Trust and Communication: Mechanisms for Increasing Farmers' Participation in Water Quality Trading

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ABSTRACT. *Trust and communication barriers have contributed significantly to the lethargic performance of many point-nonpoint source water quality trading programs—farmers are often reluctant to participate despite direct financial incentives—yet the literature lacks a comprehensive investigation of how the social context affects trading outcomes. We draw on social embeddedness theory to analyze three mechanisms of communicating with farmers and conduct a case study analysis of 12 water quality trading programs. We find that employing trustworthy third parties or embedded ties may reduce farmers' reluctance to participate, although the most effective mechanism ultimately depends on local conditions and program objectives.* (JEL Q53)

I. INTRODUCTION

Building upon successful emissions trading programs to address acid rain and lead in gasoline, the Environmental Protection Agency (EPA) now actively supports the application of emissions trading to water quality, estimating that this flexible approach could save $900 million annually in compliance costs (USEPA 2001). Water quality trading is attractive—and unique among U.S. pollution trading programs—because it can provide financial incentives for voluntary pollution control in unregulated sectors, particularly agriculture. Point sources (PS), such as wastewater treatment plants or industrial dischargers, are monitored and permitted through the National Pollution Discharge Elimination System (NPDES). Diffuse nonpoint sources (NPS) such as agriculture and urban runoff account for the majority of effluent load in many watersheds (Crutchfield 1994), yet with few exceptions these sources are exempt from regulation due to monitoring difficulties and political sensitivities. The significant challenge of NPS pollution and the fact that reducing pollution from NPS is, in general, much less costly than reducing from PS has prompted great interest in including NPS as voluntary participants in water quality trading.

In the last 20 years, there have been nearly three dozen PS-NPS water quality trading programs in the United States, 12 of which have included agricultural sources (Breetz et al. 2004).[1] The EPA issued a "Draft Framework for Watershed-Based Trading," in 1996, and the "Final Water Quality Trading Policy," in January 2003, but the flexible guidelines allow states to experiment with different designs. As a result, nearly all trading programs have de-

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The authors thank Rebecca Terry for research assistance, and Richard Woodward, Cynthia Morgan, two anonymous reviewers, and the participants of the 25th Annual Association for Public Policy Analysis and Management research conference, held in Washington, D.C., on November 6, 2003, for valuable comments on the original draft of this article. The research was supported by the Rockefeller Center at Dartmouth College and the U.S. Environmental Protection Agency.

[1] Trading programs that could potentially include farmers have been proposed for the Lower Colorado River (CO), Truckee River (NV), Clermont County (OH), and Great Miami River (OH), but the trading structures for these programs have not yet been developed (Breetz et al. 2004).

Land Economics • May 2005 • 81 (2): 170–190
ISSN 0023-7639; E-ISSN 1543-8325

veloped a unique structure for reaching out to NPS and incorporating NPS credits.

Despite the potential for significant cost savings, many water quality trading programs have experienced a lethargic start. Incorporating NPS, especially agricultural producers,[2] into trading has proven to be more difficult than anticipated. Scientific uncertainty and institutional complications make the quantification, verification, and economic valuation of tradable credits a logistical quagmire (Shabman, Stephenson, and Shobe 2002). Yet even when a trading program can get around the logistical complications, farmers are not participating in trading nearly as much as policymakers would like or expect (King and Kuch 2003; Kramer 2003). Nearly every PS-NPS water quality trading program involving farmers has had difficulty convincing farmers to participate, despite offering direct financial incentives and farm planning assistance. This has led some to conclude that PS-NPS water quality trading is unlikely to take off in the current institutional setting (King and Kuch 2003) or is likely to be limited to small, bilateral trades (Woodward, Kaiser, and Wicks 2002).

What many analyses lack, however, is a more nuanced understanding of farmers' reluctance to voluntarily participate in water quality trading programs. In this paper, we attempt to fill this gap in the literature by investigating how the social context affects program outcomes. We begin by reviewing the extensive literature on farmers' decision-making, drawing special attention to the emerging thought on farmers' attitudes and behaviors. This literature is valuable for highlighting farmers' risk aversion and environmental values, although it stops short of explaining the significance of trust that is observed in the case studies. We subsequently draw on social embeddedness theory to explore the interactions between trust, communication, and participation and identify possible communication mechanisms to alleviate these social constraints. The principle lesson from embeddedness theory is that incorporating trusted social relations into trading programs may help reduce farmers' concerns about risk and equity, effectively reducing transaction costs and creating a more efficient market.

To test our theoretical findings, we conduct a case study analysis of the 12 PS-NPS water quality trading programs involving agriculture that have been implemented across the United States. As a direct result of the EPA's flexible water quality trading policy, which provides general guidelines, but few specifications for program structures, these cases illustrate a rich array of approaches to communicating and negotiating with farmers. This variety allows us to test the effectiveness of these mechanisms in various types of trading situations.

In this analysis, we find that historical mistrust of regulators and other actors has hindered productive communication, contributing to farmers' initial unwillingness to participate in water quality trading.[3] Communication mechanisms such as education and outreach, third party facilitation, and the use of existing relationships can help alleviate these social constraints, but the mechanisms' effectiveness depends on the specific characteristics of the trading program. Education and outreach can build up trust and create a tailored, flexible trading program, but it tends to be a costly and time consuming approach. Third party brokers can more directly address the issue of trust, but this can require payment for services and depends on the identification of an unbiased intermediary. Lastly, building on embedded ties and existing formal networks with farmers can address trust most directly but may exclude NPS sources outside the network who could offer lower marginal cost reductions.

The paper is organized as follows. The following section (Section 2) reviews models of farmers' decision-making, including those that deal specifically with the adoption of environmentally-oriented practices. In Section 3, we draw on the social embed-

[2] Other NPS can include septic systems or stormwater drainage systems.

[3] We would expect that as PS-NPS trading becomes more widely implemented, resistance based on mistrust and misinformation would diminish over time.

dedness literature to explore how trusted relationships can facilitate effective communication and reduce transaction costs, and we use these findings in Section 4 to explore how different communication mechanisms are expected to address the social context of farmer decision-making. Section 5 tests our hypothesis by comparing the characteristics, communication mechanisms, and success in attracting farmers of 12 water quality trading programs. Section 6 offers concluding remarks.

II. FARMERS' DECISION-MAKING REGARDING CONSERVATION PRACTICES

Farmers face a uniquely complex constellation of factors when they make decisions about farm management and conservation practices.[4] Their economic survival is already subject to the whims of the weather and the market, and it is for good reason that they are averse to introducing more uncertainty and vulnerability. Conservation measures can indeed create greater uncertainty about future productivity and profitability (McSweeny and Kramer 1986). Farmers seldom realize savings from conservation practices in the short term (e.g., Wade and Heady 1978; Seitz et al. 1979; Putnam and Alt 1987; Batte and Bacon 1995). To the contrary, farmers may face substantial capital costs for new equipment and opportunity costs associated with taking land out of production or devoting time to new practices.

Water quality trading can compensate farmers for these costs, but financial incentives may be countered by fears that participating in trading could carry significant risk: loss of autonomy regarding farm operations; opportunities for increased government oversight; and negative publicity about agricultural pollution. More subtly, the economic bottom line may not be sufficient to drive trading because farmers have a parallel set of socio-cultural goals and concerns. A strong pride in private property, a history of tensions with industrial actors, or a desire to be recognized for land stewardship are just a few of the attitudes or values that can establish powerful norms of behavior discouraging trades.

Models of farmer behavior traditionally proceeded from the assumption that utility can be sufficiently represented by profit maximization (McConnell 1983; Bar-Shira 1992), which is reflected in the use of incentive payments as the primary tool for encouraging the voluntary adoption of environmentally sound practices (e.g., Cooper and Keim 1996).[5] This focus on expected profit, however, led to the neglect in the literature of other influences on farm management, including problem definition, values, analytical challenges, and other optimization and decision-making rules (Johnson 1987).

Refinements to the expected profit model largely focus on risk aversion (e.g., Anderson 1982; McSweeny and Kramer 1987; Hardaker, Pandey, and Patten 1991; Houston and Sun 1999). Recent decades, however, have seen increasing efforts to examine how values and attitudes other than risk aversion influence farmers' decisions to implement conservation practices. This literature has shown that farmers balance multiple objectives in a complex utility function that is not adequately captured by profit maximization (e.g., Gasson 1973; Amador, Sumpsi, and Romero 1998). One branch of the attitude-behavior literature has emphasized that farmers may have lifestyle goals that supersede profit goals (Willock et al. 1999; Busck 2002). In a study of farmers' participation in a wetlands pro-

[4] Agricultural soil erosion is a major cause of nutrient loading to waterways (Faeth 2000), and farmers generate credits for water quality trading by implementing many of the best management practices (BMPs) that address soil conservation, such as planting buffer strips along waterways, switching to conservation tillage, etc.

[5] Since land-use activities on larger land parcels tend to be more associated with monetary motives (Koontz 2001), we might anticipate that trading programs could most effectively reach their objectives by trading with larger, more profit-oriented landowners. Most programs, however, have focused on negotiating with smaller farmers thus far, while large animal-feeding operations are already permitted for water pollution discharge.

tection program, Söderqvist (2003) found that farmers viewed both public and private environmental benefits as more important motives for participation than financial incentives, while public intrusion and revenue losses were equally viewed as personal disadvantages.

Other researchers have emphasized psychological factors. Edwards-Jones, Deary, and Willock (1998) found that psychological variables, such as openness to innovation, explained 20%–30% of observed variation in environmentally oriented behavior. They concluded that psychological variables become increasingly important as a model narrows in on small-scale behaviors, such as the local implementation of conservation practices. This finding is relevant to water quality trading since it often involves convincing small, locally controlled farms to participate in innovative programs.

Trading programs have tended to be structured with the assumption that farmers will respond to financial incentives as long as trading does not pose undue economic risk, and farmers' reluctance to participate has been attributed primarily to institutional barriers, such as competition with federal subsidy programs, or the scientific complications of quantifying credits (Malik, Larson, and Ribaudo 1994; Stephenson, Norris, and Shabman 1998; Faeth 2000; King and Kuch 2003). Where an attention to attitudes has filtered into the literature, it has largely consisted of cursory references to farmer culture or broad exhortations to build community consensus around trading (USEPA 1996, 2003; Jarvie and Soloman 1998).

While we do not intend to diminish the importance of the scientific and institutional context in establishing successful trading programs, there are strong indications that farmers' participation decisions, and therefore the outcome of trading programs, have a strong social component that has been overlooked. In a study of alternative phosphorus pollution policies in Minnesota, McCann and Easter (1999) found that farmers viewed payments from industry for BMPs—essentially the same transaction for farmers as trading—as one of the least costly but also least acceptable policies. Although an explanation of this phenomenon was beyond the scope of their study, the authors ventured that it stemmed from farmers' resentment towards urbanites. Farmers also reported that the process by which policies are set would affect their compliance. This implication—that a sense of equity influences farmers' behavior regardless of substantive policy—is consistent with Lewotsky's (2002) study of building cooperation between agriculturalists and environmentalists in Oregon, where historical mistrust between these two groups was a significant barrier.

Finally, the clearest indication that social variables affect trading comes from the experiences of existing water quality trading programs. Administrators of these programs have been very candid in interviews about the strong social component of farmers' participation decisions, noting where farmers have been reluctant to participate despite clear financial incentives because of "cultural inertia" or suspiciousness about the motivations of governmental actors.[6] Our research revealed that nearly all of the programs that tried to include farmers (see list in Table 2) found the identification of agricultural credits to be a challenge because of trust and communication barriers, yet the literature on trading lacks a comprehensive investigation of how the social context affects trading outcomes. By connecting the trading literature with sociological work on trust, particularly embeddedness theory, we attempt to identify ways in which social relations can be used to enrich trading.

III. LESSONS FROM SOCIAL EMBEDDEDNESS

Embeddedness theory provides an instructive analytical lens for making sense of trading outcomes and exploring how

[6] Personal communication with C. Rudkin, March 13, 2003; A. Weideman, May 15, 2003; L. Stoll, March 21, 2003; B. Zander, March 4, 2003; S. Sparlin, April 27, 2003; J. Klang, May 3, 2003; D. Batchelor, March 21, 2003; A. Ringhausen, May 27, 2004.

water quality trading programs can better reach farmers. The concept of embeddedness comes from Karl Polanyi (1944), who argued that the social relations and reciprocity marking traditional societies were replaced in modern life by atomistic relations and market logic. Granovetter (1985) revived the concept to show that economic decisions remain situated in the structure of personal relations and networks of interaction. Uzzi (1997, 1999) developed a more systematic account of the components of embedded relations and the mechanisms by which embeddedness shapes economic outcomes. Granovetter (1985) and Uzzi (1997) both draw on a "structural" form of embeddedness, emphasizing the structure of personal relations in generating trust, facilitating coordination, and increasing information sharing.[7]

Embedded ties have two fundamentally interrelated components: trust relationships[8] and information channels. Granovetter (1985) and Uzzi (1997) see trust as an informal governance mechanism that provides economic and social incentives to reduce opportunism. The confidence that an exchange partner will not act in self-interest at another's expense generates reciprocity and flexibility in exchange relationships. Trust also builds confidence that the payoffs of transacting will be divided in a fair manner (Dore 1983), which is valuable in PS-NPS trading where farmers are concerned about equity.[9] Trading usually addresses equity questions in the assignment of initial load allocations, but since NPS do not have formal allocations, reassuring farmers that their concerns and goals are met will rely on mechanisms of trust.

Trust plays a significant role in the speed, quality, and reliability of the second component of embedded ties: information transfers. Existing communication networks facilitate rapid information sharing, trust motivates actors to share detailed and privileged information, and more integrative arrangements improve feedback. Compared to arms-length relations, embedded ties not only promote access to more accurate information at a lower cost but also guarantee the transacting parties that the information is not misrepresented (Zaheer, McEvily, and Perrone 1998). Furthermore, where uncertainty persists, actors are likely to rely on networks of trust when making economic decisions (Mizruchi and Stearns 2001; Guseva and Rona-Tas 2001). These characteristics of embedded ties have significant implications for water quality trading, where farmers' mistrust of regulators and environmentalists has created communication barriers. Working with farmers through a trusted partner or agency can not only facilitate greater information dissemination but also reassure farmers that they can trust the information they receive.

Overall, the combination of trust and established information channels creates significant economic advantages for communicating and transacting through embedded ties. Existing and ongoing personal relations can reduce transaction costs, both in negotiation (Uzzi 1997; Dyer and Chu 2003) and information costs (Granovetter 1985). Greater coordination and reciprocity be-

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[7] Other researchers have identified additional patterns of embeddeness. Zukin and DiMaggio (1990) identified four types: structural, cognitive, cultural, and political. Ecological embeddedness, defined as the extent to which a person is rooted in the land, has also been explored as an explanatory model of sustainable behavior (Whitehead and Cooper 2000). We focus on structural embeddedness, however, because we feel that the social context and patterns of interactions have greater implications for trading program design than the more amorphous psychological or ecological contexts.

[8] Embeddedness approaches trust from a sociological angle, but trust has also been a major focus of the business administration and organization theory literature. See, for example, special issues on trust in *Academy of Management Review* (1998), *Organizational Studies* (2001), and *Organizational Science* (2003).

[9] In a 2001 paper on transferable permits, the Organization for Economic Cooperation and Development (OECD 2001) identified three types of trading objectives: environmental, economic, and equity. The inclusion of equity as a formally stated goal contrasts with the goals set forth by many U.S. PS-NPS trading programs. The U.S. EPA's Final Water Quality Trading Policy lists eight trading objectives related to improved environmental quality and cost-effectiveness but does not address equity (US EPA 2003).

tween actors creates value in an exchange relationship and promotes opportunities that are inaccessible through arms-length market ties (Dyer and Chu 2003). Empirical studies demonstrate that embeddedness can thereby improve economic performance. Uzzi found, for example, that social networks can increase the survival chances of clothing firms (Uzzi 1997) and increase access to capital and low interest rates (Uzzi 1999).

Relying too heavily on embedded ties, however, can introduce problems of its own. Uzzi (1997) noted that there is a threshold for the positive effects of embeddedness, after which it can derail economic performance. Over-embeddedness can insulate actors from information that exists beyond their social networks, seal off new opportunities, and reduce their ability to respond nimbly to external changes.

There are three broad lessons to pull out of embeddedness theory for water quality trading: First, focusing on the social context of economic decisions yields a more nuanced explanation of farmers' reluctance to trade. The normative implication is that providing economic incentives without addressing social concerns will not be sufficient to establish efficient and effective trading programs. Farmers need to be reassured that their long-term ability to farm will not be impaired and that benefits and responsibilities are equitably distributed. Second, contrary to neoclassical or neo-institutional expectations that social relations are a frictional drag on the market, embeddedness shows that trusted social relations can facilitate strong communication, promote access to greater trading opportunities, reduce transaction costs and create a more efficient market. The messages above will likely be unpalatable if the communication is perceived as complicated, patronizing, or untrustworthy. Third, this efficiency gain is only operative up to a point, after which relying exclusively on social relations can stagnate innovation and close off opportunities.

IV. MECHANISMS OF COMMUNICATIONS

In the previous section, we examined the importance of trust for improving communication, reducing perceptions of uncertainty, and increasing the sense of equity in economic exchanges. Here we develop a framework of three mechanisms for reaching farmers and explore how these mechanisms incorporate trust strategies. Embeddedness theory suggests that communication mechanisms anchored in trust will be more effective at bringing farmers to the table, and we will more fully evaluate this hypothesis within the case studies.

The three mechanisms are consistent with Uzzi's (1997) discussion of the formation of embedded ties. The first, education and outreach, builds trading relations where there is no previous history of transactions. The second, third-party facilitation, takes advantage of third-party referrals and transfers of trust. The third mechanism, building on existing networks, shows how existing programs or embedded relations can be shifted to support trading. It is important to note that these are communication mechanisms, not program structures. The delineations are not rigid, and a trading program could choose to adopt more than one strategy for reaching out to farmers, either simultaneously or over time as conditions change.

The program conditions under which each communication mechanism would be expected to be preferred are summarized in Table 1. The rows in Table 1 comprise six program characteristics that we found in our case study analyses to be important (irrespective of communication mechanism choice) in the design of water quality trading programs.[10]

[10] Programs anticipating few potential trading partners or a limited exchange of nutrient credits were considered "small" in size. Programs with no immediate need to trade (due to the lack of regulation or the lack of regulatory stringency) were considered to have "low" time constraints, and programs where farmers were more reluctant initially to participate were considered "less receptive." The remaining three program characteristics describe program objectives. If the ability of the program to evolve in response to changing needs is important to the program designers, then we considered the long-term flexibility of the program to be "more important." If trades are dependent on keeping the program facilitation costs at a minimum, typically because few funds are available for developing a program or purchasing credits or because PS and NPS pollution control costs are otherwise similar, then we concluded that the goal of minimizing transaction costs is "more

TABLE 1
CONDITIONS AND OBJECTIVES OF PS-NPS WATER QUALITY TRADING PROGRAMS AND PREFERRED MECHANISMS OF COMMUNICATION

Program Conditions and Objectives		Education and Outreach	Third-Party Facilitation	Embedded Ties
Size	Small	X	X	
	Large			X
Time constraints	Low	X	X	
	High			X
Initial farmer attitudes	Less receptive		X	X
	More receptive	X		
Long-term program flexibility	Less important			X
	More important	X	X	
Minimizing transaction costs	Less important	X		
	More important		X	X
Reaching broad set of farmers	Less important			X
	More important	X	X	

Education and outreach is perhaps the most straightforward strategy for communicating with farmers. Vehicles for education can take a variety of forms, from pamphlets and public meetings to demonstration projects and one-on-one visits to landowners. Online resources for farmers are also being explored as a means for helping farmers learn about conservation and trading.[11] If farmers are willing to listen, then education can reduce opposition based on misinformation and routine. The factors that education and outreach do not systematically address, however, are the motivational barriers where farmers' suspicion of trading initiatives or program administrators prevents them from coming to the table at all. This approach can successfully build up trust and facilitate productive dialogue over time, but it can be a long and laborious process if farmers are entirely unreceptive.

As a result, education and outreach are expected to work best where motivational constraints are low and landowners are already responsive to conservation practices (Table 1). As a time-consuming process, it should be more effective where there is a strong desire for trading but no urgent need for offsets. This approach should also be more effective where the program targets a relatively small group of landowners. The most appropriate match for an education and outreach approach might be a small pilot program that is part of a community's broader water quality campaign.

Program administrators can improve on education and outreach by bringing in a third party to facilitate trades. Parties fulfilling this role could be a non-governmental organization, a civic association, or even a professional mediator. These messengers are trustworthy not because of established relationships with landowners but because they are seen as unbiased and independent of regulators. Farmers are expected to be more receptive to these third parties and more accepting of the information pro-

important." Lastly, if the program's ability to cast a wide net to potential agricultural NPS is important, either because it is desired to reach farmers with the lowest marginal cost nutrient controls or because it is ecologically required to reach a large number or wide array of farmers, then we concluded that the goal of reaching a broad set of farmers is "more important" to the program designers.

[11] For example, the World Resources Institute has created an online credit calculator (http://www.nutrientnet.org) where farmers can fill out worksheets with their farm location, facility information, and anticipated mitigation practices to estimate nutrient loading reductions and associated costs. The Idaho OnePlan (http://www.oneplan.org), supported by nearly 20 agricultural and environmental organizations, combines GIS data and downloadable software to help farmers develop conservation plans from their home computers. While not currently linked to trading, this type of resource might be valuable in the future for helping farmers explore what trading may entail for their farm.

vided. Furthermore, an unbiased intermediary might deflect some of the public focus that a larger education campaign might bring to farmers.

Compared to education and outreach, third-party involvement can cope with higher motivational constraints and should have an advantage in most cases, although the transaction cost structures are slightly different: third parties may make negotiations smoother and more efficient, but there may be additional costs if the third party is paid a fee for facilitating the process.

Finally, a trading program can reach farmers by building on embedded ties and existing formal networks with farmers, including ongoing working relationships, associations, or programs. This approach spans several levels of institutional integration. At a minimum, an existing program could be used as an efficient communication vehicle. For example, the city of Cumberland, Wisconsin, advertised its trading program to the farmers through the Land Conservation Districts. At the other end of the spectrum, a trading program could incorporate a soil conservation subsidy program[12] such that the farmers do not explicitly choose to trade. The best-known example of this is the offset provision for the Tar-Pamlico Basin Association, which requires PS members to pay directly into North Carolina's Agricultural Cost-Share program if they exceed their collective cap.

Working through embedded ties is expected to establish a trading program quickly and with low transaction costs. It should be most useful where PS need offsets with high speed and certainty, particularly if this is a widespread need that warrants a large trading program. It should also be successful where farmers are already attracted to traditional subsidy programs but might not be responsive to trading due to social norms. The danger of structuring trading around existing networks is that the speed and certainty can come at the expense of long-term efficiency. Education and outreach, with or without third-party facilitation, can tailor a program to the needs of both the PS and the NPS and based on more precise cost measurements, while the convenience of building off of existing networks may force a less efficient standardization or result in a selection bias away from the least-marginal cost NPS projects. In the long-term, structuring trading around a fixed subsidy program raises the risk of over-embeddedness, since there is less flexibility to evolve in response to changing needs. Finally, this approach assumes that there are appropriate networks in place that could serve as a foundation for trading. Using embedded ties is obviously not an option where NPS are not already linked in existing relationships or where an organization with embedded ties to farmers declines to participate.

V. CASE STUDIES

Methodology

To test the hypotheses about communication mechanism choice developed in the previous section and summarized in Table 1, we conduct a comparative case study analysis of the 12 water quality trading programs in the United States that involved agricultural non-point sources.[13] These programs and their communication mechanisms are listed in Table 2, and details on each program case study are provided be-

[12] "Cost share" programs offset the cost to farmers of retiring land from cultivation or implementing soil and water conservation BMPs. The principle agricultural cost share program is the Environmental Quality Incentives Program (EQIP), administered by the U.S. Department of Agriculture, which pays farmers up to 75% of the cost of implementing BMPs. Cost sharing is directed towards both soil erosion and water quality. In Maryland, for example, about a third of cost-share proposals have water quality as a primary purpose, although projects focused on water quality were less likely to be funded than projects whose primary purpose was erosion control. (Bastos and Lichtenberg 2001).

[13] Only 12 water quality trading programs have attempted to include agricultural nonpoint sources. This small sample size precludes us from conducting a formal econometric analysis. Although a case study does not allow us to rigorously assess the magnitude of the effects of the various program characteristics like an econometric analysis would allow, it does allow for an in-depth understanding of the trust issues and relationships that are difficult to capture in an econometric study.

TABLE 2
NPS-PS Water Quality Trading Programs that Include Agricultural NPS

	State	Nutrient Focus	Education and Outreach	Third-Party Facilitation	Embedded Ties
Boulder Creek	CO	Nitrogen	X		
Conestoga River Nutrient Trading Pilot (part of Chesapeake Bay Nutrient Trading Program)	PA	Nitrogen Phosphorus	X		
Fox-Wolf Basin Watershed Pilot Trading Program	WI	Phosphorus	X		
Grassland Area Farmers Tradable Loads Program	CA	Selenium			X
Kalamazoo River Water Quality Trading Program	MI	Phosphorus	X		
Lower Boise Effluent Trading Demonstration Project	ID	Phosphorus		X	X
Piasa Creek	IL	Sediment			X
Rahr Malting Plant	MN	Phosphorus		X	
Red Cedar River Pilot Trading Program	WI	Phosphorus			X
Rock River Pilot Trading Program	WI	Phosphorus		X	X
Southern Minnesota Beet Sugar Cooperative (SMBSC)	MN	Phosphorus	X		X
Tar-Pamlico Nutrient Reduction Trading Program	NC	Nitrogen Phosphorus			X

low. These case studies were conducted as part of a larger two-year research effort funded by the U.S. EPA to provide a comprehensive survey of all water quality trading programs in the United States (Breetz et al. 2004). Through this research, we have identified approximately 40 water quality trading programs in the United States The remaining 28 were excluded from this study because they do not allow for the inclusion of non-point sources, the non-point sources included are non-agricultural, or the program intends to include farmers but has not yet developed a trading framework. In addition to a comprehensive review of the written material on each case, our case studies are based on extensive interviews with program administrators and regulatory agencies conducted from 2002–2004.[14]

[14] Individual farmers who participate in the trading programs were not interviewed for this paper. Since many farmers had concerns about public scrutiny of their participation, program administrators declined to release their names. For the purposes of this paper, however, it was most important to speak with program administrators, since they also had experience negotiating with farmers who ultimately did not want to participate.

Complete documentation of program background, trading structure, and trading outcome is available in Breetz et al. (2004).

Programs that have built trading relationships with farmers where previous relationships did not exist were placed under "Education and Outreach." Programs that used third-party intermediaries to bring farmers to the table where a relationship between the third-party facilitator and farmers did not previously exist were placed under "Third-Party Facilitation." Programs that used existing networks or relationships to bring farmers to the table were placed under "Embedded Ties." Three programs (i.e., Lower Boise River, Rock River, and SMBSC) used more than one mechanism. It is likely that there is more behind-the-scenes overlap of mechanisms than is captured by this table. For example, the Rahr Malting Co. benefited from newspaper coverage, although third-party brokerage actually pushed trades through (Fang and Easter 2003). In general, we focus on the mechanisms that were directly explored by each trading program.

Defining program success can be tricky since the programs were initiated with different goals, ranging from small pilots exploring the feasibility of trading (e.g., Conestoga River, Kalamazoo River) to sole-source offsets in which a single point source negotiated a permit that included trading (e.g., Boulder Creek, Rahr Malting Company) to large programs providing multiple-point sources with nonpoint source credits (e.g., Tar-Pamlico River, Lower Boise River). Many of these programs have yet to see a single trade, but not all of the programs needed to complete trades to achieve their goals. Our concern, therefore, is not whether trading occurred but rather if the farmers willingly participated in the program. For the purposes of this study, we define success as the program's ability to bring farmers to the table and implement BMPs for the purposes of trading.

Education and Outreach

Five programs have adopted an education and outreach approach. Trading programs on Boulder Creek, the Kalamazoo River, and the Conestoga River show that this approach can be successful, given adequate time to build up trust (low time constraints) and a segment of the farming community that is initially receptive (even a single farmer who can conduct outreach to other farmers). This finding suggests that communication mechanisms not initially anchored in trust, or lacking the assistance of farmers to build the agricultural community's trust in trading, face significant challenges in bringing farmers to the table. All three cases are relatively small pilot projects, with a keen desire to see the program through but no acute need for offsets.

In the Boulder Creek trading program, the City of Boulder, Colorado, sought offsets to avoid a costly wastewater treatment plant upgrade. The Boulder Creek program was a small sole-source offset that had time to test the impact of stream restoration on water quality, anticipated adjusting future upgrades based on the success of the BMPs, and needed to appeal to many types of landowners along the creek. Boulder sponsored a watershed-wide educational campaign that was painted as a community effort and city employees visited landowners to explain the financial benefits of participation (Zander 2003). Even so, convincing farmers to participate was not a linear process, and the City had to work cooperatively and flexibly to meet each landowner's unique needs (Rudkin 2003). The education and outreach approach was eventually successful, but the initial response was slow and the demonstration value of the first project was crucial for building trust on subsequent projects. For example, the first landowner was initially suspicious of the project and declined to participate but invited the City back after seeing a successful conservation project implemented on a neighbor's land (Zander 2003).

Similarly, a pilot program on the Kalamazoo River in Michigan faced initial resistance from farmers despite clear financial and regulatory incentives. The Kalamazoo River Nutrient Trading Demonstration Project was a small pilot program (a single-point source wanted to explore nonpoint source offsets in anticipation of a production expansion), had time and reasonable funds to evaluate the viability of trading, anticipated the need for flexible, individually-evaluated trades, and as a demonstration project wanted to bring a broad set of farmers to the table. Few substantive differences distinguished trading from traditional subsidies for the farmers,[15] and the Steering Committee stressed that they offered payments for BMPs that might become mandatory at the farmers' cost after a Total Maximum Daily Load (TMDL) was implemented (Kieser 2003).[16] The farmers were not initially motivated to lis-

[15] The comparison was not so straightforward for regulators, since conservation practices usually address soil loss and trading required a quantification in terms of phosphorus. However, farmers did not have to perform this analysis.

[16] A Total Maximum Daily Load (TMDL) is the total amount of a pollutant that state regulators determine can be received by a waterbody without violating water quality standards. This value includes pollution from point, nonpoint, and natural background sources. Section 303 of the Clean Water Act requires states to identify impaired waters and develop a TMDL for each pollutant in each listed body of water.

ten, however, because they did not trust regulators, feared vilification by environmentalists, and hesitated to do anything voluntarily that might later become mandatory (Batchelor 2003). After two years, successful education efforts focused on personal and small group meetings directed at farmers by farmers on the Steering Committee (Kieser 2000). Education and outreach eventually proved to be a successful mechanism for communicating with farmers, although having an agricultural producer promote trading was instrumental in overcoming farmers' motivational barriers.

The Conestoga River Nutrient Trading Pilot is a Pennsylvania pilot within the Chesapeake Bay Nutrient Trading Program. It is a small, experimental program exploring multi-credit trading as a means of heading off a TMDL and is supported by the USEPA, the Department of Environmental Protection, the Pennsylvania Environmental Council, and several environmental organizations (Enterprising Environmental Solutions Inc. n.d.; Crable 2002). Given the program goals and the lack of pressure from point sources for rapid offsets, it has focused on building broad stakeholder support and reaching out to a large agricultural audience. Farmers have shown greater initial interest compared to Kalamazoo River or Boulder Creek, in part because the specter of a TMDL did motivate them to explore conservation options (Van de Mark 2003). Even so, educating stakeholders remains a huge challenge, and the program has benefited from integrating farmers into the outreach effort itself. The Steering Committee designated an outreach team, including representatives from the plain sect and Amish farming communities, to conduct informal meetings and field trips to demonstrate BMPs. Farmers have been receptive to this outreach, and the program has already pursued a demonstration project with a poultry producer (Van de Mark 2003).

Other cases, however, have shown clearly that education and outreach can be inadequate for overcoming farmers' distrust. Negotiation with farmers in the Fox-Wolf Basin was not fruitful because small farm owners were concerned about much more than the economic bottom line. Although farmers would have been more than adequately compensated for any BMP that took land out of production, a strong sense of property rights discouraged farmers from government involvement (Stoll 2003). The Fox-Wolf Basin pilot trading program had hoped for a large number of trades, but the long existence of stringent phosphorus discharge limits meant that most point sources had already installed necessary upgrades and had little urgency to seek nonpoint source offsets. Furthermore, in the absence of a TMDL, nonpoint source control costs would have to be at a minimum in order to drive trading for purely economic reasons, but in several sub-basins there turned out to be little cost differential (WDNR 2002). Although farmers' reluctance was not the primary barrier to trading in the Fox-Wolf Basin, the icy reception from farmers demonstrated that trading faced an uphill battle.

The Southern Minnesota Beet Sugar Cooperative (SMBSC) also experienced problems due to farmers' mistrust, but the Cooperative faced specific community tensions rather than general discomfort with governmental interference. SMBSC wanted to expand operations but faced a TMDL, and consequently it sought a relatively large number of nutrient offsets from local farmers. With few appealing alternatives to trading, SMBSC's decision to trade was not purely based on the cost-effectiveness of NPS phosphorus reductions, so SMBSC faced neither the economic nor environmental pressure to reach an especially broad set of agricultural trading partners. SMBSC initially tried to interest cattle ranchers, but long-seated tensions between ranchers and beet growers effectively blocked cooperation (Klang 2003). In the end, education and outreach proved to be inadequate for overcoming the trust barriers and encouraging ranchers' participation, and SMBSC resorted to another mechanism—using embedded ties with their own growers—to achieve their trading objectives.

Third-Party Facilitation

Cases employing a trustworthy third party to facilitate trades support our hypothesis that this approach can lead to more refined searches and efficient negotiations. Although the Rahr Malting Plant created a small program that desired long-term flexibility, the higher time constraints (Rahr wanted to treat its own wastewater rather than send it to a municipal plant, but a TMDL determined that there could be no new dischargers even if the net discharge was unchanged) suggested that third-party facilitation was more appropriate than simple education and outreach. The cooperative participation of the Coalition for a Clean Minnesota River (CCMR), a local environmental organization, greatly aided Rahr in successfully identifying and negotiating with NPS trading partners (Klang 2003). Farmers were receptive to CCMR because they felt that they could trust its message. As Scott Sparlin, the former chairman of CCMR explains, the farmers were unlikely to listen to anyone who seemed too much of a businessman, government agent, or environmentalist, but they felt that they could trust his message because he was familiar with their landscape and understood their concerns (Sparlin 2003). Other trades were identified by the local chapter of American Waters and a member of the Minnesota Department of Natural Resources, and this outside assistance effectively reduced the transaction costs of trading (Fang and Easter 2003).

The Lower Boise River nutrient trading program seeks to establish a large, inclusive, watershed-based nutrient market with significant flexibility and a focus on cost-effectiveness. Point sources are responsible for soliciting bids from farmers, and the program is sufficiently flexible to accept cost-shared BMPs as well as BMPs brokered by a third party for the purpose of a trade (net environmental improvement is guaranteed in either case by the retirement of a portion of the nutrient credits) (Schary 2004). In effect, the Lower Boise program can better fit the needs of both conservation-minded and profit-oriented farmers. Conservation-minded farmers have the opportunity to implement BMPs without sharing in the financial burden (as in cost-share), while farmers who may be more attracted to private contracts are not required to negotiate with state agencies (Schary 2004).[17] Trading on the Lower Boise cannot occur until a TMDL is implemented, so no trades have been initiated, but the program design shows great attention to the benefits of networking while addressing the potential for bias and exclusion.

The Rock River trading program, a Wisconsin pilot program, expected to rely on brokered trades, primarily through embedded ties but also possibly through other third parties (WDNR 2002). Over 60 sources expressed interest in trading through 1999, but by 2000, most of the seven point sources still exploring point-nonpoint source trading were only looking to trading as an inexpensive "quick fix" to supplement or delay plant upgrades (WDNR 2000). Embedded ties would have been advantageous given the high time constraints and the large program size, but the county land conservation departments (LCDs) already faced staffing and budget constraints and were largely unwilling to put in sufficient time to see trades through (embedded ties will be further discussed in the following section). Several point sources considered alternative mechanisms of communication, turning to outside consultants to facilitate trades (WDNR 2000). In the end, no point sources reached the negotiation phase with farmers, since most point sources found that trading was not cost-effective due to the trading ratio, the high existing adoption rate of BMPs among farmers, and the large amount of land on which BMPs would have needed to be implemented in such flat terrain (Wade 2004). Farmers would have likely been interested in trading if they had been offered a strong

[17] Although most PS will probably want farmers to have a certified nutrient management plan, this is not required. The market, rather than regulations, will be the ultimate determinant of farmers' involvement with soil conservation agencies.

enough financial incentive, but in early discussions it was clear that farmers also had a sense of "why should we help the city?" (Wade 2004). Overall, farmers' interest was not the major factor influencing outcomes, but without the full participation of the LCDs, there was an inherent difficulty in reaching a sufficient number of farmers (Wade 2002; WDNR 2002).

Building on Embedded Ties

Finally, building on embedded ties and existing programs can allow a relatively efficient implementation of water quality trading, although this approach can potentially come at the expense of the long term lowest marginal cost pollution reductions (Hoag and Hughes-Popp 1997). Unlike the education and outreach cases, which clearly demonstrate the impact of trust on farmers' participation, it is difficult to "prove" that the trust in these networks reduced farmers' reluctance to trade. What these cases do demonstrate, however, is that embedded ties can reduce negotiation and transaction costs and allow trading opportunities to reach a relatively large number of farmers with greater ease. Farmers have tended to be willing participants where personal relations give them greater voice in the terms of trading or where designing trading around an existing program reduces the uncertainty associated with trading.[18] These findings are consistent with embeddedness theory.

Several cases have utilized existing networks to integrate farmers more cooperatively into the design and negotiation of trading terms, ensuring farmers an equitable share of benefits. After outreach with cattle farmers fell through, the Southern Minnesota Beet Sugar Cooperative (SMBSC) traded with its own shareholders, the beet growers. The working relationship with the farmers helped SMBSC avoid many sources of transaction costs, such as trade identification, information collection, and bargaining (Fang and Easter 2003), and SMBSC successfully contracted for cover crop BMPs on 39,000 acres (Klang 2004). The embedded ties mechanism was therefore more successful for SMBSC than education and outreach, but it came at the expense of the lowest, marginal-cost, phosphorus reductions. Trading with the beet growers was certainly not an ideal arrangement for SMBSC; cover crop BMPs required a tremendous amount of monitoring through 399 individual contracts, while even the close connection with SMBSC did not stop the farmers from driving a hard bargain (Klang 2004). This is consistent with Granovetter's (1985) observation that vertical integration is expected where a network of personal relations with other firms is lacking, even though internal transactions still have a strong political element regarding transfer pricing. Now that the trading with the beet growers, via embedded ties, has provided the quick initial phosphorus credits, SMBSC is looking into surface tile intake systems as a more permanent and cost-effective phosphorus control. It will likely work cooperatively with the Hawk Creek Watershed Project, a local organization that works on water quality and quantity issues in the watershed (Klang 2003).

Selenium trading between irrigation districts in California's San Joaquin Valley shows how trading can be implemented smoothly using existing organizations of farmers and existing methods for monitoring drainage outputs. Irrigation and drainage districts, organized as the Grassland Area Farmers, initially consented to a regional selenium discharge cap as part of the use agreement for a federal canal. In the face of the selenium cap, the districts had an urgent desire to increase their compliance options by creating a trading system. Trading in the Grassland project oc-

[18] Other cases of cooperative resource management, such as transferable quotas in fisheries, have shown that participation in designing rules makes compliance more likely (e.g., Hatcher et al. 2000). We have primarily focused on farmers as recipients of information rather than active participants in designing trading programs, however, for in most cases the challenge is simply getting farmers to willingly listen and discuss trading. This contrasts with the design of mandated rules in that farmers are not automatically "at the table." Once a farmer chooses to explore BMPs for the purpose of a trade, he or she typically does have a great deal of control in determining the on-farm implementation.

curs between districts and each district designs its own portfolio of economic incentives (primarily tiered water pricing) and drainage control methods. The dependent position of the farmers means that they are not driving the trades, but the flexible and de-centralized decision-making structure of the program allows each locally controlled district to respond to local farming conditions and costs (Young and Karkoski 2000). The existing organization of drainage districts, high time constraints, and need for flexibility made this communication mechanism a natural choice and a locally popular program (Austin 2001). Perhaps the most streamlined but controversial trading strategy is to coordinate with existing soil conservation subsidies. Rather than giving farmers a larger role in guiding trades, utilizing these networks avoids social concerns and trust problems by piggy-backing onto existing cost-share programs. Most of the programs that have partnered with soil conservation or cost-sharing programs have simply used the county Land Conservation Departments (LCDs) or Soil and Water Conservation Districts (SWCDs) to identify trades. On the Red Cedar River, Wisconsin, the City of Cumberland benefited from working relationships between conservation agencies and farmers without formally building upon existing programs. The Red Cedar River pilot trading program faced similar conditions and goals as other pilots, such as Kalamazoo River or the Conestoga River. It was a small program that focused on flexibility and cost-effectiveness rather than rapid implementation of trades. However, the tight budget of the municipalities drove the choice of embedded ties. The City of Cumberland partnered with the Barron Country Land LCD, which advertised trading alongside other state and federal cost-share programs (Kramer 2003). The LCD effectively absorbed the administrative costs of the trading program and brokered trades with farmers while Cumberland funded the BMPs. With trading prices modeled on cost-share payments, the two options were virtually identical for the farmers (WDNR 2002). The primary difference was that cost-share agreements took more time to implement than trading contracts, so the farmers could receive their money more quickly through trading (Prusak 2004). Interestingly, the Village of Colfax also looked into trading as part of the Red Cedar River Pilot Trading Program, but without the cooperation of its LCD, the administrative costs of identifying farmers were prohibitive (WDNR 2002).

In the Piasa Creek Watershed Project, the Illinois American Water Company (IL-AWC) received an adjusted sediment discharge requirement in exchange for funding nonpoint source sediment reductions through the Great Rivers Land Trust (GRLT). IL-AWC has ten years to secure the nonpoint source reductions, resulting in an emphasis on cost-effectiveness rather than rapid implementation. The Project utilizes two kinds of embedded ties. GRLT had been organizing educational outreach and land acquisition programs for five years prior to the trading agreement, and the Project had a great deal of landowner cooperation even before it was approved by the Illinois Pollution Control Board (IPCB 2000). Even so, many landowners were initially hesitant to participate, and the GRLT enlisted the assistance of the County Soil and Water Conservation District (SWCD) and the Natural Resources Conservation Service (NRCS) in identifying landowners and explaining the Project (Ringhausen 2004). GRLT itself conducts the negotiations with landowners for sediment loading reduction projects, land acquisition, and conservation easements. A successful demonstration project and outreach through embedded ties has generated more landowner interest in participation than GRLT can fund (Ringhausen 2004).

Both the Cumberland trade on the Red Cedar River and the Piasa Creek program used the LCD or SWCD to identify trades but distinguished between BMPs implemented for a trade and those implemented using cost-share funds. The Rock River pilot program considered a much more integrated strategy, partly because most farmers in the basin that would have been eligible for trading already received cost-share funding. The WDNR determined that a PS could get credit for contributing to projects already partially funded through cost-share, but a PS would only receive credits proportional to the amount they funded relative to cost-sharing funds (Wade 2004). In the end, this strategy of using embedded ties failed to produce any trades, both because the point sources determined that it was too difficult and uncertain to reach such a large number of offsets and also because most of the LCDs were reluctant to donate the staff time and budget necessary to make trading work (WDNR 2000).

Trading in the Tar-Pamlico Basin, North Carolina, is the classic example of how trading can be established quickly using cost-share programs as a foundation. The Tar-Pamlico Nutrient Reduction Trading Program includes sixteen point sources who promoted trading as a cost-effective alternative to North Carolina's proposed point-source control policy. The trades are structured as an exceedence tax that funds BMPs through cost-share programs, emphasizing stability and reliability rather than simple cost of credits. If the association of point-sources, the Tar-Pamlico Basin Association, exceeded its collective cap, then it would pay directly into cost-share to purchase credits at a fixed price (NCDENR 2003). By channeling funding through an existing subsidy program, such that farmers do not explicitly involve themselves in trading, this arrangement avoids raising farmers' fears of negative social or political results (Hoag and Hughes-Popp 1997). Search costs are negligible, since farmers' interest in cost share already surpasses available cost-share funds (Gannon 2003). The Association funded a staff position in the Division of Soil and Water Conservation in the initial phase, but no new institutional structures were needed to administer the agreement. In the end, the Association was able to meet the cap and has not needed to pay for NPS offsets through cost-share, although it provided 1 million dollars in anticipation of trading (Coan 2002). By formally building trading onto existing cost-share programs, the Tar-Pamlico program is more streamlined than the Red Cedar River or Piasa Creek trades, but this strategy might not be universally desirable because it provides less feedback from farmers, less transparent accounting of trades, and less flexibility for the program to evolve.

The Lower Boise River trading program's dual use of mechanisms has already been discussed under third party facilitation, but it is worth contrasting its approach to cost-share with other programs. Unlike Tar-Pamlico, which exclusively funds BMPs through the cost-share programs, and Red Cedar and Piasa Creek, which used cost-share ties to broker trades and set prices but kept funding separate, the Lower Boise River program recognizes overlap and cooperates with cost-share without forcing trades to follow the cost-share model. This allows for networks outside of cost-share—such as personal relations between PS and NPS, or referrals from third parties—to encourage trading. In effect, the Lower Boise River program draws on the synergy between cost-sharing and trading without sealing off other trading opportunities.

Summary

As the detailed case studies above discuss, all three mechanisms can effectively reach farmers and address the social issues associated with trading, but success depends to a great extent on the details of program objectives and local conditions. Based on detailed information provided in the case studies, Table 3 provides a mapping of existing programs to the program conditions and objectives identified in Table 1. The conditions that Table 1 expects to be optimal for each mechanism are shown in the "predicted conditions" columns. Where a program uses more than one mechanism, it has been placed in both mechanism categories.

As discussed above, we define success simply as the program's ability to bring farmers to the table—whether for discussions regarding program design or for actual trades. Therefore, a program can have successfully reached its objectives even if no trade went through. For example, the

TABLE 3
EXISTING WATER QUALITY TRADING PROGRAMS: CONDITIONS AND OBJECTIVES

		Education and Outreach						Third-Party Facilitation				Embedded Ties						
		Predicted Conditions	Boulder Creek	Conestoga River	Fox-Wolf Basin	Kalamazoo River	SMBSC	Predicted Conditions	Lower Boise River	Rahr Malting Plant	Rock River	Predicted Conditions	Grassland Area Farmers	Piasa Creek	Red Cedar River	Rock River	SMBSC	Tar-Pamlico
Size	Small	X	X	X		X		X		X			X	X	X			
	Large				X		X		X		X	X				X	X	X
Time constraints	Low	X	X	X	X	X		X	X					X	X			
	High						X			X	X	X	X			X	X	X
Initial farmer attitudes	Less receptive				X	X	X	X	X	X	X	X				X	X	
	More receptive	X	X	X									X	X	X			X
Long-term program flexibility	Less important				X		X				X	X		X		X	X	X
	More important	X	X	X		X		X	X	X			X		X			
Minimizing transaction Costs	Less important	X		X		X			X	X			X					
	More important		X		X		X	X			X	X		X	X	X	X	X
Reaching broad set of farmers	Less important						X			X		X			X		X	X
	More important	X	X	X	X	X		X	X		X		X	X		X		
Program success?			Y	Y	N	Y	N		Y	Y	N		Y	Y	Y	N	Y	Y

Kalamazoo River program is widely considered to be a successful pilot program because several NPS projects were implemented and the viability of setting up trades was demonstrated, although the PS trading partner went bankrupt before a trade was completed. Based on this definition of success, we include an assessment of success for each program in each mechanism category in the last row of Table 3.

Most cases do not precisely match the "predicted conditions" under which the choice of a given mechanism would be optimal. The weights placed on each factor differ from case to case, and the extent to which a communication mechanism effectively reaches farmers is affected by the relative weights of the factors.

We find only three programs that did not achieve some degree of success, but the chart should not be read to imply that all programs reach their objectives regardless of farmers' initial attitudes and mechanism choices. In fact, the case studies clearly discuss how programs that were ultimately successful often had great difficulty convincing farmers to participate. Additionally, two of the three cases in which no degree of success was achieved (SMBSC under "education and outreach" and Rock River under "third-party facilitation" and "embedded ties") are situations where the program initially adopted one mechanism and subsequently switched to another. As discussed above, we feel that in these cases the switch was due to the fact that program objectives were not being met with the existing mechanism, although Rock River also faced the challenge of finding a supportive party with embedded ties to farmers.

Taken as a whole, the education and outreach cases tell a fairly clean story about the predicted conditions. The more successful programs were those that most closely approximated the predictions, while the less successful programs were clear mismatches for this mechanism in terms of program size and initial farmer receptiveness. Trading programs using third-party facilitation tended to be similar to programs using education and outreach with the notable exception that third-party facilitation was advantageous where farmers were initially less receptive. Trading programs that employed embedded ties were much less homogeneous as a group. In these cases, the key was that the relative weights of the factors overall favored embedded ties. For example, although embedded ties are recommended for a large program, a small program might utilize this mechanism if faced with acute time constraints. Nearly all of the programs using embedded ties did feel pressure for rapid program development, emphasizing quick and efficient implementation over long-term flexibility and cost-effectiveness.

We must be careful, however, not to make too strong of a statement about the significance of our results since our small sample size precludes us from conducting a more formal analysis that would allow us to statistically test these relationships. These results, however, are suggestive, allowing us to conclude that most programs choose the communication mechanism that is appropriate given their program characteristics, while unsuccessful programs are those that chose an inappropriate mechanism given their program characteristics.

These conclusions in light of our detailed case analysis suggest that a program's ability to attract farmers to the negotiating table is not based solely on communication mechanism choice; nor is it based solely on inherent program characteristics or goals. Rather, it seems that the interaction between these two—that is, a program's mechanism choice given program conditions—is the critical factor for program success.

VII. CONCLUDING REMARKS

In this paper, we have tried to more fully explore the social barriers to participation and argued that the mechanisms of communication and outreach may influence program performance. There are three key lessons we can draw from this study: (1) although largely overlooked by the trading literature, farmers' participation decisions often have a strong social component. In particular, the case studies suggest that farmers' perceptions of risk and equity—

and therefore their initial willingness to discuss trading—are conditioned by the degree of trust in program administrators; (2) mechanisms of communicating with farmers may influence program performance. Consistent with embeddedness theory, employing communication mechanisms that are anchored in trust, such as third parties or embedded ties, may reduce farmers' reluctance to participate and reduce the transaction costs associated with trading; (3) ultimately, a program's success in bringing farmers to the table will depend on the interaction between local conditions, program objectives, and the choice of communication mechanism. Trading programs tend to be more successful at reaching farmers if they choose a mechanism that matches the key predicted conditions. Cases that fall in the middle of the predicted conditions might consider combining communication mechanisms. This hybrid approach could simultaneously pursue multiple mechanisms, providing that a trading program does not formally limit trades to farmers with certain embedded ties. This dual use of approaches, however, may also run the risk of spreading a program's resources too thin.

Alternatively, a hybrid model might structure the mechanisms in a series, distinguishing between approaches that benefit program initiation and approaches suited to long-term program evolution. An initial partnership with existing relations or programs might help a program establish itself quickly and cost-effectively, while a gradual shift towards education and outreach could ensure long-term flexibility and inclusiveness. For example, SMBSC pursued a series of mechanisms; initially stalled with an unbrokered outreach campaign, SMBSC was able to use embedded ties to implement an early trade and is now exploring alternative trades that will be more cost-effective and permanent in the long term.

This type of series may be especially beneficial for establishing demonstration projects and providing time for educational mechanisms to gain a foothold. As electronic resources become more sophisticated and widely applicable, and as demonstration projects help more farmers become familiar with trading, we would predict that farmers' suspiciousness would be reduced, and an education and outreach approach would be more successful.

Although only 12 U.S. water quality trading programs have attempted to incorporate agricultural sources to date, an additional 15 programs have been proposed or preliminarily explored (Breetz et al. 2004). The findings on trust and communication mechanisms may provide guidance for these nascent water quality trading programs, and as more programs are implemented, there will be greater opportunity for an econometric analysis. The findings from this study may also stimulate similar research in other environmental trading schemes—such as habitat offsets, water flow trading, or carbon trading—where unregulated landowners must be persuaded to participate, and where mistrust of the government's motivation may hinder open and productive communication. For example, the Kyoto Protocol's Clean Development Mechanism (CDM) may benefit from the use of embedded ties to overcome the historical mistrust between developed and developing countries, particularly for carbon mitigation projects in which developed countries offset their emissions with reforestation or afforestation projects in developing countries. These projects face many parallels with PS-NPS water quality trading, including challenges of scientific uncertainty, monitoring, compliance, and permanence related to land-use changes, and anchoring communication and negotiation in trust could be a valuable strategy for minimizing the trading partners' perceptions of risk and equity.

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