

Society & Natural Resources

An International Journal


ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/usnr20


Exploring Trust Ecology in a Public-Private Partnership for Agricultural Innovation in the United States Bioeconomy

Dylan Rigsby & Wendy-Lin Bartels

To cite this article: Dylan Rigsby & Wendy-Lin Bartels (30 Oct 2024): Exploring Trust Ecology in a Public-Private Partnership for Agricultural Innovation in the United States Bioeconomy, Society & Natural Resources, DOI: [10.1080/08941920.2024.2420315](https://doi.org/10.1080/08941920.2024.2420315)

To link to this article: <https://doi.org/10.1080/08941920.2024.2420315>

 View supplementary material 

 Published online: 30 Oct 2024.


 Submit your article to this journal 

 View related articles 

 View Crossmark data 



Exploring Trust Ecology in a Public-Private Partnership for Agricultural Innovation in the United States Bioeconomy

Dylan Rigsby  and Wendy-Lin Bartels

School of Forest, Fisheries, and Geomatics Sciences, University of Florida, Gainesville, FL, USA

ABSTRACT

United States (US) federal agencies are endorsing public-private partnerships (PPPs) to link public institutions with industry to develop local supplies of biofuel and build a domestic bioeconomy. Although trust is a critical factor within effective PPPs, few studies have addressed the different types of trust needed to cultivate these partnerships. Employing a mixed-method design, we explore a PPP in the Southeast US through the lens of trust ecology. We describe how participants perceive trust types within different project spaces and how trust changed during the partnership. Our findings highlight the role that different interactive spaces can play in cultivating types of trust that accumulate in an additive fashion. We offer insights on process-design mechanisms and project management strategies that can bolster trust in PPPs.

ARTICLE HISTORY

Received 22 December 2023
Accepted 25 September 2024



KEYWORDS


bioeconomy; carinata; facilitation; process design; public-private partnerships; trust

Introduction

Public-private partnerships (PPPs) are endorsed by policymakers as governance arrangements for solving complex problems (Spielman, Hartwich, and Grebmer 2010; Eastwood, Klerkx, and Nettle 2017; Fanzo et al. 2021). Such partnerships are being implemented to address global challenges associated with anthropogenic climate change (George et al. 2021; IPCC 2023). Within the United States (US), federal agencies are promoting PPPs to decarbonize the aviation sector by securing a resilient domestic supply of renewable biofuel feedstock for sustainable aviation fuel (EERE (Office of Energy Efficiency and Renewable Energy) 2022). These actions are expected to reduce emissions and contribute to a burgeoning domestic bioeconomy. Valued at nearly a trillion US dollars (Frisvold et al. 2021), this emerging bioeconomy can boost economic development in rural areas (Bailey, Dyer, and Teeter 2011). However, the success of these policies hinges on strong partnerships among airlines, agribusiness, and public institutions.

Trust among partners is a key component of thriving PPPs (Klijn and Teisman 2000; Warsen et al. 2018; Markell et al. 2020). Likewise, mistrust has been identified as a major impediment (Fanzo et al. 2021). Mistrust and the lack of trust is described

CONTACT Dylan Rigsby  rigsbyd@ufl.edu  School of Forest, Fisheries, and Geomatics Sciences, University of Florida, Gainesville, FL, USA.

 Supplemental data for this article can be accessed online at <https://doi.org/10.1080/08941920.2024.2420315>.

© 2024 Taylor & Francis Group, LLC

as a conflict between the general interest of the public sector to develop public goods versus the self-interest of the private sector to develop value for their shareholders (Klijn and Teisman 2000). Because of this tension, PPPs are susceptible to opportunistic behaviors. Yet, PPP scholarship is deficient in frameworks for identifying and operationalizing trust. Boschetti et al. (2016, 857) call for empirical studies on trust that identify “key processes and core capacities” of these research programs to support global sustainability solutions.

For the past decade, the field of natural resource management (NRM) has explored trust in multi-institutional collaboratives. Specifically, Stern and Baird (2015) describe a framework with distinct trust types that interact to support collaboration. In this paper, we apply their trust ecology framework to a PPP in the Southeast US. We investigate the diversity of trust types and changes in trust over time as perceived by project participants. We also explore how the different types of trust shape collaboration within the project. Our study demonstrates that by adopting a multi-dimensional trust lens, PPPs can more effectively operationalize trust and better understand its role in advancing the US bioeconomy.

Theoretical Background

Trust

Trust is defined as “an underlying psychological condition” that precedes behavior and is informed by experiences and choices (Rousseau et al. 1998, 395). Furthermore, this state is informed by the positive expectations and experiences of a trustor toward a trustee (Stern and Coleman 2015). Specifically, we draw from Stern and Coleman (2015) framework of trust diversity where trust is delineated into four distinct types:

- **Rational trust** is based on a perceived or expected outcome from a trustee that is usually associated with past performance (Stern and Coleman 2015). Rational trust is identified as a pathway for new stakeholders to join a collaborative (Coleman and Stern 2018).
- **Affinitive trust** is based on feelings of connectedness, benevolence, and integrity toward a trustee (Stern and Coleman 2015). Like rational trust, affinitive trust is rooted in relationships between two people but focuses on personal qualities and shared values rather than expected outcomes (Vaske, Absher, and Bright 2007; Stern and Coleman 2015; Jamison and Muth 2022). Other personal qualities that suggest a collaborator to be a “good person” are important, such as empathy and honesty, being respectful and fair-minded, and their willingness to listen (Coleman and Stern 2018, 36; Jamison and Muth 2022).
- **Procedural trust** is based on control systems or procedures that reduce the vulnerability of participants (Stern and Coleman 2015). These control systems can act as stabilizers to support growth of rational and affinitive trust (Michel et al. 2022). Unlike other forms of trust in the trust ecology framework, trust in processes has been identified in strong PPPs where systems to maintain accountability are a boon to trust maintenance. Conversely, they may also provide an opportunity to erode trust when rules are broken (Klijn and Teisman 2000).

- **Dispositional trust** refers to a context-independent proclivity of a trustor to trust a trustee. This trust is suggested to be informed by personalities and cultural norms (Smith et al. 2013; Stern and Coleman 2015). Dispositional trust is understood in a trust ecology framework as a baseline from which trust can be built or diminished (Stern and Baird 2015). However, Leahy and Anderson (2008) stress that if individuals have specific knowledge or experience with an institution or agency, that background will guide their trust rather than their disposition. Yet, some scholarship has highlighted that a level of dispositional distrust, particularly toward actors or institutions, may increase participation due to a desire to have a role in guiding management decisions (Smith et al. 2013; Levesque et al. 2017). Therefore, baseline dispositional trust can be shaped by more than personalities and cultural norms to include experiences in prior partnerships.

Stern and Baird (2015) operationalize these trust types into a trust ecology that brings a focus to how trust types interact within institutional arrangements. They conceptualize how trust richness and evenness interact to buffer against disruptions and create institutional resilience. As such, an institution's trust ecology has a unique assemblage of trust types, described in term of richness and diversity (Stern and Baird 2015). Each trust type can buffer a disruption to another trust type. For example, turnover in personnel may reduce affinitive trust as stakeholder relationships are severed, but a collaborative with a richness of rational trust could maintain confidence in the project performance and buffer against potential turnover (Stern and Baird 2015). Coleman and Stern (2018) build on this ecology by positing that collaborative NRM practitioners can map trust types to identify opportunities for fostering more trust in networks. They emphasize the potential buffering qualities of different trust types, indicating that adequate amounts of rational, affinitive, and procedural trust are required for long-term collaboration to be successful.

Trust scholars suggest that the actors in a collaborative can influence rational, affinitive, and procedural trust (Stern and Baird 2015; Colman, Stern, and Widmer 2017; Coleman and Stern 2018). In particular, facilitators play a key role in influencing trust development when they invest in process design, such as promoting “democratic decision-making” and “separating people from problems” (Coleman, Stern, and Widmer 2017, 44). Other strategies include ensuring transparency, regular contact, and communicating organizational success (Cvitanovic et al. 2021). Facilitators have the capacity to guide and adapt process design as a pathway for developing trust in collaborations (Bartels and Furman 2023). Yet not all four trust types may be equally actionable. For example, it appears difficult to influence dispositional trust, particularly when preexisting relationships between actors and institutions set the tone for trust and distrust in burgeoning collaborations (Coleman, Stern, and Widmer 2017; Coleman and Stern 2018). Due to the often contentious nature of relationships among different institutions in the NRM space, any indication of a base-level (preexisting) distrust may require attention and appropriate management (Stern and Baird 2015; Dietsch et al. 2021).

Trust and Public-Private Partnerships

Public-private partnerships (PPPs) are defined as governance arrangements composed of public and private sector partners that create added value for all parties (Klijn and

Teisman 2000; Hermans et al. 2019). Rationales for including the private sector in projects vary, such as promoting better market penetration (Fanzo and McLaren 2020), or providing public access to privately held intellectual property (Hall 2006). Critically, PPPs engage the private sector in activities that generate public goods and services in which the private sector would otherwise not participate (Hermans et al. 2019).

High levels of trust between public and private partners facilitate successful research projects. For example, stakeholders who perceive higher trust between partners also perceive higher performance in the PPP (Warsen et al. 2018). Furthermore, success of these partnerships has been found to rely more on “relationships, particularly trust, communication, and a pathway to success for all partners” than expertise in scientific disciplines (Markell et al. 2020, 175). Accordingly, mistrust in private sector partners can constrain the establishment of effective PPPs (Fanzo et al. 2021). In such cases, identifying strategies for developing trust among partners becomes important. For example, some scholars suggest that third-party facilitation between public and private parties may be required (Fanzo et al. 2021). Similarly, procedural governance protocols can guide project management (Klijn and Teisman 2000).

Our study applies Stern and Baird (2015) trust ecologies framework to highlight trust development pathways. We investigate the trust types in a PPP and how trust changes over time. Specifically, we pose the following research questions:

1. What trust types were present in the PPP from the perspective of the participants?
2. How do participants perceive changes in trust over time and the factors that advance collaboration?

Methods and Materials

Study Context

Geographic and Goal Focus

The Southeast Partnership for Advanced Renewables from Carinata (SPARC) is US Department of Agriculture-funded PPP. SPARC links southeastern public research institutions, cooperative state extension, and government agencies with industry to support the commercialization of a novel biofuel feedstock crop, *Brassica carinata* (henceforth referred to as carinata) (George et al. 2021). The SPARC mission is to remove the “physical, environmental, economic, and social constraints” to carinata production while “ensuring stable markets for jetfuel and bioproducts through demonstration of enhanced value across the supply chain” (SPARC (Southeastern Partnership for Advanced Renewables from Carinata) n.d.). The crop is viewed by researchers, industry, and government alike as an opportunity to develop a rural bioeconomy in the southeast (George et al. 2021; Rigsby and Bartels Forthcoming; NIFA (National Institute of Food and Agriculture) n.d.). However, success will depend on widespread adoption of carinata as a winter cover-crop alternative (Christ et al. 2020).

Project Timeline and Group Composition

The SPARC project was funded for five years (2017–2022) and received three years of extension. The network was composed of diverse institutions from multiple states

in the southeast US (Table 1). The number of individuals who participated in the project changed over time with a peak of 100 and closing with a core of 40 individuals. The network was dominated by academia, with fluctuations driven by the graduation of roughly 30 graduate students and post-doctoral fellows during the project. Additionally, some researchers retired, and new researchers joined. The most notable change occurred three years into the project when the main industry partner was acquired by a larger agribusiness. During that transition, representatives from the first industry partner left the project and new members were introduced to the SPARC team. Total industry participation increased by four people with the new partner. The acquisition and subsequent transition were important moments in SPARC as they posed a challenge and opportunity to trust maintenance.

Project Governance

The SPARC PPP was governed and managed via several mechanisms. High-level decision making in the project was overseen by a steering committee and an advisory board. Project management, regular communication, and collaboration among the partners was structured around monthly, quarterly, and annual meetings. Table 2 summarizes group composition and the objectives that shaped interaction within these spaces. Due to the regional scope of the project and geographic distribution of stakeholders, participant interaction was mostly maintained virtually (i.e. online).

Data Collection and Analysis

This research is part of a larger investigation exploring group composition, roles, risk, and trust in PPPs. In this paper, we address the trust portion, for which information was gathered over two phases using different and complementary qualitative methods. During phase one (Sept. 2022 – Jan. 2023) semi-structured interviews were conducted with 13 key informants. Phase 2 (Mar. 2023 – Apr. 2023) incorporated findings from phase one via an online survey that was distributed across the broader project respondent group (N = 68). Both research questions were explored in phase one and two (RQ1 and RQ2). The study was reviewed by the

Table 1. SPARC network composition as of 2022.

	Participants	Percentage
Public Sector	55	81%
University of Florida	24	35%
University of Georgia	7	10%
North Carolina State University	7	10%
University of South Florida	3	4%
Auburn University	3	4%
Other Universities	2	3%
USDA National Institute of Food and Agriculture	3	4%
USDA Applied Research Service	4	6%
Other Government Offices	2	3%
Private Sector	13	19%
Seed Developer	7	10%
Engineering Firm	2	3%
End-user Representatives	4	6%
Total	68	100%

Table 2. Decision-making spaces in SPARC including their composition and objectives.

	Decision-making spaces	Composition	Objectives
<i>Project Governance</i>	Steering committee	Principle investigators, project manager, discipline-specific team leads	Align on research objectives, manage conflict, design operational guidelines (e.g. sharing data, publication review, seed contracts, etc.)
	Advisory board	Government, private industry, and academic advisors	Provide guidance to stay on track, improve performance, and achieve project goals
<i>Project Management</i>	Monthly meetings	Discipline-specific teams (i.e. agronomy, supply chain, extension)	Discuss research objectives, track progress on tasks, and share successes and challenges
	Quarterly meetings	Total team participation, includes non-SPARC invited speakers	Highlight specific actors and work, bring in critical perspectives, and share project updates across teams
	Annual summit	Total team participation, invited speakers, representatives from private industry, governmental, and non-governmental institutions	Share years-end research and commercial updates, bringing critical voices from federal agencies, gap analysis, and network building
	Field days	Regional-specific universities (researchers and extension), private industry, and farmers	Review experiments, discuss studies, inform farmers and extension of research goals and results, and network building

University of Florida Internal Review Board office and received exempt status (IRB201701894).

During phase one, the authors categorized project participants into four broad affiliations: university researchers, extension agents, industry professionals, and government agencies. We then selected 13 key informants to represent the range of affiliations and conducted interviews that lasted between 60 and 120 minutes. Eleven interviews took place over Zoom, one over the phone, and one in-person. Online interviews were transcribed by Zoom and reviewed for accuracy by the authors, while the other two interviews were transcribed by the authors. The key informant interviews explored how trust was characterized in SPARC. Respondents also answered Likert-scale questions evaluating changes in trust over time, offering perceptions at the time of the interview compared to when SPARC first began. Individuals described various points in time where their trust in the partnership changed (see [supplementary materials](#) for our interview protocol). Not all key informants replied to every question posed.

All quotes derived from our research instrument are tagged with a code number. We followed a thematic approach to data analysis (Bernard, Wutich, and Ryan 2016). Transcripts were thematically coded using Stern and Coleman (2015) four trust types: rational, affinitive, procedural, and dispositional. Once the transcripts were coded, the authors analyzed how each trust type was characterized by the key informants (i.e., how do they talk about trust and what associations do they make?).

During phase two of data collection, we drew from the initial key informant interviews to generate nine trust statements. The trust statements captured trust types, dynamism, and other emergent ideas. As a form of triangulation and to deepen our understanding, we distributed an online survey to all SPARC participants. The response rate for the survey was 57% with 39 (of N = 68) completed surveys. Survey respondents

were asked to evaluate the trust statements (see [supplementary materials](#)). All survey data were analyzed using descriptive statistics.

Study Limitations

The perspectives shared by study respondents should not be considered representative of all group members associated with that affiliation category due to sample size limitations.

Results

Trust Types Present in SPARC (RQ1)

We found that key informants discussed all four types of trust, often describing them within the context of the collaborative spaces that shaped the project. Survey respondents supported these findings. Here we show how respondents characterize trust and provide quotes that exemplify salient qualities of each type.

Rational Trust

Key informants link the practice of showcasing expertise and accomplishing research goals to trust building. They describe experiencing such performance-related trust when professional expertise was demonstrated at monthly specialty meetings, quarterly project meetings, annual conferences, and field day events. Specifically, they describe having the opportunity to express their own expertise, view their peers in a professional capacity, observe the progress being made, and engage in dialogue about the directions of research, methodologies, and findings. For example, the remarks of one key informant illustrated how these spaces cultivated rational trust:

The monthly specialty group meetings do wonders in terms of getting to know each other and trusting each other. I could see everybody making progress in their own areas, and then on a monthly basis we would hear about that progress... I think those activities played a very key role and staying on track. Everybody making progress. No freeloaders, so to speak. (KI 03)

This informant perceived aligned forward motion in the project as critical to fostering this type of trust.

Field day events in which participants gathered regularly to view the status of experimental research plots were also mentioned as reinforcing expected project outcomes. One key informant recalled attending field days and directly observing the results of progress made:

We had field days so everybody could view each other's work ... ask questions and share ideas. That's part of the scientific development equation. And that is how you develop trust. Look at [the fields] and say, 'these people are managing this research well.' So, you develop a level of expectation and then you have to carry out that expectation to continue to develop trust. That the person is actually doing the job and doing it well. (KI 05)

This key informant highlights other aspects of rational trust, such as expectations for predicted and satisfactory outcomes that are based on current performance.

Furthermore, the previous two quotes illustrate the value placed on consistency and transparency (i.e. expectations are set, goals are shared, progress is made, and new expectations are developed iteratively).

We would also note that the development of rational trust within our study occurred both within and across scientific disciplines of the informants. For example, the two key informants quoted above described their experiences of trust building within discipline-specific monthly team meetings. Yet, other respondents experienced trust building during quarterly and annual meetings in which interdisciplinary expertise sharing was facilitated. For example, one survey respondent wrote:

I became aware of the different skills inherent in this multidisciplinary collaborative group but appreciated the integrity with which each of the collaborators contributed to the effort. (SV 04)

These insights highlight how processes, like sharing research outcomes in different contexts, can have similar impacts on building rational trust among participants from different disciplines.

Respondents also describe network composition and the presence of specific individuals as strengthening their perspectives of the project as a trustworthy venture. For example, one key informant stated:

One thing I have to mention is just the trust and the confidence ...for [industry figure named] to be associated with the project. (KI 07)

As such, the project gains a sense of legitimacy because of the experts engaged who appear to be “high trust” professionals. Survey respondents concur with key informants and when asked to evaluate the statement, “Some people in SPARC proved very trustworthy and made me more confident in the project,” more than 95% of survey respondents agreed.

Affinitive Trust

Respondents illustrated aspects of affinitive trust through descriptions of interpersonal interactions in informal spaces that reveal the character and integrity of project participants. Whereas rational trust is confined to project tasks and performance, affinitive trust develops beyond these boundaries. For example, one key informant highlighted the value of being able to gauge the character of an industry partner through unstructured time together:

We had a level of social interaction outside the work that gave us experience with each other’s personalities, and that was important. I’d had interactions with [industry leader], broke bread with him, had faith in him that he was doing his best. So, I had many discussions, and I can trust what they have said in public is a reflection of what that company is. (KI 05)

Other participants also elevated the importance of non-work, informal activities during which affinitive trust could be built. For example, one survey respondent wrote, “I believe there was great value in the annual meetings and the opportunities to interact during breaks, meals, etc.” (SV 28).

Respondents also referenced the importance of relationships that highlight strong interpersonal ties prior to SPARC as well as shared histories, values, and experiences.

For example, a key informant from extension noted how another project participant built trust with farmers:

I think it's the familiarity with farmers because he's been to all our meetings. He knows them by name, and they know him. He's just been here so long, and people do respect him because they know he's farmed, too. (KI 09)

The informant weaves rational and affinitive trust together by describing the individual as both a successful farmer and also as someone who shares values and history with their farming community.

Procedural Trust

Key informants and survey participants referred to two accountability systems that exemplify properties of procedural trust. Specifically, the steering committee and the advisory board were mentioned as venues for addressing conflict arising from mistrust. For example, one key informant articulated this mistrust as self-interest taking precedence over the general interest of the partnership:

Where's my limit? Where's my boundary? Everybody wants personal mileage out of the project. All these are natural expectations. So, that's why those guidelines and that constant communication, like small group communication, conflict resolution in the right manner... as soon as we sensed conflict, the steering committee would come together, and talk to this person one-on-one. A lot of those were the processes put in place. (KI 02)

As a governing body formed through consensus with the power to enforce rules, the steering committee acted as a control system that generated procedural trust.

Dispositional Trust

Evidence of dispositional trust was not conspicuous in responses from key informant interviews. However, a study participant said that they entered the project with a modicum of trust, without which they likely would not have joined:

The folks within the [university] system, they knew each other more. I didn't know any of the players. I would say my trust was neutral. I was at a 5. I didn't have any reason to mistrust. If I mistrusted, I wouldn't have been involved in the first place. (KI 03)

This response demonstrates that the informant assumes that baseline levels of trust were not uniform at the outset of SPARC. Because other project participants had preexisting relationships that the informant did not share, he/she reasoned that some individuals may have entered with greater levels of trust. On the other hand, this respondent's lack of mistrust indicates a certain confidence in the other project participants. Therefore, we cannot conclusively identify dispositional trust in this example without disentangling the conflating influences of rational and affinitive trust.

However, one response more conclusively reflects dispositional trust in its reference to an innate belief in the good intentions of participants:

I just have to have faith that [industry partners] are standing up there, being truthful. It does come back to the humanity of who we are as individuals. And are we willing to be open and trustworthy? Are we willing to participate in a partnership like this for a collective vision, for a common good? (KI 05)

The Dynamics of Trust (RQ2)

Participants largely agreed that trust changed over time and reported that levels were high toward the end of the SPARC project. Key informants evaluated trust among partners at the time of the study (2022) on a scale from 1-10 (where 1 is no trust at all and 10 is complete trust among partners). The average response was 8.125, within a range of 7-10. Survey respondents mirrored this trend as 95% agreed with the statement, “By the end of the SPARC project, my trust in the partnership was high” (see Figure 1).

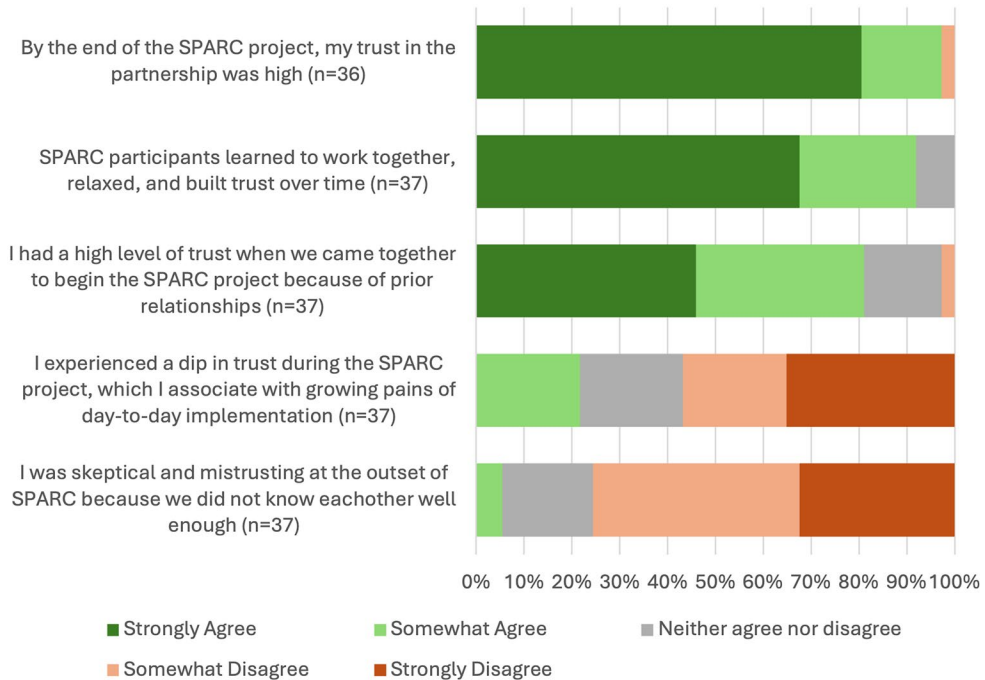


Figure 1. Likert-scale evaluation of trust dynamics. This graph shows the frequency of responses to trust statements developed from key informant interviews. Respondents evaluated the statements from strongly agree to strongly disagree. The total response number is included for each statement. We see agreement from survey respondents for the first three statements while respondents disagree more with the latter two statements.

Some key informants reported that trust levels increased over the course of the project. When asked to recall the project’s inception and retrospectively evaluate trust, responses from these informants averaged at 6.6 within a range of 5-9. Remarks suggest that SPARC participants had enough trust in the project to participate but nothing more than that. For example,

You have to start with a good level of trust to come together. I almost think it was like up here, and then went down and then went back up. So maybe a 5, then down to a 2 and then to an 8. (KI 02)

This sentiment was echoed by another key informant,

A generic 5... but it definitely was not a 0 and believe me I've seen that elsewhere. People defeat themselves before they even start. (KI 13)

In addition, preexisting relationships and pre-project planning influenced trust at the beginning of the partnership. One key informant stated:

I would think there's a high level of trust. You realize that we already had a relationship, for almost two years, by the time we wrote the proposal, got it through USDA, and had the [initial] meeting. I still think it[trust] was extremely high. I think there was a tremendous respect between in groups. (KI 07)

To better understand the role that preexisting relationships played in initial trust levels, survey respondents were asked to evaluate the statement "I had a high level of trust when we came together to begin the SPARC project because of prior relationships." More than 80% agreed and less than 5% disagreed (Figure 1). Similarly, survey respondents largely disagreed with the statement: "I was skeptical and mistrusting at the outset of SPARC because we did not know each other well enough" (Figure 1).

Many key informants discussed dips in trust that occurred midway through the project. For example, one person said they started at "Let's say 5 and then it dips down to about a 3" (KI 04). This decline in trust was primarily driven by numerous concerns regarding the industry partner. Some participants questioned the commitment of that partner. For instance, a survey respondent noted in open-ended questions: "The project was quite challenging. At times, it was not clear if the commitment from the main partner was strong enough" (SV 28). Another key informant raised concerns about the original industry partner's control over the dissemination of some unfavorable research results stating: "[original industry partner named] played a heavy hand in research output, and at times appeared to tip the scale in their favor, of course" (SV 09). Another informant echoed this negative sentiment noting that at times the goals of individuals may have overridden the common goal of the partnership:

There were so many unknowns ... a lot of excitement but also a lot of skepticism. It's just human nature, lots of excitement and motivation but can you trust your partners? Everybody wants the money for their specific needs and not necessarily looking at the team as a whole. (KI 13)

Other factors that reduced trust include the departure and replacement of the original industry partner which introduced uncertainty and threatened existing trust as suggested by this key informant:

It [trust] started off high and as we started to dig into exactly how this is going to work, we started encountering some issues. [Trust] probably dropped down below a 5 and started building its way back up. And then hiccups! Now this new entity comes in. I have no idea who they are, what they're going to do, and it's not a scale of trust at that point. There's another scale commensurate with that which is uncertainty, right? For a period of time, there was a huge level of uncertainty in the project and whether we were going to be able to salvage anything from it. (KI 09)

Although respondents described this reduction in trust as a result of the transition to a new partner, study participants also noted that trust recovered over time. This increase in trust was attributed to different mechanisms and processes. For example,

an increase in trust was associated with gradual project progress and successful outcomes (i.e. rational trust). For instance, one informant stated:

It was a gradual increase over time. There was definitely a bump after a year, year-and-a-half, when things finally got established: we knew the players, initial results started rolling in... we're making significant progress. (KI 13)

Another respondent described how affinitive trust emerged after a foundation of rational trust was established through the strengthening of relationships:

The first step of trust was purely transactional in the sense that you can fulfill my need, I can fulfill your need, and so I need to trust you to do what you can do... And then it built into: 'I know you.' It went to a different level. Where you understood each other's personalities and you learned to work within that context. (KI 02)

This sentiment was echoed by the 90% of survey respondents who agreed with the statement: "SPARC participants learned to work together, relaxed, and built trust over time," (Figure 1). Furthermore, study respondents highlighted the role that participatory spaces played in catalyzing and maintaining collaboration (i.e. procedural trust). For instance, they described the value of monthly, quarterly, and annual meetings which became more effective over time because they were more thoughtfully designed and facilitated by the SPARC coordination team. One survey respondent stated:

As the SPARC leadership invested more time in creating better annual meeting and summit spaces that brought the team together, trust seemed to improve (SV 30)

Another key informant also mentioned the role that project management played in creating opportunities for procedural trust:

SPARC was one of those efforts that I really enjoyed a lot. I credit [specific individual in management named] for that ... to feel like this is a real family. Definitely kudos to [specific individual in management named], at the end of the day that's why I attribute part of the success to everyone feeling comfortable, at ease, respected. (KI 03)

According to key informants, this procedural trust was developed through one-on-one conversations, the application of operational guidelines, and control systems present in the project, such as the steering committee and advisory board:

For SPARC, one of the key takeaways is that the Advisory Board played a very strong role in helping to establish that trust... If you have people that are talking past each other, you've got to get that conversation on the same track and the Advisory Board did a good job doing that. (KI 04)

Additionally, respondents referenced the steering committee's role in enforcing rules as crucial in managing expectations and appropriately mitigating conflict (see Procedural Trust). In evaluating these mechanisms, survey respondents agreed that they increased confidence and trust (Figure 2).

As such, our findings provide insights on process-design mechanisms and project management strategies that can bolster trust in PPPs (Boschetti et al. 2016; Fanzo et al. 2021) as summarized in Table 3.

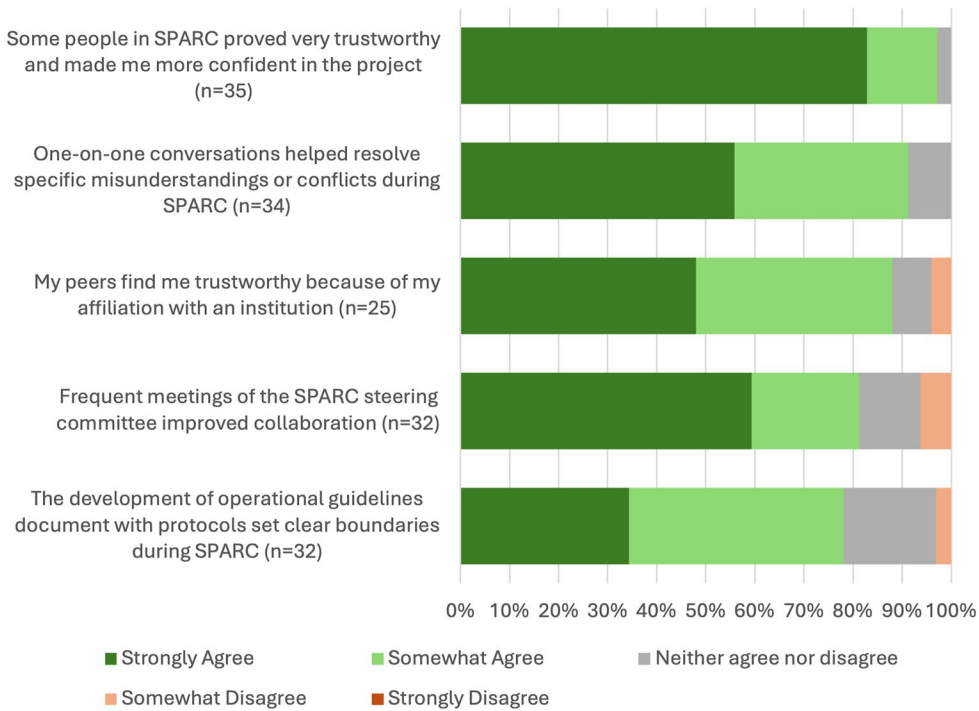


Figure 2. Likert-scale evaluation of trust strategies. This graph shows the frequency of responses to trust statements developed from key informant interviews. Respondents evaluated the statements from strongly agree to strongly disagree. The total response number is included for each statement. We see high levels of agreement with the selected strategies.

Table 3. Synthesis of findings pertaining to participatory spaces for trust development (built on Table 2 outlining composition and objectives).

	Decision-making space	Processes linked to trust	Trust type generated by processes
<i>Project governance</i>	Steering committee	Develop operational guidelines Facilitate one-on-one conversations	Procedural
	Advisory Board	Provide continuous feedback on project progress for adaptation	Procedural
<i>Project management</i>	Monthly meetings	Review progress on tasks within a discipline through consistent engagement	Rational
	Quarterly meetings	Showcase expertise within and across disciplines to build project-wide integrity	Rational
	Annual summit	Demonstrate expertise within and across disciplines	Rational, Affinitive
		Cultivate interpersonal relationships during non-work activities, breaks, and other unstructured time	
Field days	Develop comfortable and open spaces for participants to build relationships Highlight work done in the field Engage with farmers and other stakeholders	Rational	

Discussion

In our study that explored the trust ecology within the SPARC PPP, we find that participants described each of the four types of trust: rational, affinitive, procedural, and dispositional (Stern and Coleman 2015). Furthermore, respondents associated these trust types within distinct interactive spaces. Specifically, the development of rational trust was linked to monthly discipline-oriented meetings, affinitive trust to informal, non-work interactions at annual summits, and procedural trust to steering committee and advisory board engagement in project governance. By bringing attention to the important role that different interactive spaces can play in cultivating trust, our results also support the notion that coordinators and facilitators shape rational, affinitive, and procedural trust types through discrete tasks, governance, and interest-based negotiation (Coleman, Stern, and Widmer 2017). Therefore, we argue that distinct interactive spaces can be used strategically to foster specific types of trust.

In our case study, rational trust was cultivated in monthly discipline-specific meetings through consistent sharing of progress. Such intentional coordination can reinforce trust by buffering against real and perceived freeloading, as argued by Stern and Baird (2015). Other characteristics of these meetings include ensuring data quality control, demonstrating independence, and sharing ideas between actors, aligning with strategies identified by Cvitanovic et al. (2021). When preexisting relationships are scarce, projects can develop stocks of rational trust by organizing teams around expertise and designing regular opportunities for facilitated interaction. Although affinitive trust is most often associated with sharing values, a sense of shared expertise or work-ethic may similarly affect rational trust when collaborators “recognize in their peers something they see in themselves” (Jamison and Muth 2022, 864; Michel et al. 2022). Within NRM and PPP contexts where relationships are contentious or institutional missions are diverse, working from an understanding of expertise may provide a set of values that help build trust.

Our study shows that respondents’ conceptualization of dispositional trust seemed to differ from the other three types of trust. Notably, this type of trust was rarely mentioned and never linked to an interactive space. In one case, it was linked to the uncertainty or distrust associated with working toward a common goal and aligns with Levesque et al. (2017), who note initial distrust toward institutions as an obstacle to overcome. Furthermore, this instance echoes Smith et al. (2013) who state that involvement in these collaboratives requires a desire for a specific outcome, driven by uncertainty. As such, conceptualizing dispositional trust as distrust may be more useful in understanding how it influences participation and requires further study (Michel et al. 2022). However, understanding dispositional trust as a baseline trust on which other trusts are built is difficult to operationalize. We find that it is entangled with the conflating influences of rational and affinitive trust, echoing Leahy and Anderson (2008) with regards to participants who have preexisting relationships. Our experience conducting this study reveals that during interviews, respondents quickly jump to discussing relationships rather than their own capacity to trust in a self-reflexive manner. Such reticence may, however, simply be due to a methodological limitation (i.e., the broad nature in which we asked the questions). Therefore, we suggest that future studies more thoughtfully explore dispositional trust at the outset of projects.

Our study also elucidates factors that can alter trust along a project's trajectory. Throughout the SPARC project, participants perceived that trust levels wavered in response to changing relationships and unforeseen disruptions. For example, trust declined due to a real or perceived lack of commitment from the private sector partner and subsequent concerns regarding the fate of the project. This mistrust of the private sector is commonly cited as impeding PPP programing (Fanzo et al. 2021). However, we note that trust among SPARC partners was reestablished following this decline. This recovery demonstrates the efficacy of control systems, such as the steering committee and advisory board, in fostering procedural trust which rebuilt confidence in the project. Within these decision-making structures, project managers restored trust by connecting project participants through one-on-one conversations that helped manage expectations, redefine boundaries, and proactively navigate conflict.

Although our study cannot definitively offer which type of trust forms first in a project, our findings suggest that rational trust can precede affinitive trust. This was the case for new participants who did not have preexisting relationships and concur that rational trust is important for recruiting new partners (Coleman and Stern 2018). Rational trust was influenced by opportunities associated with project participation, such as access to privately held material for experimentation, collaboration with experts, and subsequent publications. We see evidence that stocks of trust were then built over time in an additive fashion. Affinitive trust was layered onto existing rational trust stocks as interpersonal relationships were built through the strategic use of the project spaces discussed above and aided in maintaining long-term collaboration (Stern and Baird 2015). This finding echoes Michel et al. (2022) who found that rational trust toward shared project goals aligned participants and led to a perception of shared values which bolstered affinitive trust. Conversely, we note that Bartels and Furman (2023) found little evidence of rational trust at the onset of their case study, instead arguing that the initial community-building phase of a project is well suited to cultivating affinitive trust. Because of the limited nature of our data, we cannot conclusively argue for a particular sequence of trust development.

Finally, although stocks of trust may be built up within a project and provide resilience to shocks and disruptions, the distribution of these different trust types across individuals is not uniformly distributed. We note that each individual may have a different trajectory for layering trust types with its own unique dynamics and capacity to buffer shocks. We posit that a medley of trust assemblages is constructed among participants who share disciplinary expertise, previous work histories, personal dispositions, and institutional affiliations. Our study shows evidence for a robust layering of trust types that converges on specific individuals. These "trust advocates" represent important components of a trust ecology and are similar to "charismatic leaders" in presence (Michel et al. 2022). Like coordinators, facilitators, and boundary spanners (Coleman, Stern, and Widmer 2017; Coleman and Stern 2018), these "trust advocates" may be better positioned to imbue spaces and processes with trust by leveraging their placement in the ecology. Future studies could explore unique characteristics and roles of similar figures and different strategies to mobilize them. These findings call attention to insights gained when framing trust research around people rather than types of trust. We posit that other trust building roles are embedded in

NRM collaboratives and PPPs, and further research is needed to illuminate roles in conjunction with trust types to enhance the trust ecology framework.

Conclusion

Trust plays an important role in advancing successful PPPs. Our study exemplifies the value of adopting a robust trust ecology framework from the NRM literature to operationalize trust between potentially adversarial partners and develop stronger partnerships for shared success. We highlight the supportive roles that coordinators and facilitators can play in cultivating trust when they strategically design interactive spaces. We demonstrate how monthly discipline-oriented meetings contribute to the development of rational trust; non-work interactions at annual summits foster affinitive trust; and project governance offer opportunities for building procedural trust. Therefore, teams can strengthen PPP proposals by structuring objectives that elevate coordination and facilitation functions to include allocation of appropriate budget. Funding organizations could require robust project management plans and provide guidance for associated monitoring and evaluation to enhance performance over the life of the project. Specifically, we see this paper as an opportunity for policymakers and program managers of US federal institutions to apply trust scholarship into the practice and design of their program portfolios. Developing strong trust between public and private partners will be key in designing and implementing climate change solutions that boost regional bioeconomies in the US and across the globe.

Acknowledgements

Thank you to all the SPARC participants who shared their stories and insight. We appreciate manuscript revisions from Akemi Inamoto Orellana and Matthew Palumbo.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by the US Department of Agriculture National Institute of Food and Agriculture under Grant [number 2016-11231].

Notes on contributors

Dylan Rigsby is a research coordinator at the University of Florida. His interests lie in agrarian change and development in the context of climate change. His work in the Southeast United States focuses on *Brassica carinata*, a novel biofuel crop, and the people tasked with supporting its commercialization.

Wendy-Lin Bartels is a Research Assistant Scientist at the University of Florida. She studies the conditions that shape collaboration among diverse groups. Specifically, she examines how choices about process design and facilitation can impact participant engagement, dialogue, learning and

trust building. She has contributed to several domestic and international climate-and-adaptation projects with multi-disciplinary teams of climate, crop, forestry, and hydrological modelers in their efforts to make research products more relevant to society.

ORCID

Dylan Rigsby  <http://orcid.org/0009-0001-8175-4909>

References

- Bailey, C., J. F. Dyer, and L. Teeter. 2011. Assessing the rural development potential of lignocellulosic biofuels in Alabama. *Biomass and Bioenergy* 35 (4):1408–17. doi: [10.1016/j.biombioe.2010.11.033](https://doi.org/10.1016/j.biombioe.2010.11.033).
- Bartels, W.-L., and C. A. Furman. 2023. Building community for participatory modeling: network composition, trust, and adaptive process design. *Society & Natural Resources* 36 (3):326–46. doi: [10.1080/08941920.2023.2177916](https://doi.org/10.1080/08941920.2023.2177916).
- Bernard, H. R., A. Wutch, and G. W. Ryan. 2016. *Analyzing qualitative data: systematic approaches*. Thousand Oaks, CA: SAGE publications.
- Boschetti, F., C. Cvitanovic, A. Fleming, and E. Fulton. 2016. A call for empirically based guidelines for building trust among stakeholders in environmental sustainability projects. *Integrated Research System for Sustainability Science* 11 (5):855–9. doi: [10.1007/s11625-016-0382-4](https://doi.org/10.1007/s11625-016-0382-4).
- Christ, B., W.-L. Bartels, D. Broughton, R. Seepaul, and D. Geller. 2020. In pursuit of a home-grown biofuel: navigating systems of partnership, stakeholder knowledge, and adoption of *Brassica carinata* in the Southeast United States. *Energy Research & Social Science* 70:101665. doi: [10.1016/j.erss.2020.101665](https://doi.org/10.1016/j.erss.2020.101665).
- Coleman, K., and M. J. Stern. 2018. Boundary spanners as trust ambassadors in collaborative natural resource management. *Journal of Environmental Planning and Management* 61 (2):291–308. doi: [10.1080/09640568.2017.1303462](https://doi.org/10.1080/09640568.2017.1303462).
- Coleman, K., and M. J. Stern. 2018. Exploring the functions of different forms of trust in collaborative natural resource management. *Society & Natural Resources* 31 (1):21–38. doi: [10.1080/08941920.2017.1364452](https://doi.org/10.1080/08941920.2017.1364452).
- Coleman, K., M. J. Stern, and J. Widmer. 2017. Facilitation, coordination, and trust in landscape-level forest restoration. *Journal of Forestry* 116 (1):41–6. doi: [10.5849/jof.2016-061](https://doi.org/10.5849/jof.2016-061).
- Cvitanovic, C., R. J. Shellock, M. Mackay, E. I. van Putten, D. B. Karcher, M. Dickey-Collas, and M. Ballesteros. 2021. Strategies for building and managing ‘trust’ to enable knowledge exchange at the interface of environmental science and policy. *Environmental Science & Policy* 123:179–89. doi: [10.1016/j.envsci.2021.05.020](https://doi.org/10.1016/j.envsci.2021.05.020).
- Dietsch, A. M., D. M. Wald, M. J. Stern, and B. Tully. 2021. An understanding of trust, identity, and power can enhance equitable and resilient conservation partnerships and processes. *Conservation Science and Practice* 3 (6):1–11. doi: [10.1111/csp2.421](https://doi.org/10.1111/csp2.421).
- Eastwood, C., L. Klerkx, and R. Nettle. 2017. Dynamics and distribution of public private research and extension roles for technology innovation and diffusion: Case studies for the implementation and adaptation of precision farming technologies. *Journal of Rural Studies* 49:1–12. doi: [10.1016/j.jrurstud.2016.11.008](https://doi.org/10.1016/j.jrurstud.2016.11.008).
- EERE (Office of Energy Efficiency and Renewable Energy). 2022. *Sustainable aviation fuel grand challenge roadmap*. Washington, DC: Department of Energy.
- Fanzo, J., and R. McLaren. 2020. An overview of the ethics of eating and drinking. In *Handbook of eating and drinking: Interdisciplinary perspectives*, ed. H. Meiselman, 1095–115. Springer, Cham. doi: [10.1007/978-3-030-14504-0_82](https://doi.org/10.1007/978-3-030-14504-0_82).
- Fanzo, J., Y. R. Shawar, T. Shyam, S. Das, and J. Shiffman. 2021. Challenges to establish effective public-private partnerships to address malnutrition in all its forms. *International Journal of Health Policy and Management* 10 (12):934–45. doi: [10.34172/ijhpm.2020.262](https://doi.org/10.34172/ijhpm.2020.262).

- Frisvold, G. B., S. M. Moss, A. Hodgson, and M. E. Maxon. 2021. Understanding the US bioeconomy: a new definition and landscape. *Sustainability* 13 (4):1627. doi: [10.3390/su13041627](https://doi.org/10.3390/su13041627).
- George, S., R. Seepaul, D. Geller, P. Dwivedi, N. DiLorenzo, R. Altman, E. Coppola, S. A. Miller, R. Bennett, G. Johnston, et al. 2021. A regional inter-disciplinary partnership focusing on the development of a carinata-centered bioeconomy. *GCB Bioenergy* 13 (7):1018–29. doi: [10.1111/gcbb.12828](https://doi.org/10.1111/gcbb.12828).
- Hall, A. 2006. Public-private sector partnerships in an agricultural system of innovation: concepts and challenges. *International Journal of Technology Management & Sustainable Development* 5 (1):3–20. doi: [10.1386/ijtm.5.1.3/1](https://doi.org/10.1386/ijtm.5.1.3/1).
- Hermans, F., F. Geerling-Eiff, J. Potters, and L. Klerkx. 2019. Public-private partnerships as systemic agricultural innovation policy instruments – assessing their contribution to innovation system function dynamics. *NJAS: Wageningen Journal of Life Sciences* 88 (1):76–95. doi: [10.1016/j.njas.2018.10.001](https://doi.org/10.1016/j.njas.2018.10.001).
- IPCC (Intergovernmental Panel on Climate Change). 2023. Summary for policymakers. In *Climate Change 2023: Synthesis Report. A Report of the Intergovernmental Panel on Climate Change. Contribution of Working Groups I, II, and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, H. Lee and J. Romero (eds.)], 36. Geneva, Switzerland: IPCC.
- Jamison, A., and A. Muth. 2022. Forest landowners and advisor relationships: Creating collaborative connections to care well for forests. *Society & Natural Resources* 35 (8):856–74. doi: [10.1080/08941920.2022.2080311](https://doi.org/10.1080/08941920.2022.2080311).
- Klijn, E.-H., and G. R. Teisman. 2000. Governing public-private partnerships: Analysis and managing the processes and institutional characteristics of public-private partnerships. In *Public-private partnerships, theory and practice in international perspectives*, ed. S. Osborne. London, UK: Routledge.
- Leahy, J. E., and D. H. Anderson. 2008. Trust factors in community—water resource management agency relationships. *Landscape and Urban Planning* 87 (2):100–7. doi: [10.1016/j.landurbplan.2008.05.004](https://doi.org/10.1016/j.landurbplan.2008.05.004).
- Levesque, V., A. J. K. Calhoun, K. P. Bell, and T. R. Johnson. 2017. Turning contention into collaboration: engaging power, trust, and learning in collaborative networks. *Society & Natural Resources* 30(2):245–260. doi: [10.1080/08941920.2016.1180726](https://doi.org/10.1080/08941920.2016.1180726).
- Markell, S. G., G. L. Tylka, E. J. Anderson, and H. Peter van Esse. 2020. Developing public-private partnerships in plant pathology extension: case studies and opportunities in the United States. *Annual Review of Phytopathology* 58 (1):161–80. doi: [10.1146/annurev-phyto-030320-041359](https://doi.org/10.1146/annurev-phyto-030320-041359).
- Michel, A. H., L. E. Pleger, A. von Atzigen, O. Bosello, F. Sager, M. Hunziker, O. Graefe, D. Siegrist, and N. Backhaus. 2022. The role of trust in the participatory establishment of protected areas—lessons learnt from a failed national park project in Switzerland. *Society & Natural Resources* 35 (5):487–505. doi: [10.1080/08941920.2021.1994679](https://doi.org/10.1080/08941920.2021.1994679).
- NIFA (National Institute of Food and Agriculture). n.d. *Bioeconomy, bioenergy, and bioproducts (B3) programs*. Washington, DC: United States Department of Agriculture. Accessed July 12, 2023. <https://www.nifa.usda.gov/grants/programs/bioeconomy-bioenergy-bioproducts-b3-programs>.
- Rigsby, D., and W.-L. Bartels. Forthcoming. Cultivating a bioeconomy: risks, collaboration, and partnerships in agricultural innovation. *NJAS: Impact in Agricultural and Life Sciences*. doi: [10.1080/27685241.2024.2420797](https://doi.org/10.1080/27685241.2024.2420797)
- Rousseau, D. M., S. B. Sitkin, R. S. Burt, and C. Camerer. 1998. Not so different after all: a cross-discipline view of trust. *Academy of Management Review* 23 (3):393–404. doi: [10.5465/amr.1998.926617](https://doi.org/10.5465/amr.1998.926617).
- Smith, J. W., J. E. Leahy, D. H. Anderson, and M. A. Davenport. 2013. Community/agency trust and public involvement in resource planning. *Society & Natural Resources* 26 (4):452–71. doi: [10.1080/08941920.2012.678465](https://doi.org/10.1080/08941920.2012.678465).
- SPARC (Southeastern Partnership for Advanced Renewables from Carinata). n.d. *Building a resilient global bioeconomy through a regional partnership*. Accessed July 12, 2023. <https://sparc-cap.org>.

- Spielman, D. J., F. Hartwich, and K. Grebmer. 2010. Public-private partnerships and developing-country agriculture: evidence from the international research system. *Public Administration and Development* 30 (4):261–76. doi: [10.1002/pad.574](https://doi.org/10.1002/pad.574).
- Stern, M. J., and T. D. Baird. 2015. Trust ecology and the resilience of natural resource management institutions. *Ecology and Society* 20 (2):14. doi: [10.5751/ES-07248-200214](https://doi.org/10.5751/ES-07248-200214).
- Stern, M. J., and K. Coleman. 2015. The multidimensionality of trust: applications in collaborative natural resource management. *Society & Natural Resources* 28 (2):117–32. doi: [10.1080/08941920.2014.945062](https://doi.org/10.1080/08941920.2014.945062).
- Vaske, J. J., J. D. Absher, and A. D. Bright. 2007. Salient value similarity, social trust and attitudes towards wildland fire management strategies. *Human Ecology Review* 14 (2):223–32.
- Warsen, R., J. Nederhand, E. H. Klijn, S. Grotenbreg, and J. Koppenjan. 2018. What makes public-private partnerships work? Survey research into the outcomes and the quality of cooperation in PPPs. *Public Management Review* 20 (8):1165–85. doi: [10.1080/14719037.2018.1428415](https://doi.org/10.1080/14719037.2018.1428415).