Field Rhetoric

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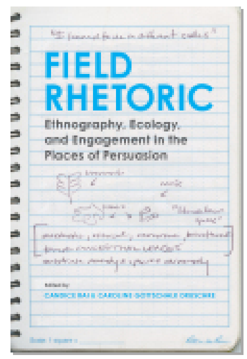

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3

What's a Farm?

The Languages of Space and Place

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> This puzzle can be stated very simply: the Greeks made one invention too many! They invented both democracy and mathematical demonstration. . . . We are still struggling, in our "mad cow times," with this same quandary, how to have science *and* democracy together.
>
> —Bruno Latour, *Pandora's Hope*

Early in this century, scholars across the humanities, social sciences, and biophysical sciences sought ways to bring citizens and scientists together to make better science, technology, and environmental policy. Critics such as Harry Collins and Robert Evans articulate a theory of experience-based expertise to better manage citizen participation in science and technology policy. Latour calls for a materialist project that moves away from critique and brings people and things together to compose a better world in the face of impending ecocide. Herbert Simons calls for a "reconstructive rhetoric" that moves beyond critique toward a rhetorical practice of judgment and collective action.[1] Meanwhile, in science studies, planning, medicine, and sustainable development, participatory risk assessment and technology development that brings diverse people together to develop policy are well-established practices.[2]

Despite these calls for citizen participation, we still struggle, as Latour says in the epigraph, to "have science *and* democracy together."[3] As climate change and the necessity for mitigation and adaptation become increasingly pressing, the need for citizen participation only becomes more urgent. But integrating the expertise of citizens with those of technical experts is not easy. Better understanding of the rhetorical challenges present when citizens participate in the making of technology or environmental policy is key for well-intentioned researchers and activists hoping to avoid the traditional technocratic, top-down model of decision making. This chapter responds to programmatic statements by Latour, Collins and Evans, and Simmons by exploring the rhetorical activity that arises when citizens and scientists alike contribute to the making of science and environmental policy. Our goal is to better understand the rhetorical dynamics that can make such collaborations difficult when, in our case, scientists and farmers talk about farms as two very different things.

Despite the emphasis in science studies, applied science, medicine, and sustainability on citizen participation in decision making, very little of this work considers how rhetoric might contribute to more democratic science and technology development. Many studies categorize the range of mechanisms for citizen participation and evaluate participatory mechanisms on a variety of procedural and outcome-based criteria.[4] While the consensus is that mechanisms that facilitate dialogic communication—such as citizen juries, planning cells, and focus groups—are better, these studies do not examine the talk involved in dialogic participation. Matthew Harvey, Robert Futrell, and Gail Davies are rare voices that call for a more careful analysis of the role of language in citizen science and participatory processes.[5]

This conjunction of disciplinary interests in citizen participation and expertise presents a unique opportunity for rhetoric. While scholars in science studies have called for participatory mechanisms but overlooked the role of language, rhetorical scholars have argued with renewed vigor that rhetoric should re-engage with the public sphere and with scientific activity.[6] In this chapter, we argue that rhetorical research can move this interdisciplinary effort forward by exploring the specifically rhetorical aspects of citizen participation in science policy. As S. Scott Graham et al. argue, the "long-standing problem of inclusion may be long-standing because the focus has been so exclusively on how to get more (or the right) people to the table. In the absence of an attendant focus on procedures after arrival, the democratization of STEM policy decision making may fail."[7] As Graham et al. suggest, we need to focus on what happens after the right participants arrive for the STEM policy discussion.

This chapter presents a case study of a rapid technology assessment project focused on cellulosic biofuel that examines what happens once the participants arrive at the table. While business has made ethanol from corn grain for some time, the technology to make ethanol from the cellulosic material in woody plants such as corn stalks is emergent. Unfortunately, the cellulosic ethanol industry is rapidly developing to meet federal renewable fuel guidelines before careful, long-term scientific studies can be conducted. As such, our research team conducted workshops with scientists and farmers to gather and analyze what these diverse experts know about the emerging technology and make that knowledge available to policy makers.

We analyze the transcripts of three rapid technology assessment workshops, one with scientists and engineers, two with farmers. Using both qualitative analysis as well as semantic network analysis (SNA), we make two interrelated arguments. First, integrating the local knowledge of non-credentialed experts with that of credentialed experts is complicated by specific rhetorical and discursive differences. As both Gerard A. Hauser and Robert Danisch argue, the vernacular necessary for participation in emergent publics conflicts with the dominant technical discourse.[8] Our analysis of workshop transcripts identifies specific patterns of discursive differences, interpreting them as issues of space and place. Drawing on Latour, Annemarie Mol, and Andrew Pickering, we suggest that the problem is not that scientists and farmers have different perspectives on the same environment and therefore produce competing epistemic claims, but that their material practices enact different farms. Thus, integrating the knowledge of the two groups is not a matter of evaluating and combining two distinct perspectives, but of calibrating the enactment of two different farms that emerge from the everyday material practices of distinct lifeworlds.

Our second claim is methodological. Given the rhetorical complexity of citizen participation, we suggest that SNA, which uses network displays to visualize relationships between concepts, is a powerful addition to our analytic repertoire that helps us better represent and investigate rhetorical knowledge. For example, SNA can represent a thematic analysis of the technology assessment workshop with one group of farmers in the study (figure 3.1), illustrating a relationship between the prominence of terminology and the "context" of related terms through node size and proximity to other terms. The larger the node, the more times the word occurs in the text, demonstrating its importance or salience.

Rhetorical scholars have begun to use techniques for managing big data,

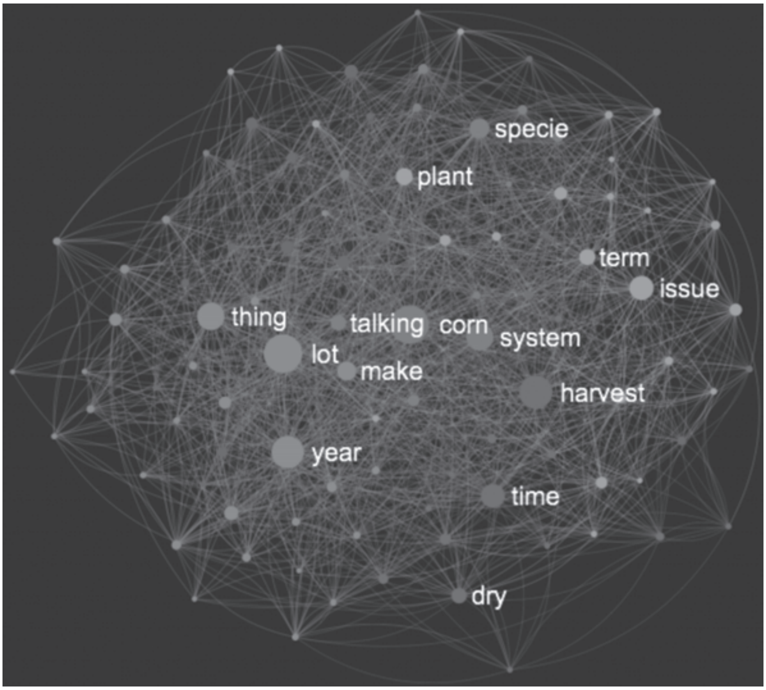


Fig. 3.1. Network graph using Textexture to visualize transcripts of the farmers' group 1 discourse.

but the utility of this methodology remains underdeveloped.[9] Our case study demonstrates that SNA can "map" the rhetorical practices of two or more groups, identifying similarities and differences in discourses. While our corpus is small, we argue that SNA can be integrated with traditional qualitative methods in ways that confirm and extend qualitative findings. Further, since SNA can manage vast data sets, it provides rhetorical studies a powerful new tool for analysis.

The Case Study: The Matrix Project

In the first decade of this century, the ethanol industry emerged as an alternate fuel source that supplemented traditional fossil fuels. This development was not without controversy.[10] As biofuels developed, researchers and policy makers considered cellulosic biofuels an alternative to ethanol derived from corn grain. Cellulosic biofuel is made by processing materials containing high concentrations of cellulose, roughly the woody material in corn stalks, wheat straw, perennial grasses and trees. In 2009, federal policy mandated that renewable fuels contribute thirty-six billion gallons to the national fuel supply by 2022. Of this, 21 billion gallons were to be derived from cellulosic sources but, as of 2011, there were few commercial facilities producing cellulosic biofuels.[11] The cellulosic biofuel industry would have to emerge very quickly to meet federal mandates, presenting a significant challenge and an opportunity for researchers, farmers, policy makers, and citizens. In the Midwest, interest in cellulosic biofuel was spurred by the Department of Energy's "Billion-Ton Report" in 2005, which estimated that a billion tons of cellulosic stem and leaf plant materials were unused annually, most from corn stover (stalks and leaves left after corn grain harvest). While offering an untapped source of biomass for conversion to biofuels, the material presented a challenge. Removing biomass such as corn stover, storing it, transporting it, and converting it to biofuels could have major impacts on soil and water resources, communities, rural infrastructure, and farmers.[12] The "matrix" project, the object of our analysis here, emerged as a response to this situation.

The rapid development of the cellulosic biofuel industry required that policy makers and industry planners make decisions before rigorous scientific research to assess long-term environmental and social consequences could be completed. It can take a decade or more to produce the agroecological data necessary to evaluate the consequences of removing corn stover.[13] By the time data are collected and analyzed, the industry would already exist. One research approach for guiding industry development in such situations is the "rapid assessment" project, which draws on distributed expertise to gather the best extant knowledge about an emerging issue to guide decisions that must be made without scientific consensus. These "participatory assessment" projects sometimes include a range of stakeholders.[14]

The rapid technology assessment project designed by our research team brought together a group of fourteen scientists with expertise in various aspects of cellulosic biofuel production, as well as two groups of Iowa farmers who had what Collins and Evans call "non-credentialed" expertise. To gather the expert opinion of these three groups, we conducted three day-long workshops: one with the scientists and one with each of the two groups of farmers. These workshops were organized by a research instrument we called the "system configuration matrix" (figure 3.2), hence the nickname of the project. The matrix combines two pairs of variables (centralized vs. distributed facilities and single input vs. multiple input processing) to present four potential structures for the emerging cellulosic biofuel industry. Broadly, cellulosic biofuels can be produced in large centralized facilities or in smaller facilities distributed across the landscape and closer to the source of “feedstock” that would be processed into ethanol. The second variable is whether the production facility processes only corn stover as a feedstock or whether it can process a range of cellulosic materials from a variety of plants. Thus, the industry can be built around large centralized facilities that process only corn stover, large centralized facilities that process several feedstocks, smaller facilities distributed across the landscape but which process only corn stover, or, finally, smaller distributed facilities that process a range of cellulosic feedstocks. The thirteen criteria or metrics that make the rows of the matrix are important measures of the sustainability of each potential industry configuration. For example, if a potential industry configuration such as the centralized, single feedstock option caused significant soil erosion, that configuration is probably not sustainable over time.

The workshop for “credentialed experts” included fourteen researchers among them chemical engineers, agricultural economists, wildlife specialists, and so forth. Each participant was a university researcher and a specialist in one of the evaluation criteria. There were six farmers in the first farmer workshop and eight farmers in the second farmer workshop.[15] These farmers represented farming operations ranging from small, two hundred-acre farms, to large operations that rented significant tracts of land. The farmers also represented significant geographic distribution, coming from all over central Iowa. Most importantly, all the farmers had extensive, often lifelong, farming experience. After a brief introduction by the research team, workshop discussions were structured by the matrix.[16] In the scientists’ workshop, discussion of each metric (e.g., soil erosion, rural development, wildlife habitat) was led by participants with expertise in that specific criteria. After each specialist identified the key issues, there was an open group discussion. Then participants were asked to fill out the matrix for that metric, “voting” whether each of the four potential configurations was likely to be sustainable in terms of that criteria.

The workshops with the farmers were similarly structured by the matrix. The farmers discussed each potential industry configuration and how that structure might affect their farms and the individual evaluation criteria. For example, farmers used their experience and their familiarity with their own farms to discuss whether soil erosion would be better or worse if the industry relied on only corn stover or an industry that processed multiple kinds of feedstocks. Unlike in the scientist workshop, there were no presentations by specialized experts. Rather, farmers contributed as they felt comfortable or

Fig. 3.2. The Matrix: Biorenewable System Evaluation Worksheet. Participants were given the following instructions: “For each cell in the worksheet, please mark ‘red’ (black) if a configuration ‘suggests major challenges will likely occur’; ‘yellow’ (light grey) if a configuration ‘suggests a caution is advised or if insufficient information is available to draw a reasonable conclusion’; ‘green’ (medium gray) if the configuration ‘currently offers or will likely offer a favorable opportunity,’ and ‘blank’ if ‘no opinion or not applicable for you.’ Your responses will remain anonymous and no identifying information will be used when analyzing and reporting results. Thank you for sharing your views.”

	-------------System Configuration------------			
Functionality Metric	Centralized Processing		Distributed Processing	
	Single sp (corn)	Multiple sp.	Single Sp. (corn)	Multiple Sp.
Will lead to **high and stable levels of feedstock production.**				
Development of required and producer acceptable **feedstock conversion** technology is likely.				
Transportation requirements can be met and will be acceptable to producers and the industry.				
Labor needs for feedstock harvest and processing can be met.				
Required **feedstock** storage is reasonable, manageable and acceptable.				
A favorable and acceptable **energy balance** is likely.				
A favorable and acceptable **carbon balance** is likely.				
Farm net income will benefit.				
Water quality will be affected favorably.				
Soil erosion will be affected favorably.				
Soil carbon sequestration will be affected favorably.				
Wildlife habitat will be affected favorably.				
Rural development will be affected favorably.				

when they had questions. And, unlike the scientist workshop, the farmers asked the lead researcher technical questions to which he offered succinct responses.[17] Each workshop was digitally recorded and later transcribed. The transcripts of these workshops comprise the data for the rhetorical and discursive analysis of this chapter.

Qualitative Analysis of the Matrix Transcripts

This chapter is motivated by our concern for what was left unrepresented within statistical and thematic analysis about celluslosic ethanol policy from an earlier publication of this research,[18] which involved interpreting the differences between the farmers' judgments and those of the scientists represented by the matrix.[19] While the statistical analysis in that earlier publication helped identify significant differences in how the farmers and scientists evaluated the sustainability of elements of the matrix, and the thematic analysis helped explain how the farmers and the scientists understood the problems involved in cellulosic biofuel production, we were not able to fully explain why they disagreed or how we might negotiate those differences without qualitative research. This chapter builds on the Iowa team's (Herndl, Polush, Cruse, Shelley) earlier belief that these different communities of practice had different ways of conceptualizing and talking about farming and sustainability that were as significant as the statistical differences. If these differences make public participation problematic, then the rhetorical analysis of workshops such as these becomes a valuable tool for the project of fostering citizen participation in science and technology development and decision making. An analysis of these ways of talking can help us understand the sources of these differences and might suggest ways to address them.

The workshop transcripts with farmers consist of 180 pages from sixteen hours of conversation. The scientists' workshop transcripts include 106 pages, representing seven hours of conversation. The analysis of these transcripts here is an extension of earlier work developed by the Iowa team. After the workshop with scientists and the first workshop with farmers, the Iowa team noticed that the two groups evaluated the criteria on the matrix differently. This was subsequently confirmed by the statistical analysis of the data. They also began to notice, however, that the two groups talked about farming, sustainability, and the different elements of cellulosic biofuel processing in very different ways. Following Barney G. Glaser and Anselm L. Strauss's concept of grounded theory, the research team compared its assumption that the farmers' expertise and knowledge could contribute to policy deliberations with the data emerging through the conversation.[20] How does one integrate the knowledge of the two groups when they are conceptualized and expressed in such different ways?

Aware of the different patterns of talk after the first two workshops, the Iowa research team was again struck during the final farmers' workshop by how differently the farmers conducted their discussions. Immediately following this final workshop, the Iowa team articulated a series of differences between the ways the farmers and the scientists talked about cellulosic biofuels, farming, and sustainability. For example, members of the Iowa research team pointed out that the scientists talked in abstract and hypothetical terms whereas the farmers told narratives about particular experiences on their farms. Scientists talked about farming systems as a collection of variables, but farmers talked about farms where they lived and worked. The lead author recorded this informal analysis and the contrasts in the participants' talk in his field notes, which provides the basis for the coding and analysis here.

Two of the authors read the complete set of transcripts using the list of contrasts the Iowa team saw between the ways the farmers and scientists talked as an interpretive frame. After agreeing on a common set of codes, the two readers coded a significant section of the transcripts independently. Where they coded differently, they discussed the differences and refined their coding process. When the two readers learned to apply the codes consistently, one reader coded the whole set of transcripts using the common coding scheme.[21] The coding included the following contrasting themes which are salient to the current discussion: (1) general versus specific, (2) abstract versus concrete, (3) global versus local, (4) formal versus personal, and (5) active versus passive.

Questions of Definition and Differentiation

The scientists' conversation is characterized by a shared insistence on technical accuracy, rules, order, precise definitions, and methodological clarity. They demanded *specificity* and precision. In addition to defining what counts as fuel, for example, scientists discussed the definition of the distributed versus centralized industry configurations that structure the columns on the matrix; they distinguished the term processing as referring both to "partially energy densified" and "processed completely"; and they questioned "what we mean by a biorefinery." One scientist even asked for a distinction between the distributed processes for single species of feedstock such as corn stover and multiple species of feedstock: "I got a question more related to the distinction between distributed and centralized," one scientist asks. "I was wondering where do we draw the line on this thing. Are we talking about distributed as soon as we get to a radius of 20 miles or less?" The scientists thus began their discussion by meticulously delineating the objects under consideration. They often broke concepts down into their component parts, so that a discussion of "climate change" became a discussion of "adaptation" and of "mitigation." Finally, the accuracy of terms was strictly adhered to and self-enforced by the group.

The scientists' concern for clear definitions of terms is echoed in their great care and precision when discussing data, figures, and measurements. If a figure had to be discussed that was not known with certainty, the scientists struggled with the imprecision. This can be seen in a discussion about distribution related to the cost of a bale of corn stover: "I realize that this is not very precise, but the definition of 'distributed' is going to depend on cost per bale, and a distributed system is going to function [differently] if you are paying $35.00 as opposed to $65.00. So if you can live with imprecision we are going to have to ask you to do that" (Scientist Speaker). The farmers' conversations, by contrast, were carried out in *general*, rather than strictly defined, terms, and tended to focus on the issues rather than definitions. For example, the farmers did not discuss the distinction between centralized and distributed systems, nor did they discuss the intricacies of the terms carbon balance and carbon sequestration. They used these terms in their discussion, but the definitions were assumed to be understood by the group and were not explicitly expressed. They made general assertions like "it's a moving target figuring out what the gain versus loss is," and "the soil loss in Iowa has to go up again." They used imprecise figures like "thirty-some dollars" or "x dollars." Unlike the scientists, the farmers were comfortable with vague and nondefinitional terminology. For example, one farmer said, "I think it's going to come to the point where government or policy makers, the EPA, whoever, is just going to look at that producer and say, 'You know what? You're above *this* level and, and *here* you're fine,' and I think that's where the road will end up going down to [in] my honest opinion"—where the terms "this" and "here" refer to imaginary unknown figures.

System Analysis and Concrete Issues as Systems

When the farmers talked about a farm, they talked about the crops, the feed, tilling, harvesting, selling, taking care of the land, and they thought of these activities in relation to themselves. The scientists, however, discussed these same issues differently. They discussed a farm, for example, as a system for which they "have to create the parameters for decision metrics." Perhaps not surprising from a group that speaks precisely, the scientists often discussed concrete issues in terms of *components* that can be arranged in a variety of ways. For example, the scientists saw decisions related to biofuels as determinable by sets of parameters and metrics regarding the farm "system" and the different ways that the system can be arranged.

This distinction between a "farm" and a "system," two terms used to refer to the same thing, illustrates the powerful change in thinking that corresponds to changes in terminology. In sustainability science, systems analysis or life cycle analysis takes a whole network extended in time and space as its object of analysis. A single farm considered in isolation obscures the system-level analysis sought by sustainability science. For the farmers, however, farm is a tangible place where you stand on the grass, sit on the ground, and dig your hands into the soil. It has a material and affective reality that can be seen, felt, and loved. A system, however, is a not a place—it is an abstract thing to be analyzed. You can't visit a system; you can only talk about it.

Talking Globally, Locally, and Using Analogies

Perhaps because the scientists talked about "systems" not "farms," they tended to talk about issues on a larger scale than the farmers, and applied outside knowledge to a localized situation. This can be broadly characterized as a "global versus local" way of speaking and thinking. For example, when discussing bio-fuels in Iowa, the scientists discussed situations, materials, and practices all over the world. One scientist described, "a guy from [the] Peace Corps in Canada [who] developed a process where you actually put urea into the bio-oil and made a super fertilizer." They described practices conducted in various places like Oregon, Wisconsin, Illinois, Minnesota, Louisiana, Australia, and Africa, as well as possibilities garnered from Monsanto and the *Journal of Agronomy*. When discussing the densification of fuels and the issue of economies of scale, they even compared biofuel processing to the production of iPods.

Where scientists discussed production with abstract principles garnered from many, often distant, cases, farmers discussed practices they have used personally or seen used in nearby farms. For example, the farmers made statements like "One of the things that we do where I'm at from Michigan . . . ," "I guess one of the things that we see in southwest Iowa is . . . ," and "I see it every single day at my job." Another farmer talked about transportation from his own perspective, saying, "Being from Boone, we'll have to put in four or five rails to transport this stuff all over." This personal, experiential evidence framed how farmers saw larger processes. Farmers tended to use anecdotal evidence and local analogies to discuss local circumstances, whereas scientists applied a wide range of data from the global to the local more readily.

The Abstract, the Concrete, and the Emotional

Scientists' talk of systems and global perspectives led them to talk in abstractions and in analytic, unemotional ways. Farmers, by contrast, talked about specific, concrete things and often about the affective values associated with issues. For example, a driver and his time, driving distance, and truckload are all components that can be described by the single term "transportation." This term can then be applied to a number of scales—it can be scaled outward to apply to a broader system, or inward for a focus on the smaller, but still collapsed, system components—as one scientist speaker broke it down, "From the transportation side we are looking at both two things. One is the cost issue and there is also the labor issue." Here, "the cost issue" and "the labor issue" are abstractions; they were framed as problems to be resolved. Speaking and thinking in this way caused the scientists to talk of actions as what should "be done," a passive way of speaking, rather than the more active "what a person does." The groups' different ways of talking about "issues" also suggest different ways of thinking and being in the world. The scientists used collapsed terms like "labor" and "logistics" to characterize actions and processes that the farmers, in contrast, spent time discussing in detail. Where a scientist talked about land use using phrasings like "the logistics of the field," farmers named those logistics, using phrasings like "I don't know how they can get a plow that close to a fence." Similarly, the farmers described the "distance issue" of transportation, more concretely, as "a lot of trips with a truck."

The difference between scientists' and farmers' talk showed a significant affective distinction. The "cost" of system components as opposed to the "cash" required for farmers to operate is a clear example. For the scientists, money was *a variable* in an equation where, for example, the costs of fuel production were considered in hypothetical scenarios to solve mathematical problems. Such talk lacked a personal valuation. In contrast, farmers tended to talk about money in terms of figures and in emotional terms, saying things like "I can't imagine the cost." Money, to the farmers, was more than a figure—it was a mortgage payment; it was a livelihood. They used words like "outrageous" and "ridiculous," whereas the scientists rarely utilized emotional diction. Farmers tended to talk about biofuel costs with statements like "The ideal would be to make a high-value product from what we're growing and the organic residue that comes from that enriches the soil as well of our wallets." Farmers asked questions like "If all this corn is going towards exports and for fuel, what's it going to do to your grocery bill?"

Talking about Uncertainty: What May Happen vs. What Will Happen

Both groups talked about the future of the cellulosic biofuel industry a great deal. But their ways of talking were quite distinct, with scientists talking about what *may* happen and farmers talking about what *will* happen. Scientists looked at potential futures, at what may happen under given conditions (variables). Farmers were more interested in knowing "What is going to happen?"

The different ways of framing the future can be seen through the contexts in which both groups use the word "happen." The farmers never used the phrase "may happen," and the scientists never used the phrase "will happen." The farmers discussed "happenings" *here,* not there. The farmers wanted to know what will happen, what was happening, and how this affected them in their location. Unlike the scientists, the farmers positioned these issues personally, in terms of themselves. The scientists, for example, never said things like "What happens if I . . ."

The farmers did not discuss possible outcomes objectively, as neutral potential scenarios under discussion. Instead, they discussed them personally and emotionally in terms of their *hopes* about what may happen. One participant mused, "they're doing some research with double cropping, which is, I think, far-fetched in Iowa, I do really think, but it sounds like it actually could happen." The farmers also used this "may/could happen" construction to characterize their *fears* about what could happen. Uncertainty for the farmers was emotionally charged and unmeasurable; for them, uncertainty tended to be a "yes" or a "no," either black or white, not shades of gray, "Is it going to matter then?" (or not?)

The scientists, however, discussed levels of uncertainty more comfortably. They discussed uncertainty as a means to an end. For example, when discussing whether farmers will cooperate with corn-cob biofuel production (a subject of uncertainty), the scientists broke down the uncertainty into parts, analyzed each part, and moved on. They first discussed the issue in the context of "current policies." Then they discussed a scenario in which policy change gives the farmers the incentive to "move away from corn based ethanol," which removes the factor of "willingness," a main source of uncertainty, from the analysis and allowed them to continue the discussion. Next, they considered the uncertainties of plant availability and petroleum alternatives. This approach allowed the scientists to effectively work through the issues of uncertainty and incorporate them into their discussion.

What Can Computerized Data Analysis Contribute?

While traditional qualitative analysis, like that provided above, provides rich understanding of discursive activity, the time-consuming coding methods limit researchers to relatively small data sets. Like Graham et al. and Karen Gulbrandsen, we think that computer-based data analysis can open up new sites, data, and audiences for rhetorical analysis. Our work in this section is exploratory and comparative, and asks two questions: What can semantic network analysis (SNA), a technique often used to analyze large sets of data, tell us about our data? And how do these findings relate to or enhance the traditional analysis we have offered above?

For rhetoricians, the applications of SNA are multiple: SNA can recover subtle structures within a text; visualize and read *inter*textually; enhance distant reading and writing of volumes of texts; quickly summarize, profile, or diagram texts for comparison; and profile a text's tenor, tone, or sentiment. Other studies have used SNA methods to classify the similarity of documents; improve text indexing and retrieval to analyze changes in topics over time; and to predict citations.[22] We are particularly interested in whether network analysis methods validate, enhance, or contradict qualitative research developed entirely by humans.

In semantic and social network analysis, nodes in the network represent words or actors and the links between them represent some kind of relationship. Social network analysis such as Nicholas A. Christakis and James H. Fowler's can tell us much about how humans interact, how communities form or dissolve, and how information and opinion diffuses across time and space.[23] Similarly, SNA graphs the relationships between *words* instead of actors. Semantic networks tell us not just what a text says, but also how texts and individual units within a text are related and what their relative importance within a system of words and ideas might be. For example, we

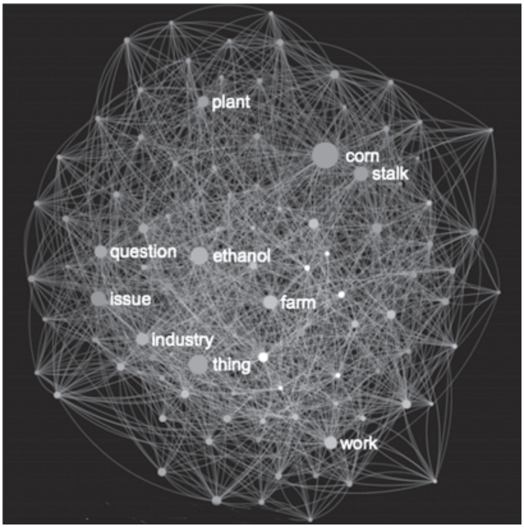


Fig. 3.3. Network graph using Textexture to visualize transcripts of the farmers' group 2 discourse.

can see that the word "system" is central to the scientists' discourse but not to the farmers' discourse (figures 3.1–3.4). In addition to tracking the occurrence of individual terms like "system," SNA can identify clusters of singular or grouped concepts that form a context, and contexts can be qualitatively themed or described.

For example, the term "system" is a concept central to the discourse because of the size of the node and the number of other concepts to which it is connected (figure 3.4). Though it is difficult to see without drilling into the network, "system" is connected to many other concepts. This means that the term "system" also serves as a junction of meaning; it is a term around which other terms are clustered, forming a context or community or theme that is qualitatively significant. A "context" is a subnetwork within the larger semantic network. Contextual clusters point to the "semantic path," the associated words and concepts through which a specific term like "system" achieves its explanatory power.

Though the tools used to analyze volumes of unstructured text offer affordances that traditional methods lack, SNA does not follow one straightforward sequence of rules. There are many ways to visualize a network, each telling a slightly different story, and most of the foundational and current research in semantic network analysis suggests such work requires a subject matter expert, someone who can interpret, identify, and validate patterns of significance within the network.[24] This is analogous to the strategy

Table 3.1. Comparing parts of speech used by farmers versus scientists

	Adjectives	Adverbs	Nouns	Verbs
Farmers 1	11,048	8,687	31,052	20,251
Farmers 2	8,297	6,507	22,802	14,865
Scientists	9,002	6,648	23,948	14,950

of member checking in traditional qualitative analysis. In our case, the lead author filled this role, having worked with this research project and the participants for many years.

At a more technical level, the use of tools like Textexture in SNA is relatively straightforward. Each transcript file was combined to represent the complete account of the discourse from each workshop. These text files were then loaded into Textexture, where "stop words," insignificant words like "a" or "uh," were removed automatically. The remaining words were encoded as nodes and each node's co-occurrence value was calculated. Every word in the corpus is a node. Co-occurrence values represent the number of times terms appear as a pair in a text, and is significant because it suggests that a specific concept or idiomatic expression only makes sense when the two words appear together. For example, the word "explanation" may appear in a text by itself, but when it co-occurs with "unnecessary," it becomes a significantly different concept. We then used AutoMap, a text analysis product that extracts information, like parts of speech. For corpus statistics and categorization dictionaries, we used WordStat. Finally, we used Textexture, a nonlinear distant reading and text network visualization tool developed by Nodus Labs to quickly "read" and visualize the interview transcripts as networks of words and concepts, using these tools to check our findings and interpretations against each other and see what the differences and similarities are.

The complexities of SNA and the software used to do the computations present rhetorical analysis with two major challenges: how to define and identify the objects of analysis and how to interpret the visualizations that result. The first challenge is illustrated by the SNA analysis of the distinction between abstract and concrete terms in the farmers' and scientists' workshops. The second challenge is illustrated by the key terms or "nodes" in the respective workshops.

Defining Objects for Analysis: The Abstract, the Concrete, and the Emotional

One way to check whether scientists were more abstract in their discussions and farmers more concrete is to track the use of abstract and concrete nouns across texts. To do this, we used AutoMap to generate a *parts-of-speech* file, which extracts each word and identifies it with the appropriate linguistic tag—noun, verb, adjective, and so on. The parts of speech were then sorted in Excel and exported into WordStat's categorization dictionary against which each of the discourses were then compared. If adjectives are considered "emotional" because they are descriptive, then indeed the farmers' discourse is more emotional than the scientists' but these categorization dictionaries are crude, and to truly support the observation that the farmers' discourse is more *emotional* further disambiguation of terms is required. The same is true to determine and compare concrete and abstract nouns.

Another way of mapping the differences and similarities in the ways that farmers and scientists talk about issues is to drill down into one specific concept, like "farm," and investigate and compare the words that co-occur. Though the single lexical item "farm" occurs sixty-two times in both the farmers' and scientists' discourse (an unusual coincidence) the word is co-located with the word "income" ten times in the scientists' discourse creating the phrase "farm income" but only four times in the farmers' discourse.

Comparatively, the article or pronoun is often co-located to the term "farm" in the farmers' discourse (e.g., "*his* farm" or "*the* farm") suggesting for the farmers "the farm" as a concept is personal; it is a system, but one meant to support *people*. Drilling deeper into the text to look at related words like "farmer" and its plural "farmers" finds the terms occurring ninety-seven times in the farmer discourse, and fifty-four times in the scientist discourse, suggesting that in-group identification is stronger among the farmers. Conversely, the term "science" or "scientist" occurs only ten times in the scientist discourse, and never occurs in the farmer discourse.

The challenge of interpreting the visualizations produced by the analysis is illustrated by the figures below that display the semantic "nodes" in the two discursive networks, indicating the centrality of specific concepts. In these network representations, the size of the node denotes its relative importance in the network and within its cluster or "community" of contextual terms. Nodes are not linked because they are next to each other in a sentence, but because they are central to a "window" of context-dependent words. This "node-edge" structure is encoded and visually represented as a graph using the open source network visualization tool, Gephi.

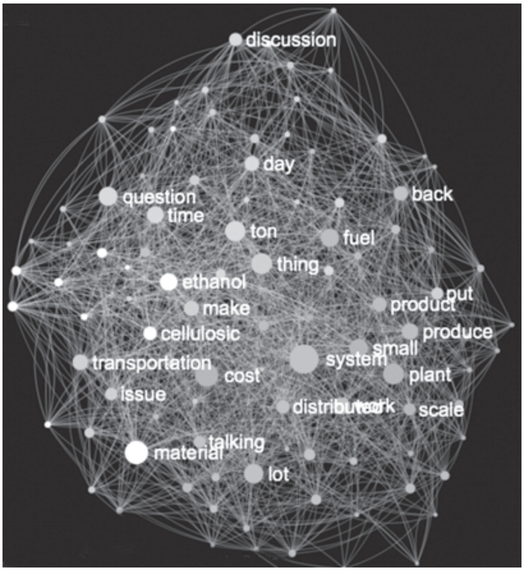
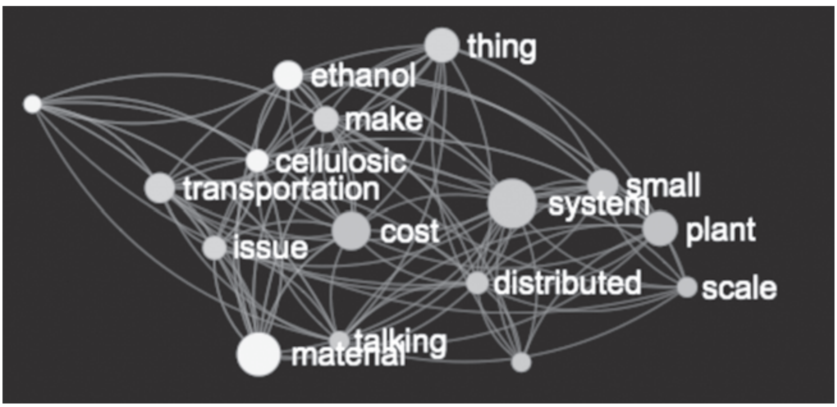


Fig. 3.4. Network graph using Textexture to visualize transcripts of the scientists' discourse.

Fig. 3.5. Key contexts, scientists.



The larger the node, the more times the word appears in the text, making it more important or salient. Colors (not reproduced here) denote a cluster or context of topics that are related to one another, so if we drilled into green nodes and links, for example, we would find that the concepts "specie" and "corn" and "talking" were closing related, likely operating in sentences spoken multiple times by multiple speakers. The size of the nodes in the network graphs depends on the network calculation called "betweenness centrality," a standard network measure that accounts for how often the shortest path between two randomly chosen nodes appears in a network.[25] In SNA, betweenness centrality is an important measure because

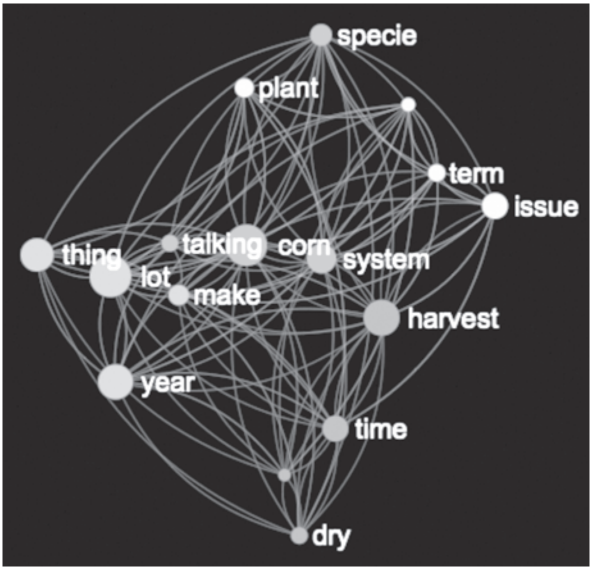


Fig. 3.6. Key contexts, farmers' group 1.

words that measure high on this scale often appear at the *junctures of meaning* such as the term "system" above (figure 3.4). A "juncture of meaning" is an area of the graph that visualizes a significant relationship, an exigency. In other words, the nodes at a juncture of meaning are not just frequent, but influential. Nodes can have high betweenness centrality within *clusters* of concepts, too, making them influential terms within a specific context or subsystem of ideas. For example, the term "system" is the central term in the scientist discourse, but it is also key within a context or community structure of terms, forming a contextual cluster. Both the central term and the contextual cluster structure the circulation of meaning in the transcripts. In other words, when the scientist transcripts are read, the word "system" will play an important role in establishing meaning for the text, as well as its interpretation.

In figure 3.4 (above), which represents the scientists' discourse, "system" has the highest betweenness centrality, confirming the qualitative assessment that scientists talked about systems. Furthermore, within the scientists' discussion of farm-as-system, there are concepts unique to their discourse: *distributed, centralized, processing*. Figure 3.5 is a "drilled into" context that offers a closer look at what terms are connected to one another in the scientific discourse. Here, the term "system" is important (as denoted by its size) and is connected to (which means it frequently co-occurred with) "distributed" and "talking."

Table 3.2. Variation in paragraphs, sentences, and words used by farmers versus scientists

	Paragraphs	Sentences	Words
Farmers 1	872	2137	44,834
Farmers 2	958	1826	34,269
Scientists	588	1622	35,450

Though farmers also talked about farms as a system, the term "system" did not have as high a betweenness centrality measure in the farmers' dialogue. Thus, "system" was not a concept that organized meaning in their discussions. Instead, as figure 3.6 shows, "word/node" "corn" had a high betweenness centrality, suggesting that farmers' meanings were organized by the crop, the *thing that composes the system*, which is more important than the system itself. The contrast between these two visualizations supports the qualitative finding that scientists often described the farm as a system and that system was distributed.

Corpus Statistics and Politeness

It is difficult to generalize these findings because there are so many variables at work here and because this experiment was not initially set up with SNA in mind. That said, one of the first observations to make about the corpus is variation in size. In statistical terms, there is significant variation in the number of paragraphs and words spoken per paragraph, which generally corresponds to turn taking. The numbers suggest that though fewer scientists talked, they spoke about ten to fifteen words *more* than farmers did. Another interesting observation involves the number of words *excluded*. One might think because farmers are more conversational and use lay terms, they would use more extraneous words, like "um," but the words excluded, those that made the "stop lists," including the word "um," were about the same with one significant difference. The word "yeah" dominates the farmers' discourse, appearing seventy times in the second farmer workshop and ninety times in the first; however, in the scientist discourse, it appears only forty times. This quantitative finding supports the qualitative

Table 3.2 *continued*

Words excluded	Words per sentence	Words per paragraph	Nodes	Edges
31,716	21.0	51.4	100	1641
24,290	18.8	35.8	100	1448
23,608	21.9	60.3	100	1526

observation that farmers are somewhat deferential to one another. They were polite and affirming of each other's ideas and thoughts and experiences. This affirmation of lived experience was integral to creating the ethos that guided the farmers' discourse, an ethos that was reflected in the scientists' discourse in the use of specific terms and definitions.

Questions of Definition, Differentiation

One final comparison of SNA and the traditional qualitative analysis concerns the finding that questions of definition and differentiation were central to the scientists' discussion. Particularly noteworthy is the scientists' concern with defining terms like "distributed" in at least three different points of the conversation, whereas the term "define" or "definition" doesn't appear in the farmers' discourse at all. This impulse toward precision and specificity is demonstrated with the use of other terms, too, like "economies of scale," a term that occurs on nine separate occasions in the scientists' discussion, but does not appear in the farmers' discourse.

The scientists not only used this economic jargon, but also indicated that the theme of economics was important to them, as signified by the volume of time spent talking about it. An economic term occurs thirty-seven times in the science discourse versus twenty-two times in the farmer discourse, which is a significant ratio considering the farmer transcripts are significantly longer. The scientists' discourse leans to the particular in other ways. The term "soil carbon," for example, appears fourteen times in the scientist discourse, but only three times in the farmer discourse, and the tri-gram (a phrase composed of three words but counted as one term) occurs eleven times in the science discourse and never in the farmer discourse (figures 3.7, 3.8).

Understanding These Different Ways of Talking

As both the qualitative analysis and SNA above demonstrate, the scientists and farmers in the workshops talked very differently. To generalize, scientists strove for precise definitions, talking in abstract, global terms about systems and their components as variables in possible scenarios to analyze. For the farmers, the future was a personal and affectively charged challenge rather than a site of manipulation. The farmers lived on their land. It was their family past, their social identity, and the source of their future wellbeing. The scientists were not tied to specific pieces of land and their future. The scientists' knowledge could be scaled up or down and was transferable to other sites. The farmers' knowledge was neither scalable nor transferable. It was embedded in a specific piece of land and an affectively charged lifeworld.

The very different material relationships the scientists and farmers have to the object of their analysis shapes both that object itself, the system or the farm, and the language through which the two groups construct that object. Using Pierre Bourdieu's work on objective social science, Henri Lefebvre's work on the construction of space, Thomas Gieryn's work on place, and Graham's "praxiography of representation," we argue that the scientists' language emerges from practices that enact a farm as an abstract space while the farmers' language emerges from practices that enact a farm as a lively place of practical activity.[26]

Bourdieu offers a critique of objective social science that suggests a practical and material explanation of the differences we see in the discourse of the workshops. For Bourdieu, the social scientist is an observer, distanced from the practice he observes because he is "excluded from the real play of social activities by the fact that he has no place (except by choice or by way of a game) in the system observed and has no need to make a place for himself there."[27] Because social scientists do not experience practical activities directly, they reduce them to an objective set of rules that captures the tacit knowledge of the native's lived experience. The scientists in our workshops were distanced from the farmers' lived experience not only as disciplinary language speakers but also as observers, positioned outside the lifeworld of the farm.

Rather than the social scientists' set of rules, the scientists in our workshops created abstract systems composed of components and variables. They talked about scenarios and models, speculating about future scenarios

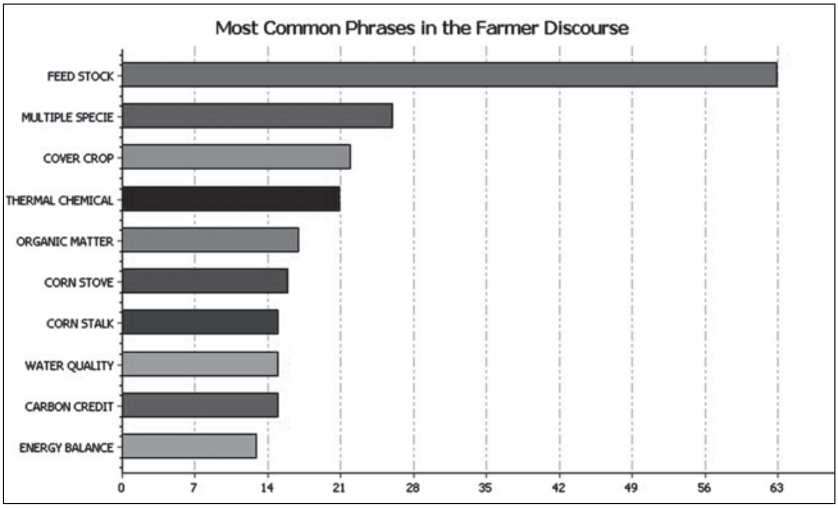


Fig. 3.7. Common phrases from farmer discourse.

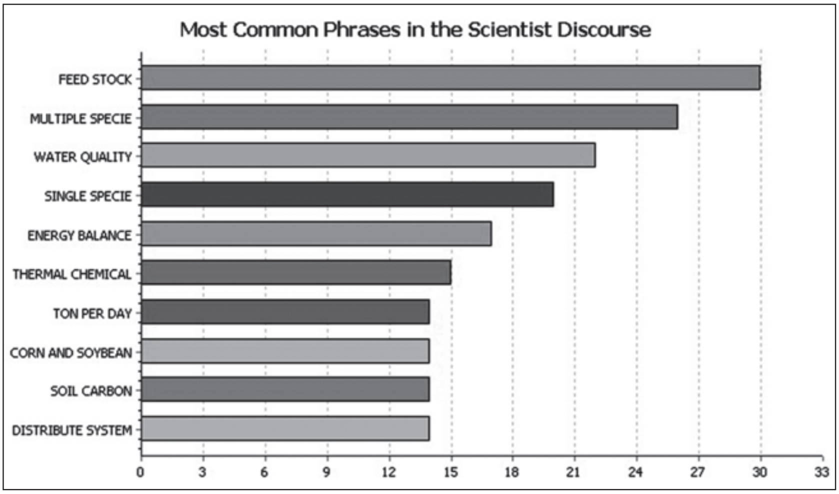


Fig. 3.8. Common phrases from scientist discourse.

for the biofuel industry and the farms that provided the feedstock. These models could be populated with different inputs and produce different outcomes, some more sustainable than others. The farmers, by contrast, rarely talked about scenarios, hypothetical situations, or alternative data sets. They spoke about concrete situations rather than abstractions. They talked about the past on their specific farms and about present conditions. The future was something to be prepared for and concerned about, but not the object of play and manipulation through the efficacy of models. As Bourdieu suggests, one experience is structured by "axes of the fields of potentialities" while the other is structured by a system "linked unalterably to our [the farmers'] bodies."[28]

The difference between the abstract space of the scientists and the practical space of the farmers is a product of what Lefebvre calls the production of space. In tracing the concept of space, Lefebvre argues that the philosophical and scientific tradition has side-stepped the way it "bridges the gap between the theoretical (epistemological) realm and the practical one, between mental and social, between the space of philosophers and the space of people who deal with material things."[29] This gap between the theoretical and practical realms captures the distinction between the scientists' and farmers' relationship to the system/farm traced in the qualitative analysis above. This gap and the different languages it separates is a fundamental challenge facing attempts to integrate the expertise of credentialed and noncredentialed experts, the knowledge of scientists and farmers.

Lefebvre's conception of how space is produced allows us to understand the gap between mental and practical space and the rhetorical differences it both produces and is produced by. Lefebvre identifies three types of social space, all operative in our case: spatial practice or space as "perceived"; representations of space or space as "conceived"; and representational space or space as "lived." Each of these spaces is produced through a distinct social activity, characterized by a particular relationship of the subject to the surroundings, and each is constituted in and expressed by a distinct code or language practice.[30]

The practical activity of scientists as analytic observers and the farmers as affectively engaged producers create two different kinds of space. Representations of space are the space of science, architecture, and engineering. They identify what is lived and perceived with what is abstractly conceived as the object of knowledge. This is the dominant space in society and tends to be associated with a highly regulated system of verbal or written signs. For the scientists with whom we worked, language is highly paradigmatic and metaphorical, moving from model to model, scenario to scenario, where an abstract model is identified with the whole. Representational space, by contrast, is lived by the inhabitants of space and full of symbolic and affective meaning. It is alive. Representational space is qualitative, fluid, dynamic, felt, often inconsistent and incoherent, and highly localized.

For the farmers, the language is strongly metonymic, fluid, and associative among often affectively charged statements and ideas.

Lefebvre's third type of space, spatial practices, captures the patterned ways we move in and through space. These are repetitive and typically unconscious movements that tend to follow established routes and routines. We perceive or make space through our familiar movements within it. Spatial practices are dialectic because our physical movements through space both follow existing pathways and establish new pathways and patterns. Spatial practices involve the body's capacity to do things.[31] We perceive our bodies by using them to do things. In our case, spatial practices emerge when a farmer talked about practical activities rather than "logistics," such as "I don't know how they can get a plow that close to a fence." Where the scientist calculated the economic cost of transportation, the farmer took a lot of trips in a truck. Representations of the body, by contrast, emerge from the accumulated sciences of anatomy and medical physiology that define the body as an external and, following Foucault, transparent object of the knowing gaze. In our case, the representation of space emerges when scientists debated about the precise distinction between centralized and distributed processing systems or when they broke the question of transportation into "the cost issue and the labor issue." Where the scientist calculated the economic cost of transportation, the farmer took many trips in a truck.

We can generalize these different ways of constructing space in our case study by suggesting that the scientists analyze a space while the farmers occupy a place. The sociological literature on place distinguishes the abstract space of science from the lived, affective, and meaningful place of the people who live in a space. Gieryn puts it succinctly: "First, place is not space-which is more properly conceived as abstract geometries (distance, direction, size, shape, volume) detached from material form and cultural interpretation (Hillier & Hanson 1984). . . . Put positively, place is space filled up by people, practices, objects, and representations."[32] Gieryn distinguishes place and space by suggesting that a census tract, so useful in sociological study, is merely a "bundle of analytic variables" used to distinguish neighborhoods.[33] It does not tell you how the residents of the neighborhood understand themselves as inhabitants, what their neighborhood means to them, or how they use space or feel as they move through it. To summarize, the distance between the scientists and their object allows them to constitute a representation of the space of agriculture while the farmers' immersion in the activity allows them to constitute what Lefebvre calls a representational space and Gieryn understands as place.

Lefebvre argues that there are distinct discourses with unique terms associated with the ways groups occupy and produce space.[34] "Codes" or ways of speaking about space are dialectical; different kinds of space embody the different relationships between subjects and their surroundings, and these in turn are expressed in very different languages. The practical activity of observing and analyzing, distant from the lifeworld, produces a *representation of space* with its characteristic way of talking: fine distinctions; refined definitions; talk of variables, scenarios, and systems. Similarly, the practical activity of farming immerses the subject in the lifeworld and produces a *representational space* with its way of talking and thinking. Emotional language, synecdotal associations, personal anecdotes, and opinion constitute the farm as a place. Talking about spaces and talking about places are two distinct activities.

Lefebvre pinpoints the question of how to integrate these two spaces and the different knowledge of scientists and farmers, credentialed and noncredentialed experts. Lefebvre's driving question concerns the relations between and potential intercourse among these three spaces: "The question is what intervenes, what occupies the interstices between representations of space and representational spaces."[35] Put more directly and pragmatically, Lefebvre questions what intervenes between the representational practices of science and of farming.

A Tale of Two Farms

To return to the motivating issue of citizen participation in science and technology policy, ours is not merely a question of integrating the knowledge of farmers and scientists expressed in two systematically different forms of language use. Ours is a tale of two farms. In discussions of expertise and knowledge, the expertise of credentialed and noncredentialed experts is typically seen as additive. We make better decisions when we combine the knowledge of both groups. This is the driving motive of Collins and Evans' theory of experience-based expertise as continuous with and potentially contributory to the expertise of credentialed scientists. It is also the hope of rapid technology assessments that include noncredentialed experts such as our farmers. But as Sheila Jasanoff, Ari Rip, and Brian Wynne argue, the expertise and knowledge of groups like the farmers and scientists in this case are not merely additive.[36] There is more at play than what Wynne refers to as "propositional" knowledge.[37] As Jasanoff maintains: "This [that farmers and radiation experts possessed different but complementary knowledge] is certainly a piece of Wynne's story, but more significant is that these discrepancies were rooted in different life worlds, entailing altogether different perceptions of uncertainty, predictability and control. The knowledges stemming from these divergent experiential contexts were not simply additive; they represented radically 'other' ways of understanding the world."[38] The representational space of a farm as an affectively rich place of identity and dwelling is not continuous with the representation of the space that makes a farm system a scalable model populated by data points and useful for scenario analysis. The prominence of the Farm-Aid movement and benefit concerts of the 1980s suggests that the space of a farming system and the place of the family farm are two different things.

Following the new materialist arguments of Mol, Latour, Pickering, and Graham, we suggest that Jasanoff's "radically 'other'" ways of understanding the world of space and place in our study emerge from the different ways scientists and farmers realize or enact different farms.[39] For example, Graham traces the way pain is made real in different ways by neurosurgeons and psychologists who not only talk differently but treat the patient differently. The warranting concept of these new materialist analyses is that different material practices ontologize or realize different things. For Graham, pain as the result of nerve damage in neurology is measured, diagnosed, and treated as a different thing than pain as the result of cognitive representation diagnosed, measured, and treated in psychology. We suggest that the material practices of studying a farm system—of gathering data points, calculating economic benefits, defining distributed and centralized systems—create a different entity than the farmers' daily actions on the farm, such as tilling the soil, driving a truck, and paying the mortgage. Where Lefebvre argues that representations of space and representational space had different codes, Graham insists that, "Practices stage modes of being that in turn encourage participants to talk about truth and knowledge in ways that are operationalized by the underlying ontology."[40]

Understanding this case as a tale of two farms captures the difference between space and place and explains why the representational practices are so different and such a challenge to integrate. It is almost literally a case of apples and oranges. Seeing these as two different entities, a system or representation of space as opposed to a farm as a representational space or a place, however offers practical benefits. The knowledge of the scientists and farmers is not in competition; they are not competing or even complementary propositions about the same thing. As such, there need not be an epistemic hierarchy between two forms of knowledge, one typically accepted as more authoritative than the other.[41] While this does not solve the problem of what to do after we get the right people to the table, it does explain the nature of the difference and suggest some practical ways forward.

In our earlier project, the Iowa team integrated the contributions of the scientists and farmers through what Graham calls "calibration by detour."[42] Graham adapts Mol's metaphor of calibration to describe how pain practitioners managed the differences among the different pains to improve patient care. Calibration does not resolve differences or determine which claims are correct, better or more authoritative. Calibration preserves and manages difference, integrating two different experiences, by detour, in medical care in pragmatic ways. In Graham's case, neuroimaging acts as a black box to calibrate subjective patient reports of pain with neurological diagnosis so that neither is dismissed. The two enactments of pain are integrated through the agency of a third party, the powerful black box of neuroimaging that legitimizes the subjective patient report through its own authority. In our case, the experience and knowledge of the scientists and farmers is calibrated through the black box of our matrix instrument and its assessment function. Our statistical analysis of the assessment results identified significant differences in the two assessments without privileging one over the other.

Moving Forward with Engaged Research

The question of how to include citizens in decision making about science, technology, and development does not have a single or simple answer. In our case, scientists and farmers enacted two different things, systems and farms, and talked about them using distinct representational practices. Our analysis does not tell us how to integrate a vernacular discourse of place with a professional discourse of space. It does, we think, clarify the rhetorical dimensions of the problem and open new ways of managing it. Graham concludes his analysis of pain and cross-ontological management of pain by describing various modes of calibration and authorizing resources that offer rhetorical and institutional strategies for accommodating different ways of enacting pain or farms and making productive use of both forms of experience. Together these strategies contribute to what Graham calls a "praxiography of representation": "a praxiography of representation focuses not so much on what people say or what texts mean, but rather on how representational activity circulates within and contributes to a deeper ecology of practices in which those acts of representation are embedded. Cross-ontological calibration is one form of representational practice that serves to navigate the boundaries among different ontologies."[43] Rhetoricians engaged with science-based projects might see their work as cross-ontological calibration, the practical understanding and management of different representational practices that intersect in a policy or decision-making space. A praxiography of representation helps rhetoricians navigate the boundaries and differences among practices and ontologies to improve deliberation, decision making, and policy formation. To answer Lefebvre's earlier question, the practice of calibration intervenes and so does the rhetorician as praxiographer.

Finally, many discussions of climate change, technology development, or policy happen in very local settings such as that of our case study. But the context that shapes a community's practices is also extended in space, time, and media. Farmers talked about a sense of place, but that place is itself embedded in a larger context and conversation. The way citizens in Iowa conceptualize climate change, interpret information, and make decisions is embedded in national and global discourses that are too large and distributed for fine-grained rhetorical analysis. As our exploratory work here suggests, big data analysis such as SNA can reproduce some of the results of traditional qualitative and rhetorical analysis. We found that SNA confirmed the qualitative finding, for example, that scientists talk about farms as systems where farmers talk about places. Besides confirming traditional findings, SNA can provide our qualitative results a quantitative element that carries considerable cultural capital. Unfortunately, there is no commonsensical or natural way to develop these analytic capacities. Rhetoricians who can do so, however, will have a powerful research tool that opens new data for analysis. SNA might be seen as a calibration by detour that authorizes more traditional forms of rhetorical analysis. Further, this research tool can warrant analytic claims in ways that will provide rhetoricians membership in large, externally funded interdisciplinary projects in ways that are very rare at the moment.

Notes

1. Harry M. Collins and Robert Evans, "The Third Wave of Science Studies: Studies of Expertise and Experience," *Social Studies of Science* 32, no. 2 (2002): 235–96; Bruno Latour, "Why Has Critique Run Out of Steam?" *Critical Inquiry* 30 (2004): 225–48; Latour, *The Politics of Nature: How to Bring the Sciences into Nature* (Cambridge: Harvard University Press, 2004); Latour, "An Attempt at a 'Compositionist Manifesto,'" *New Literary History* 41 (2010): 471–90; Herbert Simons, "The Rhetoric of Philosophical Incommensurability," in *Rhetoric and Incommensurability*, ed. Randy A. Harris, 238–68 (West Lafayette, IN: Parlor Press, 2005).

2. See Daniel Fiorino, "Citizen Participation and Environmental Risk: A Survey of Institutional Mechanisms," *Science, Technology and Human Values* 15, no. 2 (1990): 226–43; Frank Fischer, *Citizens Experts and the Environment: The Politics of Local Knowledge* (Durham, NC: Duke University Press, 2000); Julia Abelson et al., "Deliberations About Deliberative Methods: Issues in the Design and Evaluation of Public Participatory Processes," *Social Science & Medicine* 57 (2003): 239–51; Barbara Murdock, Carol Wiessner, and Ken Sexton, "Stakeholder Participation in Voluntary Environmental Agreements: Analysis of 10 Project XL Case Studies," *Science, Technology and Human Values* 30, no. 2 (2005): 223–50.

3. Latour, *Pandora's Hope: Essays on the Reality of Science Studies* (Cambridge: Harvard University Press, 1999), 218.

4. There is a long history of studies that categorize participatory mechanisms. See Dorothy Nelkin and Michael Pollak, "Public Participation in Technological Decisions: Reality or Grand Illusion?" *Technology Review* 81 (1979): 55–64; Peter M. Wiedemann and Susanne Femers, "Public-Participation in Waste Management Decision-Making: Analysis and Management of Conflicts," *Journal of Hazardous Materials* 33, no. 3 (1993): 355–68; Bretta Maloff, David Bilan, and Wifreda Thurston, "Enhancing Public Input into Decision Making: Development of the Calgary Regional Health Authority Public Participation Framework," *Family and Community Health* 23, no. 1 (2000): 66–78; Gene Rowe and Lynn. J. Frewer, "A Typology of Public Engagement Mechanisms," *Science Technology Human Values* 30, no. 2 (2005): 251–90. For studies that evaluate participatory mechanisms on procedural and outcomes-based criteria, see Deborah S. Carr and Kathleen Halvorsen, "An Evaluation of Three Democratic, Community-Based Approaches to Citizen Participation: Surveys, Conversations with Community Groups, and Community Dinners," *Society and Natural Resources* 14, no. 2 (2001): 107–26; Caron Chess and Kristen Purcell, "Public Participation and the Environment: Do We Know What Works?" *Environmental Science and Technology* 33, no. 16 (1999): 2685–92; Edna F. Einsiedel, Erling Jelsoe, and Thomas Breck, "Publics at the Technology Table: The Consensus Conference in Denmark, Canada, and Australia," *Public Understanding of Science* 10, no. 1 (2001): 83–98.

5. While there are not rhetorical analyses of talk in participatory mechanisms in the literature on science studies or policy management, some studies do recognize the importance of language in these mechanisms. See Matthew Harvey, "Drama, Talk and Emotion: Omitted Aspects of Public Participation," *Science, Technology & Human Values* 34, no. 2 (2009): 139–61; Robert Futrell, "Technical Adversarialism and Participatory Collaboration in the U.S. Chemical Weapons Disposal Program," *Science, Technology, & Human Values* 28, no. 4 (2003): 451–82; Gail Davies, "The Sacred and the Profane: Biotechnology, Rationality and Public Debate," *Environment and Planning* 38 (2006): 423–43.

6. Robert Danisch, *Pragmatism, Democracy, and the Necessity of Rhetoric* (Columbia: University of South Carolina Press, 2007); Stuart Blythe, Jeffrey Grabill, and Kirk Riley, "Action Research and Wicked Environmental Problems: Exploring Appropriate Roles for Researchers in Professional Communication," *Journal of Business and Technical Communication* 22, no. 3 (2008): 272–98; John Ackerman and David J. Coogan, eds., *The Pubic Work of Rhetoric: Citizen Scholars and Civic Engagement* (Columbia: University of South Carolina Press, 2010); Celeste Condit, "Rhetorical Engagements in the Scientist's Process of Remaking Race as Genetic," in *Public Work of Rhetoric*, 119–36; Carl Herndl and Lauren Cutlip, "How Can We Act: A Praxiographical Program for the Rhetoric of Technology, Science and Medicine," *POROI* 9, no. 1 (2013), http://ir.uiowa.edu/poroi/vol9/iss1/9/.

7. Scott Graham et al., "Statistical Genre Analysis: Toward Big Data Methodologies in Technical Communication," *Technical Communication Quarterly* 24, no. 1 (2015): 38.

8. Gerard A. Hauser, *Vernacular Voices: The Rhetoric of Publics and Public Spheres* (Columbia: University of South Carolina Press, 1999); Robert Danisch, "Political Rhetoric in a World Risk Society," *Rhetoric Society Quarterly* 40, no. 2 (2010): 172–92.

9. Two significant early uses of big data analyses in rhetorical research are Graham et al., "Statistical Genre Analysis"; and Karen Gulbrandsen, "Revising the Technical Communication Service Course," *Programmatic Perspectives* 4, no. 2 (2012): 243–54.

10. Adam Liska et al., "Biofuels from Crop Residue Can Reduce Soil Carbon and Increase CO2 Emissions," *Nature Climate Change* (May 2014), doi: 10.1038/nclimate2187; David Laborde and Siwa Msangi, "Biofuels, Environment, and Food: The Story Gets More Complicated," *2011 Global Food Policy Report (Washington, DC:* International Food Policy Research Institute), http://www.ifpri.org/node/8439.

11. Robert D. Perlack et al., "Biomass as a Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-ton Annual Supply," 2005, DOE/GO-102005–2135 ORNL/TM-2005/66, http://www.fs.fed.us/research/; Council for Agricultural Science and Technology (CAST), "Convergence of Agriculture and Energy: II. Producing Cellulosic Biomass for Biofuels" (Ames, IA: CAST Commentary QTA2007–2. CAST, 2007).

12. Brent D. Yacobucci and Randy Schnepf, "Ethanol and Biofuels: Agriculture, Infrastructure and Market Constraints Related to Expanded Production," *Congressional Research Service Report to Congress*, 2007, Order Code RL33928; Rick M. Cruse and Carl G. Herndl, "Balancing Corn Stover Harvest for Biofuels with Soil and Water Conservation," *Journal of Soil and Water Conservation* 64 (2009): 286–91.

13. The time scale difference between policy making and scientific research is a long-standing problem in the relationship between science and policy. For discussions of the problem, see, Shelia Jasanoff, "Contested Boundaries in Policy-Relevant Science," *Social Studies of Science* 17 (1987): 195–230; Bryan Norton, *Sustainability: A Philosophy of Adaptive Ecosystem Management* (Chicago: University of Chicago Press, 2005); Richard M. Cruse, Michael J. Cruse, and Don Reicosky, "Soil Quality Impacts of Residue Removal for Biofuel Feedstocks," in *Advances in Soil Science: Soil Quality and Biofuel Production*, ed. Rattan Lal and B. A. Stewart (New York: CRC Press, 2009), 45–62.

14. R. W. Howarth et al., "Rapid Assessment on Biofuels and Environment: Overview and Key Findings," in *Biofuels: Environmental Consequences and Interactions with Changing Land Use*, ed. R. W. Howarth and S. Bringezu, Proceedings of the Scientific Committee on Problems of the Environment (SCOPE) International Biofuels Project Rapid Assessment, 22–25 September 2008, Gummersbach Germany, Cornell University, Ithaca NY, 1–13, http://cip.cornell.edu/biofuels/; Government Accountability Office, "Expert Opinion on the Economics of Policy Options to Address Climate Change," *A Report to Congress Requesters*, 2008. GAO-08–605; Sherri Goodman, "National Security and the Threat of Climate Change," (Alexandria, VA: CAN Corporation, 2007); Tara G. Martin et al., "The Power of Expert Opinion in Ecological Models Using Bayesian Methods: Impact of Grazing on Birds," *Ecological Applications* 15, no.1 (2005) 266–80.

15. In the published report, only one farmer workshop is described. Because participants in the two farmer workshops were selected by different criteria, that report only included results from the first workshop. Those participants attended an earlier presentation of this project by the lead investigator. Since the current analysis concerns the rhetorical forms used by the participants and not their technical knowledge, the distinction between the two farmer groups is irrelevant here.

16. A detailed presentation of the research methodology, including the conduct of the workshops and the data analysis, is available in Rick Cruse et al., "An Assessment of Cellulosic Ethanol Industry Sustainability Based on Industry Configurations," *Journal of Soil and Water Conservation* 67, no. 2 (2012), 67–74.

17. The results of this project were published in the *Journal of Soil and Water Conservation* and in a technical report to the Aldo Leopold Center for sustainable agriculture, which partially funded the research.

18. The qualitative analysis in this section draws heavily from Lauren Cutlip, "Talking About Talk: The Problem of Communication as an Object of Study in

Public Participation Research" (master's thesis, University of South Florida, 2012). The transcripts of the Iowa workshops served as raw data for her analysis, and the lead author was the subject matter expert who provided explanations and interpretation of the salient features of that data.

19. Cruse et al., "An Assessment of Cellulosic Ethanol."

20. Glaser, Barney G., and Anselm L. Strauss, *The Discovery of Grounded Theory: Strategies for Qualitative Research* (New Brunswick, Canada: AldineTransaction, 2009).

21. A more thorough discussion of the coding and analysis appears in Cutlip, *Talking About Talk*, 2012.

22. David M. Blei and John D. Lafferty, "A correlated topic model of science," *The Annals of Applied Statistics* (2007): 17–35; *Jonathan* J. Chang and David M. Blei, "Hierarchical Relational Models for Document Networks," *The Annals of Applied Statistics* (2010): 124–50.

23. Nicholas A. Christakis and James H. Fowler, "The Spread of Obesity in a Large Social Network over 32 Years," *New England Journal of Medicine* 357, no. 4 (2007): 370–79.

24. Mark Granovetter, "The Strength of Weak Ties," *American Journal of Sociology* 78 (1973): 1360–80; Ronald S. Burt, *Brokerage and Closure: An Introduction to Social Capital* (Oxford: Oxford University Press, 2005); Kathleen M. Carley, "Coding Choices for Textual Analysis: A Comparison of Content Analysis and Map Analysis," *Social Methodology* 23 (1993): 75–126; Roel Popping, "Knowledge Graphs and Network Text Analysis," *Social Science Information* 42 (2003): 91–106; M-L. Ryan, "Diagramming Narrative," *Semiotica* 165, no. 1 (2007): 11–40.

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26. Pierre Bourdieu, *Outline of a Theory of Practice* (Cambridge: Cambridge University Press, 1977); Henri Lefebvre, *The Production of Space*, trans. Donald Nicholson-Smith (Oxford: Blackwell, 1991); Thomas Gieryn, "A Space for Place in Sociology," *Annual Review of Sociology* 26 (2000): 463–97; S. Scott Graham, *Politics of Pain Medicine: A Rhetorical-Ontological Inquiry* (Chicago: University of Chicago Press, 2015).

27. Bourdieu, *Outline of a Theory*, 1.

28. Ibid.

29. Lefebvre, *Production of Space*, 4.

30. Ibid., 38–46.

31. Ibid., 40.

32. Gieryn, "A Space for Place," 465.

33. Ibid., 466.

34. Lefebvre, *Production of Space*, 17.

35. Ibid., 43.

36. Responses to and by Collins and Evans appear in a special issue of *Social*

Studies of Science from 2003: Sheila Jassanoff, "Breaking the Wave of Science Studies: Comment on Harry M. Collins and Robert Evans, 'The Third Wave of Science Studies,'" *Social Studies of Science* 33, no. 3 (2003): 389–400; Ari Rip, "Constructing Expertise: The Third Wave of Science Studies?" *Social Studies of Science* 33, no. 3 (2003): 419–34; Brian Wynne, "Seasick on the Third Wave? Subverting the Hegemony of Propositionalism: Response to Collins and Evans (2002)," *Social Studies of Science* 33, no. 3 (2003): 401–17.

37. Wynne, "Seasick on the Third Wave,"402.

38. Jasanoff, "Breaking the Wave," 392.

39. Annemarie Mol, *The Body Multiple: Ontology in Medical Practice* (Durham, NC: Duke University Press, 2002); Bruno Latour, *Reassembling the Social: An Introduction to Actor Network Theory* (London: Oxford University Press, 2005); Andrew Pickering, *The Cybernetic Brain: Sketches of Another Future* (Chicago: University of Chicago Press, 2010); Graham, *Politics of Pain*.

40. Graham, *Politics of Pain*, 84.

41. Mol, *The Body Multiple*, 63; Graham, *Politics of Pain*, 120–21.

42. Graham, *Politics of Pain*, 117–44.

43. Ibid., 69.