a challenge to their role as stewards of the land. "We just need more time" for nutrient reduction, several farmers, as well as a few extension agents, assured me. "It's a big issue, for sure, but its gonna take us some time to get it all there" (IA35). In the meantime, this myth renders environmental regulations as unnecessary because it is inherently in line with farmers' identity, cultural role, and historical practice to support the land's natural capacity for production.

Unveiling Myth 1: Problematizing Nature, History, and Property

This myth, like other two I document later, is rife with contradictions and omissions. First, the emphasis on farmers as *historical* stewards of the land necessarily erases the Indigenous populations of the Oneota nations who occupied and worked the land for centuries before European settlers arrived. The Oneota people, thought to be the direct ancestors to the Sauk, Ioway, and Meskwaki tribes that Europeans encountered upon arriving in modern-day Iowa, were partially dependent on agriculture and maintained the grassed prairie through massive burnings, localized clearing, weeding, and planting (Hudson 1994). Living along the edges of receding glaciers, they hunted large game, including bison, and grew maize, beans, and squash (Iowa Culture 2021). Their use of fire prevented woodland incursion, allowing cultivation, and maintained the bountiful prairies (Hudson 1994; Mutel 2007). In the 1830s the U. S. government forcefully removed Sauk, Ioway, and Meskwaki populations as part of resettlement programs[5] (Mutel 2007). However, the ecological management by Indigenous populations prior to the arrival of colonists had helped to establish the fertile landscape that European settlers would later "discover."

The construction of agriculturalists as *natural* custodians of the environment also disguises the dramatic transformation of landscape that large-scale cultivation has wrought in Iowa. The view of nature that undergirds this myth demands continual intervention in landscape. Within a cultural context that values land for its productive capacity, Iowa's rivers and streams have been straightened, engineered, and even removed to increase crop harvests. The wetlands that span the prairie pothole region were turned over to the newly formed State of Iowa in a series of federal Swamp Acts on the condition that they be reclaimed for cultivation. The state facilitated draining of wetlands by authorizing Drainage Districts, quasi-governmental entities charged with constructing ditches to connect fields and remove water from agricultural lands. Together, these programs resulted in more than 95 percent of the state's wetlands being drained for agriculture by 1930, with

[5] Although there are no American Indian reservations in Iowa, many members of the Meskwaki tribe have returned to the state and currently maintain a tribal settlement in Tama County (Iowa Culture 2021).

new drainage tiles being installed every year with little government oversight (Dahl and Allord 1982; C. Jones 2019). These changes all but ensure that agrochemical inputs applied to fields (particularly those that are non-vegetated) speed into local waterways.

The "stewards of the land" myth positions individual ownership of private property as the guarantor of sound environmental management. Property ownership, according to Lockean resource logics, induces operators to conserve the resource by tying environmental stewardship to the long-term well-being of their asset. In theory, this may work well[6]. In Iowa, however, more than half the farmland is rented (Hoffman 2023; Tong and Zhang 2023). One farmer told me that rates of tenancy are likely even higher in the Des Moines Lobe, the watershed that supplies the city of Des Moines with drinking water. One farmer implicitly acknowledged this disconnect, telling me, "I mean, think about it, if it comes down to owners or helpers, those helpers don't have the same feeling toward that animal or that water or that ground or whatever" (IA21). In fact, research has shown tenant farmers may be less likely to adopt conservation practices than owner–operators (Carolan 2005; Varble, Secchi, and Druschke 2016).

The cultural identity of farmers as stewards of the land can be traced to Jeffersonian agrarianism and the belief that an agrarian society of independent farmers who own and cultivate their land fosters democratic political stability (Henke 2008). Jefferson's vision of rural life portrayed farmers as virtuous stewards, economically self-sufficient and politically engaged. In this romantic imaginary, farmers are rugged individualists and entrepreneurs prospering and taming the American frontier. Scholars have challenged this myth of the "happy yeoman," noting the economic insecurity, indebtedness, and external dependence farmers have faced throughout U. S. history (Calo 2020; Hofstadter 1956). Hofstadter argued that this myth was deployed as a rhetorical device to promote agrarian interests and to justify policies that favor landowners. The myth remains potent even as the impact of agricultural practices on rural community and environmental well-being becomes clear (Calo 2020).

Through today, the ethos of stewardship suggested by this myth is assumed to be perfectly complementary to farmers' economic objectives. However, it is frequently in direct tension with the demands of operating a successful farming business (Comito, Wolseth, and Morton 2013). The capitalist reconfiguration of agriculture in the twentieth century has made debt and dependence on purchased inputs a feature of contemporary agriculture (Buttel 2006; Cochrane 1993; Fitzgerald 2003). Securing a marginal profit, particularly in the face of escalating production costs and an unstable climate, is increasingly difficult (Burchfield et al. 2022). In turn, economic pressure forces many to rationalize the environmental costs of their management practices to sustain, if only in the near term, their livelihoods. One farmer who exclusively produces corn and soybeans told me, in a slightly deflated tone, this:

> If somehow you could make forages or, you know, some kind of sustainable agriculture profitable, it would help everything — it would help the nutrient runoff into the Raccoon River, it would, it would just do a world of good for everyone. But economics, you can't do that. (IA44)

[6] Wendell Berry (1997) was critical of the limits to ownership as an incentive for care, noting that as farm size increases the attention farmers can give to each field correspondingly decreases.

This contradiction between environmental stewardship and financial pressure leads to the invocation of the second, and arguably the most potent, myth in industrial agricultural production, that Iowa farmers "feed the world."

Myth #2: Iowa Farmers 'Feed the World'

Justifying production decisions in terms of economic feasibility can overwhelm the noble responsibility of land stewardship, supplanting this core identity with a deeper moral imperative to "feed the world" (Comito, Wolseth, and Morton 2013). This phrase was by far the most common explanation of the contemporary agricultural landscape that I heard in my interviews as well as in the public discussions over water quality that I observed while in Iowa. In my conversations, when farmers acknowledged the deleterious effects of agriculture on the environment, they consistently asserted the need to "feed the world." Continued production is necessary to meet global demand, they would tell me, and some tradeoffs, such as N pollution, are unavoidable to fulfill this obligation. When I asked about the DMWW lawsuit, one farmer told me:

> People think that tile and soil is hurting a lot, but also as far as helping to feed the world, I guess. You're, you're doing, I mean, there's very little we do that doesn't have some sort of cause and effect. (IA03)

In this vein, another farmer said:

> As far as [the DMWW lawsuit], I think everybody kind of went, you know, if you, if you want reasonably priced food, or if you want ethanol to drive your cars, we're gonna raise corn and corn needs nitrogen, which creates nitrate. (IA13) (See Figure 20)

These farmers suggested that nitrate pollution was an unfortunate consequence of their role as global food providers. This myth presented frequently in conversations about the role livestock production in water quality impairment, as well, with one farmer noting, "[Confinement] is more efficient, and there is a world to feed" (IA26). Conservation professionals I spoke with were well acquainted with this refrain, telling me: "Farmers really feel like they're under siege. And I think that food, feed the world, kind of, mantra is a way that they help to make themselves feel better about things" (IA31). Several farmers mentioned their duty to feed the world with a sense of pride, declaring that "We take it seriously, we feed the world" (IA78), and "It's what we do, we provide food to a hungry world" (IA17). Another farmer, after giving me a tour of his farm, said, "I'm just happy to show how we help feed the world" (IA24).

Iowa farmers' claims of feeding the world echo the rhetoric employed by Iowa politicians, farm groups, and agribusiness leaders. Following a damaging derecho storm in 2020, Governor Kim Reynolds was quoted as stating, "Iowa farmers feed the world and it's essential that we keep business open, from the farm to the processor to the grocery stores" (Putze 2020). The same year, the president of Tyson Fresh Meats announced a partnership with Iowa State University by celebrating their shared vision: "We strive to feed the world" (ISU 2020). The Iowa Corn Growers Association highlighted this powerful myth in their Iowa Corn Message Toolkit, noting their mission to assist the "state's farmers to continue to feed and fuel the world" (ICGA 2018). Their current social media toolkit likewise encourages members to share reminders that "Countries rely on us to feed their people. #StrongerTogether" (ICGA 2023). The well-established feed-the-world narrative

frames agricultural production as a heroic duty in the face of global hunger (Rissing 2021). Under this myth, success in farming is defined as ever-increasing crop yields, positioning Iowa agriculture as fulfilling a moral obligation to feed a growing population.

Unveiling Myth 2: 'Food? For whom?'

The claim that Iowa farmers feed the world attempts to evade critique of industrial agriculture practices by moralizing productivity. Just as food was explicitly used as "a weapon" by Nixon's Secretary of Agriculture, Earl Butz, the narrative refrain that Iowa farmers "feed the world" has been weaponized in the current era to justify gross overproduction (Rissing 2021; Wallensteen 1976). In reframing productivism as humanitarianism, conventional farming avoids confronting demonstrable environmental degradation by equating high yields with beneficence.

The feed-the-world myth has accompanied broader changes in agricultural production paradigms and politicized food security discourses (Holt Gimenez and Shattuck 2011; Nally 2011, 2016). The last century brought a transformation in grain farming through innovations in mechanization, hybrid seed, and ammonium nitrate fertilizers, which together allowed for dramatic increases in crop yields across the Corn Belt. This revolution in agricultural production, and the overproduction that it created following World War II, required government intervention to secure new markets for American farmers' products. Neo-Malthusian assumptions about hunger aligned with U. S. imperialist interests in the Cold War period, resulting in a heavily subsidized food aid program undergirded by deep political and ideological motivations. Formerly self-sufficient nations became reliant on imports from the United States (McMichael 2009). Under this model, amid growing fears of communism's influence, agricultural exports and Green Revolution technologies were shipped across the globe to prevent starvation while ensuring international allegiances. The political convenience of this narrative was repurposed in the 1990s to promote free trade and open markets as trade liberalization became directly linked to food security (McMichael 2009). The current world order carries these political–ideological undercurrents in the myth that Iowa farmers must feed the world. Today, the United States remains a net exporter of agricultural commodities (USDA ERS 2022).

To fully understand the pervasive feed-the-world myth, it is useful to question its key components: who or what constitutes "the world," and what does it mean to "feed" them? In my conversations with Iowa farmers, the world was typically framed in two ways. First, agricultural producers are responsible for providing the primary sustenance for non-agricultural populations, that is, urban dwellers, across the United States. As discussed in more depth later, this relates in part to the myth of the fundamental divide between urban and agricultural populations. With a slight note of disdain, one farmer noted:

> It's a cycle where the world needs to eat. People, some people don't want to hear that. And I don't like the elitism that a lot of people are taking with their food, this way and this is how you have to raise it. Well, okay. What are the people? You know, there are people who can't afford that. (IA31)

It is true, of course, that rural agriculture undergirds much of urban development and industrialization (Danbom 2017; Mazoyer and Roudart 2006). Farmers of all types should and do

feel pride in their capacity to provide food for themselves and other workers, allowing for a diverse economy and social community.

More acutely, however, in this rhetorical account "the world" refers to the malnourished and impoverished people living in other countries[7]. When discussing her marketing position within one of Iowa's commodity boards, a farmer told me: "I said, don't ignore Africa. Because there's a whole mess of people there. And we need to feed them" (IA06). Here the Neo-Malthusian undercurrents of the feed-the-world myth configure the problem of starvation and hunger abroad as one of underproduction rather than of distribution or access. Assuming that scarcity is the primary cause of food insecurity reinforces that the "narrow utilitarian goal of yield and productivity increases" (Nally 2016, 576). Scholars have long argued that famines are not caused by demand outstripping supply and that current food production could potentially meet global needs if food waste and equitable access were systematically addressed (Sen 1982). Yet, popular accounts of hunger and food insecurity in policy, industry, and media spheres continue to bolster investment in large-scale, high-yielding agriculture under the guise of humanitarian rhetoric (Nally 2016).



Figure 20. Ground field corn being prepared for fermentation at an ethanol plant in Eastern Iowa. Photo by author, June 2023.

The feed-the-world myth suggest that farming is oriented around food provisioning. However, conventional agricultural production in the Corn Belt is increasingly entangled with industry. In Iowa, the primary crops of maize and soybeans are not foodstuffs — that is, they are not predominantly consumed by humans. Nearly 60 percent of the corn grain yield from the state is used to make ethanol, and most of the rest is used for livestock feed (ICGA 2021). Soybeans, rich in protein and oil, primarily feed animals, including the twenty-four million hogs in the state (USDA NASS 2018b). The oils are increasingly used to make biodiesel and household replacements for petrochemical products (Hinrichs 2003; Iowa Soybean Association 2021). Meanwhile, Iowans

[7] The colonizer's concept of the "white man's burden" is a claim as powerful as ever (Nally 2016).

import up to 90 percent of their food from out of state[8] (ISU 2021). Upon sharing this statistic and lamenting the rates of childhood hunger in the state, one conservation professional remarked, "Okay, let's feed the world, but let's feed Iowans first" (IA47). How livestock-fattening feed and industrial inputs contribute to alleviating global food insecurity is open for debate, but I contend that the emphasis on *food* in the feed-the-world myth fails to acknowledge agribusiness interests and the political–economic inequalities of the current food regime.

Myth #3: Dualism of Town and Country

The DMWW lawsuit alleged that tile-drained farm fields ought to be considered point-source polluters and therefore subject to federal water quality standards. In making this its juridical claim, the legal action identified and centered two discrete groups: municipal ratepayers in metropolitan Des Moines, the capital city, and agricultural producers in Sac, Buena Vista, and Calhoun counties (Vos 2017). This positioning generated national media attention, articulating this specific conflict with broader historical and contemporary political frames of urban versus rural (e.g., Masters 2016; Royte 2017; Shapiro 2018). In response to the lawsuit, then-governor of Iowa Terry Branstad proclaimed that "Des Moines had declared war on rural Iowa" (Petroski 2015a). Other politicians reiterated his combative framing and one rural state assemblyman calling on all Iowans to boycott Des Moines (Masters 2016). He maintained: "Being a rural Iowa legislator, I see this snob urban-versus-rural mentality on a regular basis. Urban cities no longer have any regard for the state's agricultural community" (Petroski 2015b).

Agribusiness publications located the blame for water quality degradation on urban sources, including residential lawns and municipal golf courses (Comito, Wolseth, and Morton 2012; Kilen 2016; Lamm 2019). Echoing the findings by Farber (2018) and Houser et al. (2020), many farmers I spoke with pointed to the use of fertilizer on suburban and urban lawns as equally, if not more, responsible for Iowa's degraded water quality. When asked about the lawsuit, one farmer told me: "Oh yeah, the lawsuit was just ridiculous. I mean, you know how much of that stuff is dumped on [urban] lawns" (IA17). Another row-crop farmer reiterated this claim, saying, "You know, relatively, the fertilizer you put on your lawn is so much stronger" (IA25). As to why farmers, instead of other sources, were being blamed for nitrate pollution, I was told that "Everyone's so far removed from their food now that they have, and they're being told things that are not true" (IA34). For these farmers, city folks just don't understand farming and therefore should not be prescribing agricultural practices.

The perceived duality of town and country is a longstanding ideological framing in agrarian spaces that posits an oppositional and exploitative relationship between urban citizens and farmers (Mooney and Hunt 1996). At its core, this third myth advances the idea that town and country are not only different, but distinct, and often intrinsically opposed (Williams 1975). This myth goes beyond apparent differences of towns in their spatial arrangement, demographic makeup, and key economic sectors. Urban and rural populaces, in this telling, are understood to be fundamentally divergent, antagonistic, and inherently in competition for resources.

[8] Many Iowans, including the group FeedIowa1st, critique the overuse of the feed-the-world narrative and have been working to build robust local food systems. This figure, however, suggests that there is much more work to be done.

Unveiling Myth 3: Distracting with a False Dichotomy

The oft-invoked dualism of town–country, urban–rural, industry–agriculture locates geography as a central fault line in modern American economics, politics, and social life (e.g., Badger 2019). Conflict and antagonistic relationships between urban and rural geographies have been documented across a range of socio-ecological issues, including economic disparities, environmental exploitation, and political representation (e.g., Cramer 2016; Kelly-Reif and Wing 2016; Lichter and Brown 2011; Pellow 2016). It has been argued, however, that the dichotomy of town and country is not a simple binary opposition but rather a complex and evolving relationship shaped by myriad factors (Woods 2009). Raymond Williams (1975) traced the historical development of this relationship, illuminating the political–economic structures, technological changes, and cultural values that are embedded in representations of the urban–rural divide.

In Iowa, political interests have leaned on narratives of farmer victimhood at the hands of townsfolk to cultivate loyalty among farmers. The Iowa Farm Bureau (IFB), a powerful lobbying organization, foments this division by stoking fear that urban citizens and environmentalists are intent on installing oppressive regulations aimed to destroy farmers' profession (Rissing 2021). The IFB claims to represent producers' interest, guarding them against unfounded accusations from environmental activists, public health advocates, and others deemed to be urban elites. In part fueled by the rhetoric used by the IFB and other agribusiness organizations to frame conversations around food systems, many conventional farmers today perceive their livelihood as being under attack by urbanites with little knowledge about rural lifeways, as the quotes here highlight. This polarizing framework, however, misrepresents the productive unity and structural interdependence of these two seemingly disparate spatial locations in Iowa (Woods 2009).

While the political rhetoric around water quality in Iowa has relied on the mythic trope of urban vs. rural, the false dichotomy inaccurately represents the spatial and economic overlap characteristic of human and hydrological concerns. Obscured in this myth is the messy reality of on-the-ground relations between "municipal" and "agricultural" water users. In my fieldwork, I spoke at length with a full-time farmer living on the outskirts of a small rural town whose farmhouse drinking water was served by DMWW. He told me frankly:

> Farm Bureau, is, they were behind a lot of this, right? Farm Bureau is going to find some way to make it, you know, you know, rural versus urban. But, you know, it's, it really is not a rural versus urban problem because it's a rural area and an urban problem. (IA13)

In conversations with the managers at DMWW, I learned that many urban dwellers own farmland upstream and are being recruited to participate in new programs to protect water quality on their fields. Although some farmers contest this dualistic urban–rural framing, including the ratepaying farmer I spoke with, the myth persists in the circulation of media, policy, and community discourses.

Like the other myths, the urban–rural rhetoric overstates the relative power of the individual farmer in the contemporary food regime and hides the significant structural constraints that limit the individual agriculturalist's ability to protect rural drinking water. Intertwined state policies and corporate influences work to maintain the material conditions that ensure nitrate pollution of Iowa's shared waterways (Jackson 2008). Beyond the prairie pothole, national agriculture policies, including those implemented at local levels, have enabled capitalist production dynamics to become the norm

in U. S. agriculture. These processes divide farmers from means of reproduction, ensure reliance on purchased inputs, and expose farmers to increasingly untenable levels of debt (Burchfield et al. 2022; Harris et al. 2009; Roberts and Lighthall 1991, 437). Rural community organizers are well aware of the intentions behind this political maneuver:

> The urban versus rural narrative…. [We] think it is real in some senses, but not in the ways that that Branstad and then industrial ag were using it. They were using the urban versus rural to divide and to steel their supporters against this lawsuit, out of, out of fear for their own economic interests, to drive a wedge to cause division where there shouldn't have been division. We would say that the rural–urban division, they were using it in a way that was inauthentic. We do believe that there is an urban–rural divide right there. We would connect it back to this lack of economic opportunity. And because of that, you know, who's leaving rural communities for jobs in town? Who's left in those rural communities? And what's there for them? (IA49)

The shift in power from individual farm operators to consolidated agribusiness industries vertically integrated across the supply chain is well documented in the political economy of agriculture literature, which highlights the pronounced roles of market-oriented, productivist policy in mediating dispossession of the "American family farm" (Davidson 1996; Jackson 2008; Roberts and Lighthall 1991). To the individual farmer in the competitive landscape of the industrial Corn Belt, nitrogen fertilizer becomes "cheap insurance for expensive seed" and an inescapable feature of the market economy in which they operate (Royt 2017).

A deeper problem with this framing of the water quality debate is that it invisibilizes non-farming rural residents. Rural residents largely obtain drinking water from individual wells, which are not subject to environmental regulation under the CWA and are often more vulnerable to agrochemical contamination due to their proximity to cultivation (Eller 2019; Schechinger 2019). Further, these Iowans cannot benefit from economies of scale to purchase the expensive equipment necessary for treating nitrate-polluted water supplies (Royte 2017). A community activist I met called this out explicitly:

> You know, it's the rural communities that are very much impacted by, by water quality, you know, particularly communities that have, you know, rely on the wells. And, and here's the thing, it's like, municipal-, most municipalities in Iowa do not have the money to get the nitrates out of their drinking water that Des Moines Waterworks has, you know, so they're not, they're not able to denitrify their water. (IA56)

A water quality expert put it even more bluntly, saying, "I think that this urban versus rural is one of these fake tropes, because if you're on well water, you're rural, you're pretty much screwed, right?" (IA42).

Discussion

Braided throughout each of the myths explored here are post-Enlightenment ideas of nature, security, and modernity that together perpetuate productivist cultural scripts and associated claims to resources (Worster 1994). The myth that farmers are stewards of the land disguises the socio-economic precarity of Iowa farmers who work the land, many of whom do not own the resource

they are working. Further, this myth sustains the voluntary approach to nutrient management, interrupting attempts to install the type of regulatory oversight on agricultural practices that might improve water quality. The feed-the-world myth distorts the geopolitical and industry interests that propel ever-increasing commodity production through a veil of heroic humanitarianism. The town-and-country dichotomy depicts rurality in opposition to metropolitan areas, reflecting notions of civilization and progress and provoking resentment among producers and consumers. Together, these myths legitimate ever-increasing yields as the ultimate production goal and impede widespread adoption of alternative agricultural practices that emphasize smaller fields, diversity in production, and fewer chemical inputs.

Although I have presented each of these three core myths separately for analytical clarity, they often work in and through one another. The passive view of nature inherent in the stewardship myth frames the environment as an external entity, separate from and subservient to human civilization (Merchant 1990). This resource logic fosters the othering of those who work the land from those who do not, sowing divisions between producers and consumers, and between rural and urban spatialities (Wenzel 2019). The agrarian logic underpinning the myth of the urban rural dichotomy, in turn, serves to discredit critiques levelled against the other two myths. Similarly, production practices like tile drainage were often characterized as both a form of caring for the land and a way to guarantee food production for a hungry global population.



Figure 21. Grain bins in Tama County, Iowa. Photo by author, June 2021.

A critical reading of common narratives evoked in response to the DMWW case reveals the productivist values undergirding the contemporary mythology of Corn Belt agriculture. This mythology influences management decisions by narrowing the spectrum of possible metrics through which to comprehend human–environmental interactions (Ribaudo 2015). In Iowa, success is measured by gross profit, acres harvested, and, above all, yield (Arbuckle 2013; Burton 2004; Buttel

2005; McGuire, Morton, and Cast 2012) (See Figure 21). As one local scientist told me, summarizing the state of Iowa's water quality, "We're not willing to sacrifice one bushel for better water" (IA20).

Mythology is a product of collective consciousness and reflects cultural values, but it is frequently cultivated by particular parties, such as commodity groups, agribusiness publications, and politicians, to serve ideological purposes. The pervasive propagation of the myths discussed here naturalizes the current hegemonic order. As a result, farmers evoke certain narratives that emphasize commodity and economic orientation "almost without thinking" (Shipley et al. 2022, 1473). The analysis presented here extends previous scholarship by emphasizing the ideological functions and historical precedents of three key myths in producing, and reproducing, the polices, practices, and programs that maintain Iowa's immense production. The theoretical framework of mythology provides a lens for recognizing and disrupting power relations in commodity agriculture.

Farmers are subject to both ideological and structural forces that constrain their choice of what they produce, how they produce it, and where they can sell it, limiting their agency and participation in an agro-ecological transition (Hendrickson and James 2005). The findings discussed here complement existing literature that documents the influence of agribusiness in perpetuating productivist agriculture (Bell, Hullinger, and Brislen 2015; Stuart and Houser 2018) as well as the forms of agrarian ideology that propagate the industrial farming system (Houser et al. 2020; Mooney and Hunt 1996). As Roesch-McNally and co-authors described, I found that some monoculture farmers recognize the environmental benefits of a diversified cropping system but feel unable to implement such changes on their farms due to both field-level and structural economic barriers (Roesh-McNally et al. 2018). As U. S. farmers face increasingly precarious livelihoods (Burchfield et al. 2022), the perceived risk of under-fertilizing will likely continue to spur farmers to apply N fertilizer to cash-cropped fields and result in further degradation of drinking water downstream (Ribaudo 2011; Robertson and Vitousek 2009).

My intention in this analysis has not been to discredit or devalue the cultural identity of farmers in Iowa. Rather, I have tried to disentangle the origins and impact of the myths I discuss in order to highlight both the structural and the ideological constraints that limit farmers' ability to participate in an agro-ecological transition. Mythic forms circumscribing the social roles and moral responsibilities of farmers as stewards and heroes reinforce modern capitalist agriculture, resist regulatory intervention, and constrain diversified forms of production (Blesh and Wolf 2014; Comito, Wolseth, and Morton 2013; Vanclay and Enticott 2011).

For Barthes, the use of the term "myth" allowed readers and theorists to recognize the ways in which contemporary society was still subject to mythic constructions of culture, despite assertions of being more technologically advanced than the classical Greek and Roman cultures typically associated with mythology. I adopt his term to undercut the post-Enlightenment ideology sustaining productivism in Iowa. While other scholars have utilized alternative framings to describe the powerful discourses operating in conventional agriculture, such as cultural scripts or narratives, I suggest the tool of mythology to attend to the seemingly neutral and timeless presentation of these forms and to suggest a process for demythification. Mythology reminds us of the ideological, the political, and the historical undercurrents informing our perception of our modern reality.

Conclusion

I have explored how, in response to the DMWW lawsuit and escalating water quality crisis in Iowa, farmers, agricultural groups, and politicians recapitulated three core myths that serve to legitimate commodity (over)production. I argue that the myths that sustain productivism both influence the agronomic practices that contribute to non-point source pollution and inform reactions to it. I expose the contradictions inherent in this mythology as the first task necessary to break down the obstacles precluding progress on both ecological and public health goals and begin to imagine an alternative system that works for people and planet. The durability of these myths despite their contradictions highlights their power to shape the social relations and material distribution of resources among Iowans.

I do not suggest that simply naming and complicating these myths will alleviate the ecological and human health crises in the Corn Belt. However, given the imbrication of structural and ideological forces at play, I argue that revealing the hidden power of contemporary mythology is a necessary task, rather than sufficient, in beginning to move toward a just agro-ecological transition. While Barthes's original essays advocated semioclasm, or the complete destruction of myth, a nuanced approach may be more feasible. The myths Barthes identified were almost exclusively considered corrupting influences on culture. However, as social constructions, myths need not be negative. Lévi -Strauss and other scholars of pre-modern cultural myths have documented their role in explaining natural phenomena, conveying moral lessons, and shaping cultural identities (Lévi-Strauss 1995). As such, myths may function as useful heuristics, collaboratively created and disseminated through cultural institutions.

While most farmers recited the core myths to explain their practices, several of the community organizers I spoke with emphasized how restoring the nuance obscured by the myth of the urban–rural divide helped them build political solidarity across groups facing interconnected social and environmental challenges. Could exposition of the distortion embedded in the other two myths similarly be used in advocating for positive change? Policy reform could assist farmers to actualize their role as "stewards of the land," just as it could direct resources from production of industrial feedstocks to distribution of edible foodstuffs.

I have focused on the role of mythology in the debate over water quality in Iowa. However, the interlocking myths identified here may be deployed to foreclose action on a range of environmental issues. The DMWW lawsuit explored here provides a useful window into mythologies of the Corn Belt more broadly. In addition to lacking access to safe drinking water, Iowans face extensive soil erosion (Thaler, Larsen, and Yu 2021), rural community collapse (Edelman 2021), deteriorating air quality (Hunt et al. 2020), and environmental injustice (Son and Bell 2022), each linked to the productivist project discussed in this chapter. Farmers, too, are ultimately victims of the resulting economic and cultural model that impels increasing production (Burchfield et al. 2022). The lens of mythology can be applied in other contexts across food systems, as well, such as debates over agricultural water allocation in California. Future work should extend this analysis to examine how the ideological power of myths functions in global resource challenges and the potential socionatural transformations afforded by nuancing the monolithic realities they purport to represent.

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Chapter 4

Cultivating Doubt:
Epistemic Politics and Practices of Nitrate Pollution

"It's just depressing. I'm really disappointed. And maybe I'm naive or just optimistic, but I can remember a time when opposing groups could say, well, at least, let's go to the science and we'll start there. But, hell, we can't even do that now."

Richard L., Hardin County, June 2021

"Frankly, it's pure censorship."

Jane G., Powashiek County, August 2021

Abbreviations

AAI	Agribusiness Association of Iowa
CE	Cooperative Extension
DNR	Iowa Department of Natural Resources
EPA	U.S. Environmental Protection Agency
IAWA	Iowa Agriculture Water Alliance
IDALS	Iowa Department of Agricultural and Land Stewardship
IEC	Iowa Environmental Council
ISU	Iowa State University
INREC	Iowa Nutrient Research and Education Council
INRC	Iowa Nutrient Research Center
NRS	Nutrient Reduction Strategy
UIowa	University of Iowa

Ten years after it was implemented, the Iowa Nutrient Reduction Strategy (NRS) once again became a flashpoint in Iowa politics. For some, including the Iowa Secretary of Agriculture, the tenth anniversary was heralded as a "Defining Decade:" a period of progress and laudable accomplishment toward water quality improvements. For others, however, including the Iowa Environmental Council (IEC), the same period was seen as a "Declining Decade" (See Figure 22). The environmental advocacy group decried what they saw as inaction and stalled progress on nitrate pollution, even regression. These conflicting characterizations stem from an ongoing epistemological debate about the state of water quality in Iowa. State actors, including the Secretary of Agriculture and their private partners at the Agribusiness Association of Iowa (AAI), advocate state-of-the-art predictive *modeling* based on surveys of on-farm practices, assuring the public that is the best way to represent the changing conditions of water quality. Environmental groups like IEC and concerned scientists, on the other hand, argue that continuously *monitoring* water with in-stream sensors is the appropriate method to rigorously determine nutrient levels.

The debate over modeling versus in-stream monitoring escalated into a significant political controversy when the state legislature announced a proposed defunding of the state's in-stream

monitoring network and an outspoken chemist at the University of Iowa (UIowa) resigned. The scientist, Dr. CJ, had been overseeing the network of in-stream monitors and documenting nitrate's persistent presence and intensification in the state's waters. On the side, CJ shared his thoughts in a popular blog that was often critical of the modeling approach for concealing the reality of the crisis. The blog, which was hosted by the UIowa, had generated political backlash in the past for suggesting the legislature's fealty to agribusiness over clean water. But in 2023 the tension came to a head, and CJ was given a choice to amend his statements and end the blog or resign. He chose the latter.

The politically charged conflict over competing narratives of water quality change inspires this inquiry into the epistemic politics and practices of nitrate pollution in Iowa. In this chapter, I examine the debate over *how to know* water quality as a window into the political economy of environmental governance in Iowa, using the governmentality of knowledge restriction as an analytical lens to examine the currents of power in Iowa's water. Specifically, I explore the strategic cultivation of doubt through a series of practices that render the problem of nutrient pollution technical (Li 2007b) and, in doing so, uphold a regime of accumulation for the benefit of agro-industrial interests.



Figure 22. Competing narratives of the decade since the implementation of the NRS. On the left is the website published by IAWA, on the right is the counter website created by IEC.

The decennial anniversary of the NRS may have elevated deliberations about the appropriate forms of knowledge production in public policy, but this debate was only the most recent iteration of historic and on-going conflicts over the practice of science in Iowa's agrarian landscape. For many of the Iowans I spoke with throughout my fieldwork, the controversy in 2023 stirred up memories of the cessation of the popular citizen science water monitoring program, IOWATER[1], and the repeated threats to the Leopold Center for Sustainable Agriculture. These events, as well as the impact of funding restrictions at monitoring agencies and the increasing role of private capital in

[1] The name of the program, IOWATER, is not an acronym, but is consistently written in all caps in DNR material. I follow their formatting convention here.

university research at the state's land-grant, contextualize the more recent dispute, underscoring patterns of (non)knowledge production around agriculture and the environment in Iowa.

This analysis contributes to a well-established critique of the role of expertise in agricultural and environmental governance. I extend this scholarship by providing a contemporary exploration of the role of doubt – the way power restricts knowledge and doubt, in turn, reproduces power (Foucault 1991). I attend to the practices of (non)knowledge production in Iowa and the state-capital power hierarchies that they underlie, inform, and reproduce (Foucault 1991; Proctor and Schiebinger 2008).

In what follows I draw on ethnographic data and document analysis to interrogate the restriction of embodied accounts of water quality and they ways state-capital imperatives contribute to sustaining commodity production. I begin with a review of theoretical scholarship on the politics of scientific expertise, strategic ignorance, and critiques of the state agricultural research complex to situate this case, reflecting on the appropriation of institutional expertise as a domain for corporate control. I then provide context on the landscape of water quality monitoring in the state of actors, including the network of state-based, academic, and private actors involved in contested relations of knowledge production. Next, I historicize the recent debate over progress on nutrient reduction, drawing connections between the recent controversies and previous attempts to discredit and defund alternative sources of knowledge production. I argue that in Iowa's water politics, environmental governance is coopted to conform with a regime of accumulation, frequently mediated through state institutions. Within a system that cultivates doubt about nitrate pollution by distancing, denying, and defunding dissenting voices, economic interests prevail and water quality continues to deteriorate. I conclude by reflecting on the continued resistance of Iowans (scientists and non-scientists alike) and suggesting the possibility of a new regime.

Governing Water

The Politics of Scientific Expertise

In contemporary discussions of environmental or resource challenges, such as water quality, scientific expertise holds a privileged position as the dominant form of knowledge production guiding policy decisions. This status reflects society's deep-seated trust in modern science and technology (Carolan 2006; Kloppenburg 1991). The authority of technical science rests on presumptive objective and rational methods of appraisal of the natural world, irrespective of the social context in which it is carried out. Scientific expertise is assumed to be unbiased and impartial, but is actually enmeshed in the vested interests of myriad players (Foucault 1995).

Scientific expertise plays a central role in environmental governance. Technical knowledge and specialized skills held by scientific "experts" – including engineers, economists, planners, and other technical professionals – are valued for their perceived ability to enhance efficiency, mitigate risks, and address complexities in environmental challenges (Mitchell 2002; O'Reilly 2017; Gibbons 1994). Experts are frequently called upon to design and execute policies and projects, wielding substantial influence on public discourse on a range of issues.

Shortcomings of technical and apolitical approaches to environmental problems have led to critiques by political ecologists on the perceived neutrality of environmental "science" and the political construction of the domain (Forsyth 2004; Neumann 2005; Rychnovská, Pasgaard, and Berling

2017). Aligned with science, technology, and society (STS) scholars, this literature has demonstrated that science and expertise are bound up in cultural structures that favor some types of research questions, practices, and methods over others (Felt et al. 2017; Ferguson 1990; Jasanoff 2004). Choices made in problem scoping and methodological approach inevitably influence the findings, often reinforcing and consolidating existing power structures (Mitchell 2002).

The prevailing paradigm of modern science constrains the type and range of knowledges that inform the definition, assessment, and resolution environmental challenges. Political scientist Timothy Mitchell refers to this as "the rule of experts" and argues that it tends to lead toward "techno-politics" (Mitchell 2002). Alternative epistemologies, such as local or indigenous knowledge systems that are intimately connected to place, tradition and embodied experience are marginalized or excluded in the dominant paradigm of expert knowledge, frequently at the expense of democratic accountability and justice in environmental governance (Berkes 2017; Haraway 1988; Rose 1997).

The depoliticization of scientific expertise further engenders the potential for it to become a productive domain for state and corporate control (Foucault 1984; Li 2007b). As the boundary of science and state politics is blurred, scientific expertise is susceptible to political capture. Institutions and authorities employ various forms of knowledge, using their power to define and regulate claims to truth[2]. In her case study of community forest governance, Li builds on Foucault's theory of governmentality to explore how expertise is defined and legitimated and the depoliticizing effects of bureaucratic and technocratic interventions in environmental management (Foucault 1991; Li 2007a; 2007b). Li follows Foucault in a focus on *how* power produces knowledge, which in turn (re)produce power. This analytic of governmentality allows for a nuanced exploration of the contested nature of expertise in environmental management, revealing the actors, processes, and power relations informing water quality debates and interventions.

A growing body of scholarship has extended the theoretical framework of governmentality to address this strategic function of ignorance in the politics of expertise (Eyal and Buchholz 2010; Martin 2021; Montenegro de Wit 2016; Porter 2021; Proctor and Schiebinger 2008). Accepted truths are privileged and amplified while dissenting accounts are silenced, casting enough doubt to allow economic interests to guide policy. As with the production of knowledge, the production of ignorance is a deliberate tactic to maintain expert control, and even expand expert jurisdiction (McGoey 2012; Proctor and Schiebinger 2008). Cultural production of ignorance is central to the function of capital, perpetuating an economic system of accumulation (K. Schneider 2023). Rendered invisible, the lack of knowledge about environmental phenomena, such as pollution, upholds this regime at the expense of those whose embodied experience is ignored by experts (Harrison 2006). This scholarship highlights the dynamic, continuous, and contingent forms in which expertise and (non)knowledge are mobilized, negotiated, and contested (Li 2007b). I draw on their insights to explore the power dynamics involved in Iowa's waterways, and how delimitation of expertise conditions the outcomes of environmental appraisals and interventions.

[2] [2] Truth, following Foucault, is neither objective reality nor immutable fact. It is produced within specific regimes of truth (Foucault 1995 [1977]). It is contingent and constructed, emerging from the interplay of power relations. The process of truth production is central to the exercise of power and is underpinned by specific logics that influence the justification and practices of governance. While the techniques, procedures, and rationalities underlying knowledge production can be quite subtle, they inevitably influence socio-material conditions on the land.

Agricultural Science & the State

Understanding the relationship of the state and agri-environmental governance necessitates a historical perspective on the agricultural research complex. Today's public research system grew out of a series of federal bills that routed public funds toward the development and dissemination of science in the service of improving rural living and working conditions (Henke 2008; Buttel 2005). In the first step toward this development the federal government gave land to states through the Morrill Act of 1862 that they were then free to sell to endow establish a college supporting agriculture and mechanical arts[3]. The state of Iowa accepted this grant in 1858, transfiguring Iowa State University (ISU), which was then known as the State Agricultural College and Model Farm in 1858, into one of the first U.S. land-grant universities. The Hatch Act of 1887 built on this system to establish the state agricultural experiment stations and the Smith-Lever Act of 1914 completed the vision of the scientific progressives to establish a cooperative program of extension and outreach[4] (Danbom 1986). As part of the land-grant complex, Cooperative Extension (CE) was intended to disseminate research-based knowledge and technical expertise from land-grant universities to agrarian communities across the United States.

In the early days of CE development, agrarian leaders and New Dealers envisioned a "low modernist" form of agricultural and rural planning (Gilbert 2015). Planners hoped to promote rural development and enhance the well-being of rural populations through education and outreach programs. This approach emphasized decentralized, participatory planning processes and interventions tailored to the specific needs and contexts of rural areas. Agrarian intellectuals advocated for integrating modern techniques and technologies with traditional knowledge and community-based practice to achieve economic progress while preserving the social and environmental fabric of rural life. As Jess Gilbert documents in *Planning Democracy* (2015), the federal government's emphasis on centralized planning and top-down interventions (exemplified by programs like the Agricultural Adjustment Administration) redirected CE from low modernist priorities. Increasingly, activities aligned with a high modernist approach to rural development, characterized by large-scale, technocratic solutions, and centralized decision-making (Gilbert 2015; Danbom 1987). At the land-grant institutions, agricultural scientists reinforced the paradigm of productivist agriculture in service of feeding the world (Buttel 2005). Today, the original vision of community empowerment has been overwhelmed by the scientific progressive's emphasis on rationality, scientific expertise, and industrial management practices oriented around ever-increasing production (Henke 2008; Danbom 1987).

The rapid growth of the American public research agricultural system constituted by the agricultural colleges, experiment stations, and extension helped establish the consolidation of a technologically attentive class of farmers (Buttel 2005). The surpluses these farmers produced further reinforced the need for federal commodity policies and strengthened the economic power of industrial processors (Graddy-Lovelace and Diamond 2017). As productivist priorities began to sway CE's activities, questions soon arose about the extent to which its mission remained aligned with the principles of

[3] [3] The land grant system is marred by a deeply racist history, in which lands stolen from Indigenous people were sold to European settlers in a massive theft and transfer of wealth that is too often understood as educational donation. This institutional legacy continues to fund commodity-focused science and influence uneven and agricultural funding distribution (Ahtone 2020; Hightower 1972).

[4] Dubbed "cooperative" because of the multi-level funding, split between counties, states, and the federal government (Henke 2008).

rural vitality. Jim Hightower's seminal report "Hard Tomatoes, Hard Times," drew attention to the ways in which public funding privileged corporate benefit at the expense of the independent farmer and rural society (Hightower 1972). The report highlighted the tensions inherent in public agricultural research and extension, arguing that the preoccupation with technology, efficiency, and production served corporations while ignoring the "crisis in the countryside" (Hightower, 1972, p. 11). In particular, Hightower critiqued what he saw as a misguided fascination with technoscience and entrenched affiliation with industry, as publicly-funded scientists worked alongside agribusiness in the name of science.

The historical backdrop of the imbrication of the land-grant research complex with productivist agriculture provides important context for the suite of practices used to claim truths and resources in the water quality debate. Next, I review the methods used to build my argument before returning to the controversy over water quality methods and the practices used to maintain a culture of doubt.

Methods

The following is based on fieldwork conducted in Central Iowa between 2021 and 2024. My arguments draw on ethnographic observation, in-depth interviews, and document review, focusing on the practices of state-affiliated institutions regarding agricultural nitrate management in the past two decades. As part of a larger project, I conducted over 90 semi-structured interviews with individuals from state and local government agencies, environmental organizations, community groups, and agricultural producers, and observed meetings, workshops, and field days. A complex web of actors, including state agencies, research institutions, advocacy groups, and industrial agribusiness, abut and align in attempts to know water in Iowa. To understand the contestations over nitrate contamination I center key groups involved and the framework of the Nutrient Reduction Strategy developed by the state. As such, the material in this chapter is drawn primarily from interviews with individuals currently or formerly employed by Iowa State University (ISU), ISU Extension & Outreach, Iowa Nutrient Research Center (INRC), Iowa Department of Natural Resources (DNR), Iowa Department of Agriculture and Land Stewardship (IDALS), University of Iowa, and the Iowa Nutrient Research and Education Council (INREC) who had direct engagement with nutrient reduction programs, including development, implementation, measurement and evaluation of the Nutrient Reduction Strategy (NRS). Nearly all had training in biology, chemistry, or agronomy, and had been employed by the agency for many years. I also include the perspectives of rural and urban residents, including farmers, community activists, and policymakers, to situate environmental governance within broader social relations and the experience of the stakeholders in water quality conflicts. Interviews were transcribed, coded, and analyzed for emergent themes, which included expertise, loss, accumulation, accountability, access, and (in)visibility. I include representative excerpts from interviews throughout the chapter to illustrate the concerns and assessments that participants presented. Document review included newspaper reports and scientific and agency literatures, including annual nutrient reduction survey reports and semi-annual impaired water assessment summaries.

Knowing Iowa's Water

At the heart of the competing claims over water quality progress[5] are competing ideas about the appropriate methodology to reveal the status of water quality in the state. The "Defining Decade" website and marketing material was produced by the Iowa Agriculture Water Alliance (IAWA), a nonprofit founded by the big three commodity groups in Iowa (the Iowa Corn Growers Association, the Iowa Soybean Board, and the Iowa Pork Producers Council[6]) following the creation of the NRS (IAWA 2023). At a gathering hosted by IAWA to celebrate the decennial anniversary, Iowa Secretary of Agriculture Mike Naig praised farmers for reducing fertilizer use and extolled the virtues of taxpayer-subsidized cost-sharing programs that help farmers install buffer strips and bioreactors[7] (Naig 2023). Adoption rates of these farm management practices had been collected in surveys that fed into models and presented a rosy picture of water quality improvements.

The optimism expressed by Secretary Naig and IAWA was not shared by everyone. Academics at UIowa and the Iowa Environmental Council (IEC), contested this account and argued that the secretary's rhetoric revealed the department's preoccupation with protecting the agriculture industry, rather than objectively measuring progress toward water quality (Eller 2023). To combat this framing, IEC developed their own website arguing for an opposing account of water quality: "Iowa's Declining Decade" (See Figure 1) (IEC 2023).

Developed collaboratively by Iowa Department of Agriculture and Land Stewardship (IDALS), Iowa Department of Natural Resources (DNR), and Iowa State University (ISU), the NRS was finalized in 2013 and led to the creation of the Iowa Nutrient Reduction Center (INRC), housed at ISU (See Figure 23) (ISU 2024a). The NRS establishes a suite of in-field and edge-of-field practices[8] known to reduce nutrient loading that landowners and operators can flexibly implement. Voluntary in nature, the strategy also emphasizes the importance of public-private partnership. Thus, the three principals of the NRS (IDALS, DNR, and ISU) have partnered with the Agribusiness Alliance of Iowa (AAI), a trade group representing industry, to distribute a survey to agricultural retailers through the subsidiary Iowa Nutrient Resource and Education Center (INREC).

INREC sends its annual survey to 150 randomly selected retailers across the state. The survey focuses on "inputs," as defined in the logic model developed by ISU Extension, and is the primary

[5] The NRS defines water quality in relation to the historical baseline (1980 – 1996) and benchmark (2006 – 2010) annual nutrient load averages from nonpoint sources, like agriculture.

[6] The Iowa Corn Growers Association (ICGA), Iowa Soybean Board (ISB), and Iowa Pork Producers Council (IPPC) are pivotal players in the state of Iowa, representing three of the main commodities the state produces. All three are non-profit organizations that represent farmer members and actively lobby on their behalf at both state and national levels. The ICGA is membership-based entity advocating on behalf of corn producers for policies that support their economic interests, including ethanol production and market expansion. The ISB is funded by the soybean checkoff, a federally mandated assessment on soybean sales, and invests in research, market development, and sustainability initiatives to promote soybean profitability. The IPPC represents hog farmers and engages in advocacy, education, and promotion around issues such as animal health, trade, and environmental regulations. Collectively, these organizations represent most commodity producers in the state and as such wield significant influence on state-level agricultural policy and research priorities in the state.

[7] Secretary Naig made similar statements in an op-ed published in *The Storm Lake Times,* a small newspaper is based in Buena Vista County, IA. The editor of The Storm Lake Times, Art Cullen, won a Pulitzer Prize for Editorial Writing in 2017. Cullen's editorials were notable for their tenacious reporting on the secretive corporate agricultural interests that were funding defendants in the DMWW Lawsuit. His engaging writing helped illuminate the environmental and financial implications of agricultural runoff and the lack of transparency of the companies involved.

[8] In-field conservation practices, such as cover crops and nutrient management, are implemented directly within crop fields to improve soil health and reduce nutrient runoff. Edge-of-field practices, like buffer strips and constructed wetlands, are established at field boundaries to intercept and treat runoff before it reaches water bodies.

means whereby the principal agencies obtain data on in-field practices, such as tillage, cover cropping, and fertilizer application (INREC 2024). Although DNR and USGS also engage in water quality monitoring through intermittent sampling and ambient sensing, the NRS relies primarily on data generated through the survey instrument. The collected data on farm practices are entered into models that translate farm practices into expected nitrate and phosphate concentrations to extrapolate and estimate state-wide water quality. This process reflects the strategy's commitment to measuring inputs as the primary sources of water quality metrics, to be supplemented by empirical water quality monitoring[9] (IDALS 2024). According to their advocates, models are preferable to in-stream monitors because they are cost effective, scalable, and are not subject to annual variations in weather, which they contend influence stream load levels and render in-stream sensors unreliable. As one representative of a major agricultural lobby told me, "We have large scale water quality monitoring, but that does not, but in no way, shape, or form could that ever be used as an [annual] indicator to say, we did really good" (IA188). His colleagues at other agribusiness-affiliated organizations had made similar statements, asserting that the best way to track progress on nutrient reduction goals is "practice-level adoption" using the "best science" (IA242).

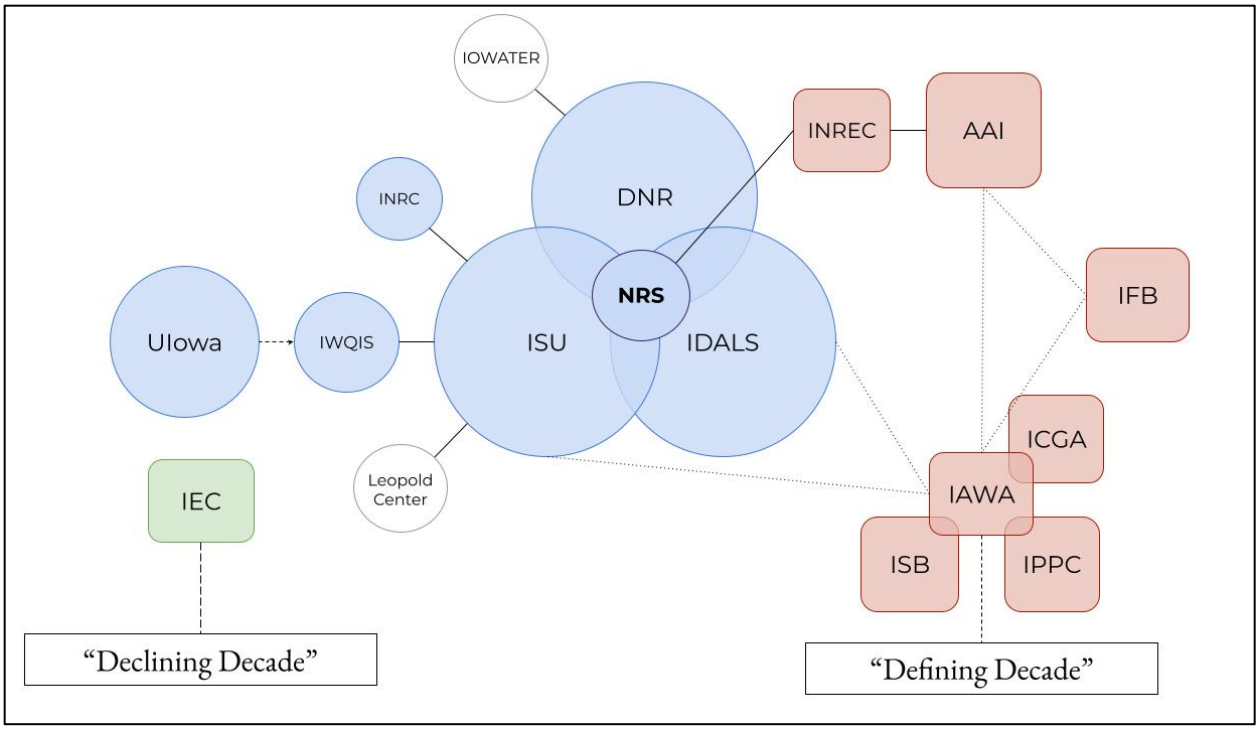


Figure 23. Key actors and relationships in Iowa's water governance. Circles represent public institutions. Rounded squares represent private and non-profit organizations. The empty circles indicate defunded programs.

I waded into this debate over how to know water when, hoping to learn more about the background of a prominent lawsuit between the city of Des Moines and three upstream agricultural counties

[9] The models used to assess water quality changes are grounded in empirical evaluations of the effect of farm-level practices on water quality outcomes, generated by sampling water quality. The key distinction here is that the inputs to the models focus on a select set of conservation practices and funding levels, but do not consider other landscape changes that influence nutrient loading. Therefore, the imputed water quality derived from models is likely to diverge from what would be observable directly through in-stream sensors and continuous monitoring.

over persistent water quality degradation, I became a regular reader of Dr. CJ's blog in 2019[10]. At the time, the blog was hosted by the University of Iowa (UIowa), where the Iowa native and (non-tenured) academic chemist shared his research, wrapped in country charm, on water quality with the public. Holding a PhD in analytical chemistry, CJ previously worked for the Des Moines Water Works utility and Iowa Soybean Association before being hired as a research scientist at the UIowa's Hydroscience and Engineering laboratory, where he managed the network of approximately 70 in-stream water quality monitors across the state (IWQIS, 2024). Dr. CJ was committed to rigorous monitoring of the state's waters; he had dramatically expanded the number of sensors across Iowa (up from only a dozen when he began) and developed an online interactive map to make the real-time data accessible to the public.

In the essays on his blog, CJ detailed the science of water quality, as well as the political and economic forces that he saw as responsible for its long-term deterioration. His writing seamlessly weaved observations made in his personal and professional lives and frequently faced pushback from politicians across the state (Jordan 2021). The essays, which have now been collected into a book, *Swine Republic: Struggles with the Truth about Agriculture and Water* (2023), were often critical of the incentive-based NRS and the methods it relies on to track water impairment. As it happened, the ten-year anniversary of the NRS ultimately coincided with political machinations that ended CJ's blog and his position at the UIowa.

During the summer of 2023, while various groups were debating the status of water quality improvement in the ten years since the NRS was released, the Republican-led legislature proposed a new state budget[11] that removed funding for the network of in-stream monitors that CJ managed (Jordan 2023b). CJ and his allies alleged that the content of his blog was behind the defunding. In particular, they cited his frequent coverage of the private investment of two Republican state senators involved in the development of a feedlot upstream of Bloody Run Creek, an especially sensitive creek that held one of the state's in-stream sensors (Masters 2021). In interviews with local journalists, CJ asserted that these two senators had pressed UIowa administrators to terminate the blog, insinuating that the university's state funding was at risk if the essays continued (Jordan 2023b; Masters 2023). In the end, CJ resigned rather than be quieted[12]. The funding cuts went through, but the sensors were spared when a department at ISU offered to take on their costs, albeit at a lower funding level, at least for now (Jordan 2023a).

Sowing Doubt

In this section I trace analogues and antecedents of this conflict and contested knowledge relations to describe the strategic production of doubt in Iowa's terraqueous landscape. I identify three broad practices that work in and through each other to engender doubt: distance, deny, divert. Together,

[10] I met Dr. CJ on my first trip to into the field and have since stayed in regular contact with him and two of his colleagues at University of Iowa that regularly speak out about ongoing nonpoint pollution in Iowa's waterways. He has been asked to review this chapter.

[11] This bill also sought to terminate a state goal of having 10% of lands held by the public. Currently Iowa is about 2% public land (Jordan, 2023a)

[12] CJ asserts that since he was close to retirement anyway, he chose to resign and continue to publish his blog on his own. He blames the economic interests of the agricultural industry for the censorship of his blog. Following his resignation he said of the farm industry: "These guys now are going to own all the messaging. They're going to be able to say whatever they want about progress towards nutrient management goals. There's not going to be anyone here to do these calculations and use the sensor data to draw conclusions about what's in the water." (K. Schneider 2023)

these techniques enclose the issue of water quality within a technical domain, privileging "expert" perspectives, and suppressing competing accounts. Situated in historic social practices, I will show how the contrasting narratives of nitrate levels in Iowa's water ways are part of an ongoing effort to cultivate enough uncertainty over the status of water quality to allow the economic interests of agribusiness to prevail.

Distancing

Knowing water quality is challenged by what Michael Carolan calls "epistemological distance," which makes it difficult or impossible to directly observe environmental phenomena, like nitrates in water, with your own senses[13] (Carolan 2004). While some qualitative aspects of water quality are detectable – you can smell a manure spill or see an algal bloom – quantifiably assessing the nitrate load in a water body requires intermediating tools. In Iowa, the primacy of authorized expertise magnifies epistemological distance, further amplified by the tendency to prioritize state-of-the-art modeling over in-stream water monitoring to measure nitrate levels.

Iowa's Experts

In this analysis I understand "experts" to be those scientists and engineers who are authorized to produce knowledge that informs environmental policy and governance (Li 2007a). Although there are scientists on both sides of the methodological water quality debate, all of whom likely see their work as revealing an objective reality, their relative institutional positionalities influence which practices of knowledge (or which of their knowledge products) are elevated and endorsed[14]. As I have just discussed, the models produced by the land-grant university, ISU, in conjunction with their private partners are praised by political actors, including the state Secretary of Agriculture, while scientists like CJ at UIowa, also a publicly funded institution, are derided by state senators.

According to the Iowans I spoke with, the association of INREC with ISU is a critical piece of authorizing the knowledge their survey data produces[15]. Remarking on a disagreement we both witnessed at a field day focused on bioreactors as a tool for improving water quality, a conservation professional told me "Iowa State is a science-based institution. So that does help to kind of pull the conversation back" (IA740). A farmer had expressed skepticism that there was more tile going in, credulous of a recent report out of UIowa that used remote sensing to measure increasing extent of drainage. The reminder that ISU also collected survey data showing 40 percent of farmers intended to install more drainage gave the farmer reassurance (despite the evidence being arguably less strong). This aligns with what I heard from other farmers, who spoke of their respect for the agricultural scientists at ISU and their confidence that the land-grant status of the university meant

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[13] Epistemological distance asks: Can an individual directly perceive or witness an environmental problem, or are they reliant on intermediary tools and devices? Some environmental challenges are inherently more difficult to observe. Consider the disparity in observing litter on the street, an oil spill in an ocean, or detecting ozone levels. The epistemological distance for each of these examples is greater than the last.

[14] As the preceding section highlighted, there is a plurality of science. The scientists involved in this case all likely understand their work to be unveiling an objective reality, though they do so with different methods. Some prefer predictive models, others in-stream monitors to gauge water quality. What makes this interesting, to me at least, is how methods are chosen and results are elevated through the influence of state power.

[15] According to two anthropologists deeply engaged in the politics of expertise in the state, the agricultural university of ISU holds "the imprimatur of science" conferring credibility in the eyes of citizens, farmers, and policymakers alike (Durrenberger and Thu, 1997, p. 35).

they had "farmers' backs" (IA144). As a land-grant, the institution held privileged expertise within the domain of agriculture, conferring authority for the science produced there (Li, 2007b). Competing perspectives by scientists at UIowa may still be recognized as science but are not necessarily sanctioned as expert.

De-authorizing Knowledge

As I learned from walking around many of Iowa's rivers and lakes, which were often covered with a foul brown froth, some components of water quality can be easily assessed through one's own senses. Algal blooms and sediment loads are visible; manure is readily detectable by scent. But before they lead to eutrophication, nitrates and bacterial contaminants are not readily evident: there is an inherent degree of epistemological distance in directly observing nitrates for the average citizen. However, a larger gap is strategically produced in the consistent de-emphasis of water quality monitoring. Today, real-time ambient monitoring data only exists for a small fraction of the streams across the state. Everywhere else, the models are the source of truth.

According to critics of the modeling method (both at academic institutions in the state and at environmental community groups), the survey instrument that informs the models is grossly incomplete, as it does not measure critical factors that could be expected to impact water quality and worsen impairment, such as installation of drainage tile and expansion or development of new confinement livestock operations in a given watershed (Masters 2023). As a result, critics claim that the modeled estimates of nutrient loads in Iowa surface water are likely to be significant underestimates. They contend that the limited in-stream monitoring that does occur demonstrates a conflicting story from what the Iowa Secretary of Agriculture Mike Naig and the AAI espouse: nitrate pollution in the state is actually getting worse (Eller 2023).

Keith, a retired agronomist told me "At least in certain areas of the state, water quality has gotten worse since the nutrient management strategy was put in place in 2013." Scholars, including Dr. CJ, pointed me to the fact that over half of the streams evaluated by DNR with grab data as part of Clean Water Act requirements, are considered impaired. Advocates at community-justice organizations sharply denounce the claim that water quality is improving. Erika remarked "It's absurd. It's like trying to evaluate something, while only looking at one side of the ledger and also while making a ton of assumptions about how well all those practices are working" (IA570). She and others I met with expressed frustration with the messaging and "propaganda" around supposed progress (IA217).

The epistemological distance around water quality between experts and everyone else in Iowa is not new. The attempted defunding of in-stream monitoring (which some Iowans I spoke with argue was already inadequate statewide), reminded many of the ways in which nitrate monitoring had been limited and constrained in the state's waters in the past, when a popular program that relied on volunteers to measure nitrate levels was ended. In interviews both before and after the ten-year anniversary of the NRS, half a dozen rural residents told me with sadness or frustration about the cessation of the citizen-science water quality monitoring program, IOWATER. "It's just such a shame," a teacher in Des Moines told me, "we used to be able to go out and get in the water, and the kids loved it, but then they ended it" (IA941). A feeling of loss, of both the knowledge and the ability to be part of procuring it, was common among those I interviewed. On top of the difficulty in

detecting nitrate levels, knowing water was further removed from the domain of the citizen-scientist, ensconced in the realm of the authorized expert (Li 2007a).

For nearly twenty years, IOWATER was a state-wide program led by the Iowa Department of Natural Resources (DNR) focused on cultivating citizens' and students' awareness of local water quality. IOWATER connected educators, DNR agents, community members, and individuals to their watersheds. Volunteers waded into creeks, streams, and lakes, dipping test strips into tubes of collected samples and interpreting the results in real-time (See Figure 24). Their findings could then be uploaded into a state-wide database, where all could view the results. In 2016, the State of Iowa discontinued IOWATER, citing financial constraints ("Volunteer for IOWATER" 2002; Iowa Department of Natural Resources (DNR) 2016)[16].



Figure 24. Nitrate strip testing. Photo courtesy of Iowa Environmental Council.

Through IOWATER, DNR once sponsored over 1000 sites around the state for water quality monitoring, actively engaging both farmers and residents in "meaningful data collection" by stressing the critical importance of long-term, in-stream data gathering for "understanding and reversing current environmental trends[17]" ("Volunteer for IOWATER" 2002). The data collected by

[16] DNR's website says they are now focusing on locally-led volunteer monitoring programs, as opposed to the state-wide IOWATER, but the DNR agents I spoke with were unable to identify any and I have not been able to document these programs.

[17] Even this program, though, emphasized a focus on solutions and results, "not regulation".

volunteers in this program was the property of the sampler, though DNR strongly encouraged sharing of data through the program's portal to supplement the water quality sampling done directly by DNR and help provide baseline data on water quality trends. Residents appear to have been supportive of the objective to produce a robust dataset of water quality across the state – as of 2002, nearly 75% of registered sites had submitted water quality data ("Volunteer for IOWATER" 2002). Unfortunately, since the programs dissolution that data is no longer accessible.

In ending this program, the state increased the epistemic distance that separates citizens from water quality information, confining it to the realm of experts[18]. Rather than relying on in-stream monitors and citizen sampling, the state emphasized the exclusive authority of trained scientists and their models in tracking water quality changes. Where once Iowans could actively participate in data collection, they now must rely on the models. DNR still manages about 62 monitoring sites, but only uses grab data from 18 sites to interpolate nitrate loads for the entire state (ISU 2024b). The persistent epistemic gap divorcing authorized knowers and their models from the general populace effectively disembodies non-experts from water quality, opening space for uncertainty and doubt around water quality (Carolan 2004; Li 2007a).

Epistemic distance is also amplified by social norms. To supplement the limited number of in-stream nitrate sensors deployed by the state, a few researchers both at the federal level and at universities in the state have pursued water sampling as part of larger projects exploring the connection between conservation practice water quality outcomes, often to inform underlying the models used in the NRS. I spoke with a few of these researchers, who reported that they had faced difficulties pursuing water sampling for these projects as well. They could find some farmers and landowners who were eager to participate, but once the in-stream water sampling began, those farmers often faced considerable social pressure to drop out. Lamenting one project that ended prematurely, a retired researcher (who had not worked for one the state agencies) told me: "[The landowner's] neighbors didn't like it. We tried to make it work, but, it was too much. So, he eventually had to stop. You know, it was just too bad" (IA589). Apparently, farmers of nearby fields saw the researchers parking and entering the streams with their test kits and monitoring equipment[19]. Even though the property owner had given approval, the social relations of farming limited how much knowledge about the water quality flowing off his own farm he was able to access. I heard similar anecdotes from other researchers[20], each noting their disappointment that social constraints limited their ability to overcome the state's emphasis on modeling over monitoring. Epistemic distance, both natural and cultivated, confines knowledge production around water to a select cohort of scientists, away from the public who is left to consume it. Values embedded in scientific practice do more than inform research outcomes; they also shape the contours of social life (Carolan and Bell 2003).

Denying

[18] CJ tried to remedy this chasm by dramatically increasing the number of sensors from 12 to 66 and creating a public-facing, accessible webpage (IWQIS) where Iowans could view up-to-date metrics on stream turbidity, flow rates, and nitrate levels among other things.

[19] Peterson-Rockney (Petersen-Rockney 2022) has also documented the influence of social risk on farmer behavior. She found that although farmers actively adapt their management practices to the effects of climate change, they perceive social consequences if they assert a belief in climate change, including loss of access to formal and informal farming groups.

[20] Dr. CJ discusses a similar incident involving the IFBF and drainage district head on his blog: https://riverraccoon.substack.com/p/bureau-behaving-badly

The problem of water quality in Iowa has been bounded and reduced to a technical and quantifiable issue of nutrients in water. As a result, the questions asked and solutions proposed tend to focus discrete technical factors, denying and eliding the messiness of socio-material relations into a bounded space with predictable and universalized logics. In Iowa, the problem of water quality is delimited to the domain of technical agronomic experts, dismissing political-economic and structural questions about nutrient loading that might suggest more radical transformations of the control over means of production. This project of "rendering technical" involves defining problem legibility within precise analytical limits and recasting political questions into the neutral language of science (Dreyfus, Rabinow, and Foucault 2002; Li 2007b; Mitchell 1991).

Rendering technical (and apolitical)

As a strictly technical problem, nitrate runoff is the result of discrete farming practices and behaviors, which themselves can be measured and evaluated. Codified in NRS (and revealed in its naming) is the limited goal of reducing the amount of nitrates and phosphorous entering the water. An alternative framing would recognize nutrient loading as simply a symptom of a systematic *process*, one that includes political and economic factors. These forces, however, are rendered outside of the scope of the Nutrient Reduction Strategy, which instead sees nutrient loading as a *condition* that can be adequately addressed with the right combination of technical interventions. In doing so, the NRS, constrains both the approach to addressing the issue and the ways in which progress is assessed. Keith, the retired agronomist explained this dichotomy neatly:

> There are two ways to look at the [water quality] problem. One is, with appropriate engineering solutions and enough money, you can probably treat the water coming out of agricultural land and make it clean enough… That isn't going to happen. The other way… is to think about water quality is a symptom of a larger systemic failure. There's no way to fix it until you change the constraints. That would involve a much larger degree of change… And most likely involve regulation. (IA871)

The first approach treats nutrient pollution as a condition, one that can be fixed with technical means. The second recognizes impairment as a process, or a "systemic problem" (IA871), requiring systemic transformation and incorporating social and political dynamics. Keith followed up this explanation by clarifying that the first approach, the one articulated by the NRS, is failing, not due to lack of technology or information but because of the lack of "political will" (IA871). Jane G., a grassfed cattle rancher outside of Des Moines, saw the situation similarly. Shuffling through a stack of newspapers to find an op-ed published the previous week about water quality, she told me:

> We already know what we have to do, it's just a matter of getting the balls to actually do it. The powers that be don't want to admit the problem is the whole thing. But we could really turn Iowa around, make smaller farms a thing again. (IA762)

Jane and Keith, along with others I met, expressed frustration with the myopic focus on technological solutions[21]. Understanding nitrate pollution as a discrete condition rather than a symptom of a larger process suggests very different approaches to improving water quality,

[21] Other scholars have documented similar dissatisfaction. (Farber 2018) notes the Farm Bureau's resistance to the development of IWQIS for its deviation from a solution-oriented focus.

including the actors that must be involved. As a condition, nitrate pollution needs only technological intervention, such as bioreactors, saturated buffers, precision agriculture, and nitrogen stabilizers catalogued in the NRS. These approaches often stop and start within the farm gate. As a process, though, the situation would require extensive changes to Iowa's political economy and structural market constraints surrounding agriculture. A framing that includes socio-political questions is incompatible with status quo productivism and, therefore an economic threat to continued accumulation by agroindustrial actors.

Erasing complexity

The specific practices of knowledge production in Iowa, while resonant of similar regimes technical expertise, are directly rooted in the materiality and unique biophysical arrangement of the agricultural landscape. As noted in the previous section, the principals of the Iowa NRS privilege metrics based on "inputs," including in-field management changes, edge-of-field installations, and funding sources, in their assessment of water quality improvements. These inputs can be fed into a logic model, which then outputs predicted water quality estimates. The focus on inputs prescribes intervention with technologies that have measurable outcomes. Importantly, the technical ability of the models to function relies on a fundamental transfiguration and manufactured uniformity of the landscape in which they are utilized. That is, the models used by scientists at ISU to estimate nonpoint source pollutants themselves rely on the fixity of the vegetal forms of monocultures of corn and soybean that dominate the state. The extent and relative uniformity of these fields allows agricultural scientists to translate data collected on fertilizer or cover crop seed sold in the state into estimates of nitrate loading in streams.

The focus on isolated inputs, rather than measured outputs, also facilitates a focus on exemplary actors (DeLind 1995). The trade media put forward by IAWA and AAI often lean on images of model farmers who have installed saturated buffers or bioreactors or wetlands on their lands. A small collection of the same farmers is consistently highlighted and showcased, even by CE at ISU. I do not want to suggest that this focus on a select group of exemplars is inherently problematic. I have met and interviewed several of these conservation-minded farmers and applaud the work they do; peer-to-peer knowledge sharing is an important part of fostering widespread conservation practice adoption in agriculture. However, this practice of repeatedly promoting select icons is frequently leveraged to deny important social factors that influence farming decisions. One farmer, Dick, I met with was featured in numerous articles and websites, had earned a doctorate specializing in environmental communication, only beginning to farm in his retirement. Suffice to say, he was not representative of most farmers in the region. Even Dick was critical of the overly technical approach to research and the lack of widespread monitoring:

> You know, I've been involved a, a few of these [research projects], and they're great and I've learned a lot about my own water, but the people always move on, so it's hard to know what's really happening. I'm trying some automated things to measure my tile water, but, to me the question is, why the hell isn't the state of Iowa monitoring all of our water? (IA315)

The focus on exemplary actors flattens the diversity of barriers, including structural and economic impediments, that farmers face implementing in-field conservation by showcasing to the wider public the few that have been able to incorporate these technologies. Their experience is

universalized, even though their specific conditions that facilitate their farming management decisions are often unique.

After touring the saturated buffers and prairies strips featured on his farm, Dick followed up with a critique of the Iowa Secretary of Agriculture, calling his proclamations regarding water quality progress "lip service" (IA315). Dick is just one of a small handful of farmers I met who had undeniably unique backgrounds and approaches to conservation, though I saw them frequently in news coverage about water quality. Exemplars obscure the broader systemic constraints that influence production practices and nitrate pollution, reinforcing the idea that a few simple technological tweaks are all that is needed to improve water quality.

Silencing dissent

Restricting the problem of water quality to a technical condition to be solved with technological interventions alone reminded many of my interviewees of the repeated attempts to control and dismantle the Leopold Center for Sustainable Agriculture, housed at ISU. Named for Iowa's own Aldo Leopold, a tireless advocate for conservation, this center was created in 1987 and funded through a portion of fertilizer sales tax with the intention of supporting research on sustainable agricultural production in Iowa. Unfortunately, the Leopold Center exists today in name only, having been gutted of all funding in 2017. Those close to the Center's work and early leadership told me, "The defunding wasn't the final straw. Okay, it was the final straw, but it was not the only straw" (IA997). In fact, the first significant blow against the Leopold Center came in 2006 when Dr. Fred Krishcheman, then director, was "fired in the form of a promotion" (IA997). According to many familiar with the situation, this was because his work at the Center documented the social and ecological wreckage wrought by industrial agriculture.

Dr. Fred Kirschenmann is a renowned academic and organic farmer, and an outspoken advocate for sustainable agriculture. In late 2006, he was given 48 hours to resign and accept a ceremonial position of "Distinguished Fellow." According to several informants, the Dean of the department overseeing the Center forced him out of a leadership position due to pressure from commodity agriculture organizations. Fred Kirschenmann was allegedly targeted, and ultimately ousted, for focusing too much on family farmers within and beyond Iowa, instead of the large-scale industrial operations that comprise much of Iowa's production (Philpott 2005; 2010). Under his leadership the Center was doing the wrong type of agricultural science, or perhaps serving the wrong stakeholders.

> [The researchers at the Leopold Center] were looking at the farmers of the middle, so not the giant CAFOs, and not the small artisanal farms that, you know, had ten pigs, but the ones that had 100 or 200. At how they could raise them in a way that nurtured the health of say, the pig, or the cow or the chicken so that [the meat] did not have antibiotics, and, also all the things you needed to put together a system for butchering, for transporting for, you know, that that whole system of an agriculture of the middle, rather than the tiny or the gigantic. And Fred was at the center of that thinking, writing about it, you know, writing about grass fed beef. He was on a National Academy of Sciences panel, he [was] aggressive, he was, he was everywhere around that. And so the pig, the hog association came after Fred. (IA997)

Other sources, including Dr. Kirschenmann himself in an interview with Tom Philpott relayed the events similarly (Philpott 2005). Many community activists and sustainability scholars have suggested that the ousting of Dr. Kirschenmann (and the later defunding of Center's research program) was a result of the Center's critical approach to the status quo in agriculture (Carter, Chennault, and Kruzic 2018; Collins 2017). Proponents of the Leopold Center's work on family farming claim that the reason for Dr. Kirschenmann's dismissal was his unwillingness to appease agribusiness, reflecting the political influence of industrial agriculture on the type and domain of science.

When I asked Tom, a retired professor (formerly at UIowa), about the state of science in Iowa he responded, "There's no right type of science. There's science, and there's non science. The question is what happens when the science gives you the wrong answer?" (IA099). His wife, Jodie, jumped in to provide the answer,

> That's why there's no Leopold Center. all the people there were fired. Defunded. They literally said 'We already have sustainability, we have all the answers to sustainable agriculture. So we don't need the Leopold Center anymore'. Just defunded it (IA100).

The professor nodded, lamenting the loss of the Center and agreeing that that was what had happened to Dr. Kirschenmann: "He kept getting the wrong answer" (IA099). Sustainability science has been constrained and bounded, and dissenters dismissed, influencing both the methods and the questions asked, or perhaps more critically, not asked (Felt et al. 2017; Carolan 2006).

Diverting & Defunding

For thirty years, the Leopold Center supplied financial support for graduate students and working farmers, funding academic research grants to study agricultural issues including conservation buffers, integrated crop and livestock production, and regional food economies. In 2017, however, just weeks after the DMWW lawsuit was dismissed, it was defunded by state budget cuts (Carter, Chennault, and Kruzic 2018). Republican representatives proposed complete closure of the Leopold Center, proclaiming its mission complete (Charis-Carlson 2017). "We already have the sustainability," as Jodie had remembered it, and legislators argued that the state's financial resources should be directed elsewhere. The Center itself was saved by a last-minute veto by then Governor Branstad following an outpouring of public support (over 13,000 letters were sent to Branstad's office, reportedly a record response). However, without state funding, the Center lost its staff and its ability to maintain a research program. As of the time of writing, the institution is "alive in name only" (Cox and Brown 2019). When I visited in 2021 to interview the outgoing director, I found that I had to walk under a stone archway etched with the name 'Monsanto' to find the downsized offices.

Although the Center technically exists today, the funding it once had has been entirely shifted to the Iowa Nutrient Research Center (INRC), also located at ISU. The Leopold Center's position at ISU was always unique (one of its founders described the Center as "at" but not "of" the university (IA471)) and its research agenda did not fit the technical fix approach favored by the agricultural establishment. Ultimately, the Leopold Center was the victim of a regime that valorizes science for a productivist purpose (Buttel 2005). The INRC's focus is narrowly scoped to the problem of "nutrients," rather than the complex, multiple, and compounding issues facing agricultural production in the state, including climate change, labor relations, and environmental health. The Center's attention to local food systems and subsistence production, prioritizing community needs over exports and profits, did not align with the model of science that serves industrial agriculture's

economic interests. Consequently, funding and resources were diverted under a guise of economic rationality.

Privatizing Knowledge in the Neoliberal University

Within the contemporary university system in the U.S., there is institutional pressure to produce certain types of knowledge for economic advancement. Funding cuts for public research, beginning with the Bayh-Dole Act of 1982 forced universities to turn to private and corporate donors, including corporate agribusinesses (Bartlett 2010; Bodine and Peikes 2021; Food and Water Watch 2012; Hettinger et al. 2021; Montenegro de Wit 2016). With the increased precarity of publicly-funded science, researchers at land-grant universities have been encouraged to partner with private entities to fund basic science and, often, develop patented products. The "corporatization of science", as Carter and co-authors have dubbed it, influences the types of research undertaken at public universities (Carter et al., 2018, p. 76). As Hightower warned, this has meant an outsized focus on things that boost revenues for processors over developments intended to benefit public good (Carter, Chennault, and Kruzic 2018; "U.S. Agricultural R&D in an Era of Falling Public Funding" 2020).

Across the country, public agricultural research funding has been under threat for the past several decades, and Iowa State University is no exception. As suggested by the engraved arch I encountered in 2021, Monsanto, now owned by Bayer, has been a longtime funder of ISU, having gifted more than $2 million dollars across more than 20 academic departments to support university research[22] (ISU foundation). Other industry sponsors include Deere & Co., Ceva Sante Animale, BASF Corporation, and Merck & Company (ISU Funding Overview, 2024). In 2008, the private sector overtook public funding for research and development in agriculture according to the USDA (Bodine and Peikes 2021). These trends are raising concerns over the tendency to focus on research that increases profit for the funding partner, rather than studies aimed at public benefit, echoing the warnings of the Hightower report over 50 years ago[23] (Hettinger et al. 2021; Hightower 1972).

Regulatory Fatigue and Academic Fear

At the same time funding cuts tilt the scale of power at public universities toward private interests, budget realignments at state agencies impact the ability of regulatory agencies to monitor and enforce environmental protection of water quality. Rosie, one community leader with whom I met, told me about the local activists who volunteer their time to review manure management plans. She casually, but with a tone of annoyance, commented on how often these citizen advocates catch applications that fail to include the required amount land to spread manure (without creating an environmental hazard), but which have already been approved. I asked, "Isn't that something the DNR should be checking?"

[22] Monsanto has also been exposed as having ghost-written academic papers without identifying their affiliations, pressured journals to retract studies that link glyphosate to health impacts, and influenced the EPA review of the controversial chemical (Clapp 2020).

[23] In a three-part series called "Big Ag U," Investigate Midwest, in collaboration with Harvest Public Media expose the significant influence of corporate funding on public university's agricultural programs. The series highlights the complex relationship between universities and agribusiness corporations, examining how financial contributions from large agricultural companies can shape research agendas, academic freedom, and public policy recommendations.

> RD: Well, that's the problem with the DNR. And this is not the field officers. It's not their fault. They are way understaffed. So you've got, you know, a field office might have like, maybe one and a quarter, one and a half people in a field office basically taking care of 1/6th of the state, so like about 15 or 16 counties.
> AH: Wow.
> RD: Yeah. So, it's a lot to cover, a *lot* to cover. So, they don't have the capacity to really dig in and do a complete analysis on a manure management plan. (IA251)

I later connected with a current field officer and two former staff members of DNR, who confirmed these limitations, expressing fatigue, slight outrage, and a tinge of sadness, underscoring the impact of dominant regime not just on those whose experience is marginalized, but also on the individuals entrenched its hegemony. Remembering the staffing cuts she witnessed during her tenure at DNR, Debbie also commented on how the dearth of sustained funding for long-term positions hampered the ability of the agency to do its job. "When all those people left state government that it was, you know, that knowledge just walked out the door. That knowledge just walked out the door" (IA030). The current employee lamented how the funding limits constrained their ability to monitor threats to water quality, saying "we had to run it on a complaint basis, because we wouldn't go and check every [manure management plan][24]" (IA264). He spoke to me anonymously, confiding that although many people at the agency were dissatisfied with the current situation, "Our management, a lot of them are scared to rise up" (IA264). Even when agents were aware of problem areas, the information was siloed away from the public:

> We [at DNR] know where some of those problematic places are, right? But that information isn't shared with everyone. But you could put monitors on some of those. I don't know. I mean, we've got to do something different. And different as in better. Because, again, we've been creeping at this nine-point-whatever level [ppm] for nitrates. And it's like, what are we doing? (IA264)

His frustration, both as dedicated public servant and native Iowan raising his family in a county with a growing number of hog confinements, with the lack of resources available to monitor water was palpable. In a study of the governance of wolf populations in Central Idaho, Martin finds ignorance to be a result of a dilemma between political controversy and funding cuts: federal agents charged with environmental governance are increasingly unable to carry out their duties to monitor and implement wildlife management (Martin 2021). Similarly, Iowa's DNR is institutionally unable, if not reluctant, to effectively perform environmental management, resulting in an aura of uncertainty within which economic interests take control. A former commissioner who worked closely with the department remarked, "There's definitely a pressure to not notice, to not make waves." (IA873).

Several academic scientists I spoke with also suggested a sense of unease with their ability to be critical of agribusiness or even in speaking to me about contemporary politics of water quality. Did they fear that they themselves may face a similar fate as Fred or the Leopold Center if they got "the wrong answer?" I cannot be sure, but I can appreciate the awareness of fragility of their position in a state where lawmakers have repeatedly attempted to revoke academic tenure at the state's three public institutions (Murphy 2023). A few former employees and students did share concerns over industry influence, prioritization of certain research agendas, and the marginalization of embodied

[24] Manure contains ammonium, a nitrogen compound, that can leach into water sources as nitrates when not managed properly.

forms of knowledge at the land-grant university. A former graduate student of ISU told me about the university's relationship with Bayer-Monsanto: "We were just beholden to their funding, and they knew it" (IA102). The faculty were legitimately fearful, in her telling, but "even more than funding, [the faculty] risked social capital" (IA102). She spoke of a bifurcation, some accepting the terms of the university's benefactors and working to tweak the agroindustrial system, others resisting in favor of more radical reformation – and being forced out as a consequence (Cox and Brown 2019; Hettinger et al. 2021). With attention and financial resources diverted away from alternative research and agency programs, water and agricultural science is constrained to fit a regime of accumulation that better suits agroindustrial interests, perhaps at the expense of the rest of the state.

Contesting a Regime of Accumulation

Through these practices, knowledge about water quality, as well as the relationship between agriculture and other socio-material outcomes, is dismissed, denied, and distanced from stakeholders who consume and recreate in Iowa's waters. The cultivation of doubt around the status of water renders their experience, and the pollution they are subjected to, invisible (Harrison 2006). In the uncertainty that remains, economic interests are able to ensure environmental governance continues to allow commodity production and accumulation.

Some have argued that the objective of the NRS was not to reduce nonpoint pollutants in Iowa's lakes, streams, and rivers, but rather to convince the U.S. Environmental Protection Agency that they did not need to federally regulate nutrient pollution in the Mississippi River basin, as is the case in the Chesapeake Bay (Masters 2023). If true, this strategy has largely been successful; economic interests have effectively contained knowledge (non)production at the state level. State-sanctioned experts working through private agribusiness partners provide enough evidence to stave off federal intervention but must do so by distancing water quality data collection from the Iowans who are most impacted.

These efforts, however, are not met without resistance. The publication of the "Declining Decade" website and the publishing of CJ's blog in a complete collection demonstrate the attempts of actors to reclaim control over their water. Scientists and experts formerly or currently at state institutions, too, critiqued the systematic hollowing of the production of rigorous knowledge about agriculture's impacts. Defunding programs and cutting staff may restrict agencies abilities to monitor and enforce environmental protections, but even dismissed dissenters remain active and vocal in trying to expose the entangled relationship between agro-industrial interests and representatives of the state.

Academics and NGOs continue to critique the outsized corporate benefit of public research funding (Food and Water Watch 2012; Howard 2020; Peterson, Fairbairn, and Lu 2024). In Iowa, Durrenberger and Thu (1997) examined the role of the agricultural university, ISU, and associated CE agents in mediating and bolstering the interests of agricultural processors and industrial producers, while at the same time minimizing the voices of rural residents. Studying the development of hog production facilities they demonstrate that politicians further amplify industrial interests by granting certain messages and metrics the credibility of "scientific," while ignoring or minimizing others (Durrenberger and Thu 1997). Their findings continue to resonate in recent debates over water quality, as models based on select surveyed inputs are cast as objective truth, while in-stream sensing is dismissed as overly sensitive to weather conditions—a claim that veils industrial interests under the guise of scientific scrutiny.

Critics of the of the expert-driven model and overreach of "big ag" in agricultural research have long posited locally-situated and practitioner-derived knowledge as a valuable and under-utilized source of knowledge that could be brought to bear on environmental problem solving (Ashwood et al. 2014; Carolan 2006; Montenegro de Wit 2016; Bell 2004)[25]. Contested forms of knowledge production highlight the plurality of ways in which different positionalities generate, validate, and diffuse knowledge about their environments (Rose 1997). Feminist geographers have recognized this plural vision for decades – one's identity and situated perspective influences their partial vision of the world and problem domain – any attempt at objective, universal understanding is merely a 'god-trick' (Haraway 1988). This insight underscores the importance of knowing water from multiple perspectives, particularly in informing more inclusive and effective strategies for addressing nitrate pollution.

By delegating water quality evaluation to the AAI and INREC, the state elevates their partial knowledge at the expense of embodied knowledges that may reveal an alternative account. I have shown how this influence of capital in environmental governance aligns with other attempts to defund or discredit knowledge production that might prompt regulations and threaten the economic viability of agoindustry. Authorized experts thus become agents in a technocratic field of power that suppresses subaltern and embodied forms of knowledge to facilitate a regime of accumulation characterized by denial of non-technical influences and inquiries, diversion of resources and attention away from alternative epistemologies and rigorous supervision of water quality (Li 2007b; Martin 2021; Mitchell 2002). Through the cultivation of doubt, economic interests infiltrate state institutions, ultimately distancing the public from knowing the status of their own water quality and perpetuating continued degradation (Proctor and Schiebinger 2008). These actions mirror the strategic use of science and restriction of knowledge production in other domains, such as tobacco smoke, acid rain, and climate change, to delay regulatory action in service of industry interests, at the expense of public health (Oreskes 2010).

Conclusion

My objective in this paper has been to situate the competing narratives of water quality progress within the political-economic patterns and processes that condition environmental governance in Iowa. Within the state and beyond, land-grant university research and expert assessments play a central role in shaping policy responses and public perceptions of water quality issues (Buttel 2005; Henke 2008; Hightower 1972). This chapter has explored these dynamics by critically analyzing the roles and implications of scientific expertise in informing policy responses to water quality challenges. Focusing on *how* the politics of expertise operates in Iowa further illuminates the project of exclusion inherent in claims to know water, as well as the agency and historical contingency at play in the contemporary crisis (Foucault 1991; Li 2007b).

I have provided a critical engagement with the ways in which power and capital govern knowledge production, or lack thereof, in Iowa. By cultivating doubt around the status of water quality, legislators and state agencies ultimately perpetuate a regime of accumulation for agribusiness (L. Schneider 1962; McGoey 2012). Foucault reminds us, though, that all regimes of truth are subject to contestation and that scientific narratives are not immune to critique or reform (Foucault 1984).

[25] Of particular interest has been the outsized role of expert knowledge in risk assessment, especially regarding transgenic crops (i.e., Lacey 2005, Kinchey 2010) and pesticides (Shattuck 2021).

Understanding how power hierarchies operate in the state at present can help reveal covert mechanisms of social control and open avenues for resistance and transformation. Various stakeholders, including affected communities, advocacy groups, and policymakers, can challenge the validity, relevance, or implications of scientific findings based on their own perspectives, interests, and values. This analysis suggests that reinstating in-stream sensors and citizen science programs may help overcome attempts at censorship, allow residents reclaim knowledge production, and challenge the agribusiness' monopolistic control over tracking water quality progress (Marquez, Ishii-Eiteman, and Schafer 2020). We may yet detach the power of "truth" from existing power structures, engendering new possibilities for political action, social change, and embodied knowledge.

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Chapter 5

Reservoirs of Resistance: Reflecting on a Landscape of Capitalism

"I saw my reflection in the lake water and I'm old now. Not like decades ago when we swam at the beach with friends and neighbors and all those kids. I wasn't old then.

I'm old now and someone asked me if the water is supposed to be like that, kind of dark and dirty. I say I don't remember; it's been too long that way. But I can't forget the question, 'Is it supposed to be like that?'

The water isn't clear and neither is the future. When will it be safe to swim in the water again, safe for all those friends and neighbors and all those kids?"

Julie D., Hardin County, July 2024

Abbreviations

CAFO	Confined Animal Feeding Operation
DMWW	Des Moines Water Works
DNR	Iowa Department of Natural Resources
EPA	U.S. Environmental Protection Agency
IFB	Iowa Farm Bureau
PFI	Practical Farmers of Iowa

As I finish writing this dissertation in the summer of 2024, heavy rains have returned to Iowa after years of drought and nitrate levels in streams and rivers are rising. Beaches are closed as toxic algal blooms carpet the surface of lakes across the state. The foul-smelling green sludge, a product of eutrophication caused by excess nutrients in the water, is a potent reminder that water quality in Iowa continues to be poor[1]. Almost a decade after the Des Moines Water Works (DMWW) lawsuit, which sparked my inquiry into the politics of water quality in Iowa, the utility is once again running its costly nitrate removal system to keep nitrate levels below the federally-mandated safe drinking water threshold (Gerlock 2024).

Amidst the ongoing pollution, new conflicts and contestations surrounding the state's dominant industry continue to emerge. Iowans are calling for fertilizer spills to result in significant fines (that might actually deter careless handling), for large Confined Animal Feeding Operations (CAFOs) to require permits for the pollutants they inevitably release, and for sensitive, treasured ecologies to be

[1] Earlier this spring, the DNR released a draft of the "impaired" waters list for the U.S. EPA, finding that only 24 water body segments of more than 1,400 that they report on, met the standards for their designated use. While this number is slightly better than the report two years ago (in which only 15 of the 3000 segments were too polluted for their intended use), the poor performance highlights the disappointing progress on water quality goals (Iowa Department of Natural Resources (DNR) 2024).

protected from unfettered capitalism (Elkadi 2024; Jordan 2024; Strong 2024)[2]. In short, they are asking for change.

As was the case with the DMWW lawsuit in 2015, political actors and agricultural groups are framing these demands within an urban-rural binary and alleging that they demonstrate a bias against farmers among city dwellers (Elkadi 2024). But are these challenges truly "anti-farmer" or are they simply anti-farming as it is currently done in the agronidustrial Iowa prairie? What is the role, or the responsibility, of the Iowa farmer in the matrix of political-ecological dynamics that condition water quality?

I have argued that understanding and explaining the water quality crisis in Iowa requires a nuanced examination of historical power relations, discourses, and techno-materialities of which the individual farmer is only a small part. It is true that Iowa's farmers use much more fertilizer today than in the past, and that this fertilizer (along with the manure produced in CAFOs) is the ultimate source of the excess nitrates[3] that shutter beaches and threaten the safety of drinking water sources. But it is also true that farmers themselves bear the brunt of this pollution, both in their health (they must drink the water too) and in the cost of treating the water. While Des Moines and the state's larger cities can spread the cost of nitrate removal over thousands of customers, small rural, often agricultural, towns cannot do the same. Private well owners, too, incur this cost on their own.

When the large grain elevator at the center of town only buys corn and soybeans, many of Iowa's farmers begin to feel that they do not have any alternatives other than engaging in row-crop commodity agriculture, which, as I have remarked upon repeatedly throughout this dissertation, is inherently leaky with respect to nitrates (See Figure 25). When land rental rates and input prices creep ever upwards, such that any price increases received for your commodities are quickly absorbed by the costs of running your business, the economic squeeze encourages farmers to ensure they get the largest yield they can, even if it means applying a little more fertilizer than what is recommended (Ribaudo 2011). Cultural politics, social norms, and strategically cultivated uncertainty imbricate with political economic forces to keep farmers entrenched in this system. As Debra, the wife of a third-generation farmer, lamented "Corn is king, even when you're going broke" (IA671).

When capitalist patterns, of specialization, extraction, and accumulation, configure agricultural production, all of Iowa, both the human and nonhuman inhabitants, suffer. Iowa's remaining farmers are certainly not the only "losers" in this system, but they are not "winners" either. All of Iowa must endure the degradation caused by the relentless pursuit of profit through the production of commodity crops. This remains as true today as it was in the late nineteenth century when the

[2] Environmental groups in Iowa are asking the federal government to intervene and protect Iowan's drinking water from contamination by agricultural runoff (Strong 2024). Following three failed lawsuits in the state of Iowa (including the DMWW lawsuit), a group of thirteen advocacy groups have filed a federal lawsuit against the U.S. Environmental Protection Agency (EPA) and a coalition of major agricultural industry associations including the National Pork Producers Council, American Farm Bureau Federation, U.S. Poultry & Egg Association, and United Egg Producers (Elkadi 2024). Iowans are also seeking stronger penalties for fertilizer spills after a spate of incidents this year alone has left hundreds of thousands of fish dead across miles of streams. A group of concerned citizens, led by a Professor of Law at Drake University (in Des Moines) filed a petition to the state Attorney General asking them to go beyond the minimal fines DNR is allowed to assign and seek litigation (Jordan 2024).

[3] Although numerous scientific studies have demonstrated the relationship between agricultural practices and nitrate pollution, this fact is still contested. Many farmers and industry representatives are quick to point out that soils can naturally give off nitrates, though this contribution is much lower than the levels currently plaguing the Corn Belt.

reclamationist dream of drainage first took hold, if not more so, as broader technological and political changes have led to waves of dispossession by way of farm consolidation.



Figure 25. Grain elevators in Prairie, IA. Photograph by author March 2023.

The preceding chapters of this dissertation have documented the uneven and damaging impacts of agrarian prairie capitalism on Iowa's ecologies and communities by attending to the hydrosocial history that prefigures persistent drinking water impairment, the hidden ideological underpinnings of commodity production that obscure this political-ecological construction, and the power-knowledge regime that legitimates continued accumulation at the expense of public welfare. Braiding together geographically specific insights regarding the symbolic-material infrastructure of drainage and the techno-productivism it engenders, I present an in-depth case study of a socio-ecological landscape of capitalism and an argument for the common cause of all those "living downstream" (Steingraber 1998).

By way of a conclusion, in this final chapter I review what is revealed in struggles over Iowa's persistent water quality crisis and the geographies of capitalism that enable socio-ecological drainage. I then present a counter-discourse to the metaphor of drainage in the form of reservoirs of resistance to draw attention to those Iowans working from within the drained landscape to adapt and imagine an alternative future. I comment on the questions raised by this dissertation and end with a discussion of the implications of this analysis for resource politics beyond water quality.

Draining the Heartland

I began this inquiry by recounting a particular social conflict around water quality – the lawsuit brought by Des Moines' water utility alleging that farm tile drains were violating federal safe drinking water standards – to introduce the key elements in the politics of water quality. Explaining the contested functions and meanings of water in Iowa's modern agricultural landscape, however, requires an historical political-ecological analysis rooted in the expropriation of Indigenous lands and the vision of progress exemplified by wetland reclamation. Tracing the symbolic and material flows

of both power and pollution, I outline the hydrosocial history of farm drainage in Iowa and document the enduring socio-ecological significance of the vast network of subterranean infrastructure. Drainage and hydraulic management of water constructed Iowa politically as an agroindustrial state, dramatically homogenizing the land's natural heterogeneity in the process. Although easily overlooked, this hidden infrastructure enabled Iowa to ascend to the top ranking of commodity production in the nation. Pervasive water pollution is a by-product of this export-oriented political economy.

Driven by a development logic to improve, the state, capital, and technology all played a critical role in producing the contemporary landscape, locking the tile-drained soils into row crop commodity production and severely constraining the ability of landowners to pursue alternative land uses. Along with significant ecological sacrifices, including loss of prairie, agricultural diversity, wildlife, meandering rivers, and, of course, clean water, the social ramifications of this history are critically important for understanding the current moment. The state is nearly entirely held in private hands and the farmers that have been able to withstand decades of consolidation are entrenched in cycles of debt. Like the tile drains themselves, which operate silently beneath the surface, these impacts are concealed and naturalized as simply part of the modern order of the state.

Attention to tile drains and the hydrological management decisions of the past increased following DMWW's announcement of their intent to sue three upstream drainage districts. The cultural and ideological responses to the lawsuit, and the crisis of water quality in general, further reveal the extent to which the constraints on Iowa's agriculturalists have been naturalized and generally accepted. Even as they identify their inconsistencies, individual farmers echo the dominant discourses articulated by politicians and agricultural groups that obscure the historical construction of the landscape. The circulating narratives these groups proffer, I argue, can be best understood as myths: seemingly neutral and timeless, but in fact socially constructed and historically contingent. In Iowa, three interlocking myths rooted in post-Enlightenment ideas of nature, security, and modernity reconfigure farmers as heroes and stewards 'feeding the world,' rather than hostages of an agroindustrial system that degrades landscapes and livelihoods in tandem.

Mythology unveils what is hidden in socially accepted cultural forms: the ideological and the political undercurrents constituting contemporary capitalist landscapes. The myths that sustain and extend productivist agriculture in Iowa are empowered by technocractic knowledge practices that cultivate doubt about water quality trends and enable continued accumulation for agricultural industry interests. Knowledge production is strategically restricted to and within state institutions in service of maintaining the status quo and obscuring the contradictions inherent in mythic representations of Iowa agriculture. Science and scientists are ensnared in power relations that shape the form and function of knowledge making and use: science can expose the extent of the damage done to Iowa's water ways, fostering resistance, but scientists are socially situated and subject to political pressure and censorship if they challenge the dominant discourse. As a result, power dynamics between state institutions and agribusiness interests facilitate continued profiteering at the expense of public welfare. Again, an ideological commitment to modernism, reflected in the emphasis on scientific expertise, can be seen as powerful force shaping the terms and values central to the conflict over water.

Together, attention to symbolic-material infrastructures help explain the origin and progression of Iowa's contemporary conflict and answer the question of why water quality remains so poor. Historical state-building created a path-dependency that enclosed the physical landscape alongside

agricultural imaginaries. Socially circulating narratives advanced by agricultural groups and political leaders helped to naturalize the dominant order, masking the embedded capital interests that remade the landscape and locked-in artificial boundaries between land and water in service of agricultural extraction. More than nitrates flow through Iowa's drainage ditches; the pollutant is carried by discourses, state-sanctioned knowledge regimes, and the capital interests they each reinforce.

Unseen, yet powerful, forces configure nitrate pollution in Iowa and alienate residents from both the land and each other. Thinking through the metaphor of industrial drainage, a concealed infrastructure that facilitates extraction and enclosure, I counteract capital's erasure of the base conditions that allow it to function. Polluted waters threaten more than human and ecological communities, they threaten the very power structures that maintain industrial production. The extent and severity of the socio-ecological crisis is a consequence of the present paradigm; struggles over water quality reveal the socio-material infrastructures underneath the capitalist landscape and the common cause of all Iowans to challenge the current order.

Reservoirs of Resistance

Attending to the interconnected flows of nutrients, narratives, and knowledges, this analysis raises questions about how to reconfigure Iowa's agricultural landscape and restore vitality to communities and ecologies. Within each of the cases I present in this dissertation there exist dissenters – activists, community groups, journalists, and organic intellectuals calling for an alternative future for Iowa. Critiquing capital from within its bounds (Fraser 2016), farming and nonfarming Iowans I met on my 'listening tour' identified many of the socio-ecological fractures that I have elaborated on here. Within the drained landscape, reservoirs of resistance remain.



Figure 26. Constructed wetland attached to tile drain outlets in Benton County, IA. Photograph by author August 2023.

Despite former Governor Branstad's declaration that "Des Moines has declared war on rural Iowa" in response to the DMWW lawsuit, urban and rural Iowans have more in common than political rhetoric suggests. Both groups live downstream of the social and ecological landscape of capitalism, and both suffer its ill effects. I have shown how ideology permeates Iowa's socio-ecological metabolism. What remains open is how to ensure that that ideology represents the moral and cultural values of everyday Iowans today and in the future, rather than the entrenched interests of agroindustry.

Reservoirs offer an apt analogy for the forms of resistance that exist in Iowa's agroindustrial prairie, and a mirror to the metaphor of industrial drainage. Like subsurface tile drains, reservoirs are material infrastructures imposed on Iowa's reordered landscape, but they serve the opposite purpose: reservoirs slow and retain water. Stream channelization and the extensive network of subsurface drainage crisscrossing the state of Iowa accelerates the movement of water across the landscape. Along with climatic changes that have increased the intensity of precipitation events, the speeding up of water has resulted in frequent flooding, which is managed through construction of dams and levees to create reservoirs. Reservoirs are adaptations to the current system, yet, against the logic of drainage, reservoirs of resistance are restorative, imaginative, and frequently explicit. They bridge social relations, foster collaboration, and suggest a way forward.

The water quality crisis in Iowa can seem dire, and it is not the only challenge facing the state. Rural residents in particular are simultaneously contending with poor air quality from hog confinement operations and social disempowerment in the forms of population decline, loss of schools and rural hospitals, and an epidemic of methamphetamine use (Edelman 2021; Halawith 2022; Reding 2009; Swayne 2023; Vujicic 2016; Wing et al. 2008). However, there are robust models already on the land for remaking the system. Practical Farmers of Iowa, a nonprofit dedicated to promoting sustainable agriculture through farmer-led initiatives, for example, has shown that with dialogue and collaboration, it is possible to resist the monologic power of Big Ag (Bell 2004). Emphasizing a "big tent" approach and a commitment to practicality, the group empowers farmers to consider and directly address their community's needs and values in their production decisions.

Throughout my ethnographic fieldwork, I met and interviewed members and leaders across myriad institutions dedicated to re-embedding (agro)ecological management practices in moral values of care and community (Polanyi 2001; Carter 2015). In addition to PFI, I spoke with representatives from the Iowa Natural Heritage Foundation, the Tallgrass Prairie Center, Prairie Rivers of Iowa, and the Iowa Prairie Network, each of whom are actively working to restore alienated relationships with the land and among Iowans (including farmers and nonfarmers) by highlighting shared sacrifices and collective opportunities. Against a dominant market-based logic, these groups are drawing attention to the common fates of ecologies and communities and extolling a politics of opportunity for the future of Iowa.

Change will not be easy, but it is possible. As a farmer (and PFI member) in Marshall County told me while we were touring a restored prairie on a corner of his family's land, "People say 'We've always done it this way.' No, we haven't. Nobody I know farms with oxen, nobody" (IA512). A historical perspective shows just how much Iowa has changed since its initial settlement and the structural transformation of agriculture in the twentieth century. Several farmers reminded me that "Iowa used to be the number one producer of apples and grapes." Imagine, they asked me, how much food Iowa could grow if it abandoned even a fraction of the acres currently in corn and soy.

Young and beginning farmers, without large tracts of land or easy access to credit to procure it, are charting this course by necessity. On the small plots of land they can afford, commodity crop production cannot support a family. Instead, many are turning to novel alternatives, including lavender farms, bison ranches, agrotourism, and nut orchards. I met several farmers taking this approach at PFI field days, but also in communities I did not expect, such as meetings of the Iowa Farm Bureau (IFB). Jacob, a member of IFB's Young Farmer Program[4], told me while rocking his infant daughter "We act like focus on production ag will just always help, but most of us are finding niche markets are the only way to be viable" (IA913). Like other young farmers I spoke with, Jacob was explicit in his rebuttal of the mainstream dogma surrounding commodity production and the constraints that made land inaccessible and pushed him to seek an alternative path for his young family. Encounters like these raise new questions in the territorial struggles over water: As the current cohort of (mostly male) farmers grows older and retires[5], how are gender and generational dynamics shaping the possibility of an economically and ecologically sustainable agricultural transition?

Similarly, Holly and Mark, district representatives for IFB, inherited a small plot of land from Mark's dad and are now raising goats, hazelnuts, and pumpkins with their adopted son. On a long bus ride to a newly opened feed mill at Iowa State University, Holly told me about the long hours their family was putting in to develop their business, on top of their day jobs as a custom sprayer and a youth agricultural coordinator. This story was not uncommon. Most of the farmers I met who were implementing novel practices relied on incomes from larger, industrial operations. Often, those who spent significant time advocating for local policy changes were supported directly or indirectly by commodity production on inherited, tile-drained, and row-cropped land. Resistance is not necessarily transgressive in Iowa; often it is adaptive, conditioned and constrained by the context of the industrial agriculture.

Attending to the entangled contradictions and incongruities in the experience and practice of agrarian capitalism provokes new inquiries about how to build geographically and historically situated anti-capitalist political alliances (Andueza 2021). These questions require consideration of simultaneously ideological and material infrastructures that shape the social lives of agrarian landscapes. Engaging these complexities, we may ask how the historical palimpsest of enclosures intersects with contemporary political processes to shape the form and function of resistance efforts.

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In the nearly ten years since the DMWW lawsuit, the rhetoric of the urban-rural divide is still pervasive. But even in this commodified geography, the lives of Iowa farmers comprise non-commodifiable needs and attachments and there is a growing awareness of the ways those values needs are threatened by business-as-usual policies and practices. Crises, such as the struggle for clean water, expose the value structures draining the landscape and reveal the common position of farmers and nonfarmers as victims of the dominant model. Realization of this shared fate may help erode the symbolic power of a rhetorical division between city and country, which serves to alienate farmers from both their land and their neighbors.

[4] Iowa Farm Bureau defines "young" farmer as members between the ages of 18 and 35.

[5] As their husbands pass away, women now own the majority of Iowa farmland, suggesting a possibility of a different relationship to land (Carter 2015). Currently, however, most of it rented to tenant farmers who, according to my interviews, continue to farm like their fathers.

Uncommon collaborations are already actively forming that challenge the urban rural dichotomy. As an example, the past two years have seen a unique coalition of farmers, environmental groups, and Indigenous-led community organizations joining forces to resist a series of proposed carbon dioxide pipelines (Masters 2022; Kruzman 2022). The project seeks easements across fields for a pipeline to carry liquified carbon dioxide from the state's many ethanol refineries to geologic sequestration sites in North Dakota. Farmer engagement in resistance to a project so closely associated with agroindustry suggests opportunities exist to challenge the rationalizations of techno-productivist agriculture when it threatens. Considered surprising to many, allyships of this sort reflect the mutually held values of seemingly disparate groups in the socio-ecologies of prairie capitalism.



Figure 27. Wind turbine for above a corn field in Marshall County, IA. Photograph by author August 2021.

In thinking through the invisibilized symbolic-material infrastructures of the geography of capitalism, this dissertation provides insight on resource conflicts beyond water quality in the region. Renewable energy projects, like wind and solar farms, are proliferating across the state in response to federal decarbonization objectives, prompting a renegotiation of the functions, meanings, and values of the agricultural landscape. Attending to these tensions requires an appreciation of the history and ecology of the state, alongside the workings of capitalist imperatives and divisive political rationalities seen in this case study. Climate change policies are also encouraging new commodification practices through the creation of soil carbon markets, which propose to pay farmers for adopting new practices that sequester carbon from the atmosphere in agricultural lands. This analysis suggests that the relational dynamics governing emerging markets will influence whether they simply entrench the current configuration of agroindustrial power or contribute to a sustainable transformation of Iowa agriculture. The social and environmental impact of each of these developments will be shaped by existing subterranean infrastructures, which biophysically

constrain where and how they can be implemented, as well as their corresponding productivist ideological manifestations.

Despite the uniformly cultivated landscape of capitalism, social relations on the ground are variegated and unsettled. "The water isn't clear and neither is the future," as Julie reflected in a Des Moines Art Center exhibit on flooding and memory. The future of Iowa is embedded in the past, but not determined by it; it can be decided by the many who call it home. Just as the state's channelized rivers have reclaimed their natural course, farming and nonfarming Iowans can leverage their collective power to build a better future. By exposing the entangled political, cultural, and ecological processes that constrain and disrupt local relations in Iowa, this dissertation helps explain the uneven geographies of capitalism. There are "countless Iowas beyond Iowa", where ecologies and livelihoods are transformed by techno-productivist imperatives and rationalities (Swanson 2017). In these spaces, thinking from and through the invisiblized processes that facilitate capitalist logics reveals the struggles over meaning and value embedded in contestations over material resources.

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Appendix

Interview Guide for Farmers

1. I would love to start off by learning a little about your history in Iowa and with farming: Where did you grow up? How and when did you start farming?
2. What do you think are the biggest issues in agriculture, or Iowa generally, today?
3. What are you most excited about in Iowa and in agriculture?
4. Could you characterize the changes you have seen in Iowa agriculture since you began farming? How is farming different for you than for previous generations?
5. What types of [conservation] practices do you use in your operation? How often?
6. What do you think are some of the best agricultural practices? What would be the best things to do for Iowa's landscape in general?
7. Do you talk to other farmers about conservation practices? What do they think?
    a. Do you talk to other people (conservation groups, extension agents, academics) about it?
8. Do you remember hearing about the Des Moines Water Works lawsuit? What did you think about it? What have you heard from others about it?
    a. What do you think has been the long-term impact of that lawsuit, if any?
9. Where do you get your drinking water?
    a. If on well water: Have you had your water tested for contaminants? Why or why not?
10. Do you or does your family own the land you farm? Would you like to?
11. Do you participate in any community organizations related to environment or rural vitality?
12. How do you understand success in farming?
13. What is your favorite part of your job?
14. Is there anything else I should know about you or your farm?

<u>Demographic Information</u>

Age:
Gender:
County:

<u>Farm Information</u>

Crops:
Livestock:
Acres farmed:
Acres tiled:
Acres owned:

Do you or your spouse have an off-farm job?

Interview Guide for Community/Environmental Organization Leaders

1. I would love to start off by learning a little about your history in Iowa and how you came to be involved in this work. When did you start working for this organization and what does your job entail?
2. What are the main areas that you focus on in your work? What types of activities do you undertake and with whom do you primarily interact or collaborate?
3. Do you talk to farmers at all in your work?
4. What do you feel are the most pressing issues in Iowa agriculture today?
5. What are you the most excited about in Iowa and in agriculture?
6. What changes have you seen in Iowa agriculture since beginning your work or over your lifetime?
7. How would you describe water quality in Iowa?
8. Do you remember hearing about the Des Moines Water Works lawsuit? What did you think about it? What have you heard from others about it?
    a. What do you think has been the long-term impact of that lawsuit, if any?
9. Who is involved in your group? Do you have farmers in your membership? If so, what types?
10. Could you characterize the changes you have seen in Iowa agriculture while you've lived here, if any?
11. What is your vision for the future of Iowa? How do we get there?
12. What is your favorite part of your job?
13. Is there anything else I should know about you or your organization? Is there anything else you think I should be attending to or aware of?

<u>Demographic Information</u>

Age:
Gender:
County of residence:
County of workplace:
Engaged in farming?

Are you a member of any other environmental groups? Any agricultural groups?

Interview Guide for Rural Residents

1. Could you tell me how long you have lived in this county? In Iowa?
2. Have you ever farmed? Do you have any family members engaged in farming?
3. What do you feel are the biggest issues in agriculture, or in Iowa generally, today?
4. What are you the most excited about in Iowa agriculture?
5. What changes have you seen in Iowa agriculture during your time in Iowa?
6. What is your vision for the future of Iowa? How do we get there?
7. Where do you get your drinking water?
    a. Have you ever had it tested for contaminants? Why or why not?
8. What do you think about some of the current efforts to address nutrient reduction, such as the NRS or others?
9. Do you ever talk to farmers about water quality? What do they say?
10. Do you remember hearing about the Des Moines Water Works lawsuit? What did you think about it? What have you heard from others about it?
    a. What do you think has been the long-term impact of that lawsuit, if any?
    b. How did you feel about the urban-vs-rural framing of the lawsuit?
11. When you think about nitrates in drinking water, do you
12. Are you a member of any environmental or community groups? If so, what are the key concerns of your group and what types of activities do you engage in?
    a. Can you tell me a little bit about how you see your group fitting into broader efforts?
13. Are there any other topics you'd like to share with me?

<u>Demographic Information</u>

Age:
Gender:
County of Residence: