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Limitations of Certification and Supply Chain Standards for Environmental Protection in Commodity Crop Production

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Abstract

Motivated by recent increases in water pollution in major US agricultural watersheds and by the shortcomings of government programs to control non–point source pollution, this paper examines the prospects for using product certification (ecolabeling) and business-to-business supply chain standards for environmental protection in commodity crop production. We introduce the sources of demand for certification and supply chain standards and the political and economic context in which they have expanded since the 1990s. We explore how various agrifood certification and supply chain standards have been used to achieve changes in production methods and/or in product attributes to meet social goals, and we discuss the prospects for applying these models to commodity crops. We conclude that the nature of corn and soybean production, distribution, and consumption—with numerous sales outlets and invisible consumption as part of processed foods and other products—makes certification schemes to limit agricultural pollution unrealistic and supply chain standards extremely challenging.

INTRODUCTION

There are limits to government regulation of an agrifood system in which consumers are concerned not only with food quality and safety but also with externalities such as animal welfare, environmental pollution, and fair labor practices. The increasing heterogeneity of consumer demand and the increasing consciousness of externalities associated with agricultural production have extended into areas in which products and processes cannot easily be regulated. The US government has limited ability to regulate value chains in other countries, for example, to curb deforestation in Ecuador or to protect coffee producers or banana plantation workers in Nicaragua. Within the United States, regulation of non–point source pollution such as nutrient runoff from crop production has been very limited, even as strong legislation restricts point source forms of pollution such as that from factory smokestacks and wastewater discharge pipes.

In commodity crop production, nitrogen and phosphorus, and the sediment to which they are bound, leave agricultural fields when soil erodes, typically during runoff events caused by heavy rainfall. One impact of soil erosion is siltation, which hampers biodiversity in streams and can interfere with navigation and thus require expensive dredging. Another impact is unsightly algae blooms that can kill fish, close beaches, and cause a range of adverse symptoms in humans (Chorus & Bartram 1999). These problems appear to have been worsening in recent years in the United States (Michalak et al. 2013, Wisconsin Department of Natural Resources 2013). At the same time, the relationship between phosphorus runoff and algal blooms is not linear. Algal blooms occur with different frequencies in different years, even if the level of phosphorus remains constant, and they could rise even with a decline in phosphorus runoff. In addition, implementation of conservation practices is likely to have a more beneficial impact on water quality in some areas than in others (Bosch et al. 2013), depending on local topographic and soil characteristics. As a result, conservation practices need to be implemented where they will be the most effective, and substantial research is under way to identify the most cost-effective locations for implementing conservation practices (e.g., LimnoTech 2013).

Farmers are within their rights to use nitrogen and phosphorus as inputs to their crops, and in most cases there is no requirement that they use agricultural practices—such as cover crops, buffer strips, and reduced nutrient application—that would mitigate the problem. In essence, from a Coasian perspective (Coase 1960), farmers own the property right over the use of public waterways to absorb sediment and nutrients that leave their fields.

Because farmers are within their rights to deposit nutrients into waterways, efforts to reduce agricultural pollution typically consist of an offer to farmers of incentives to change their practices. In particular, various US government programs such as the Conservation Reserve Program (CRP) and the Environmental Quality Incentives Program (EQIP) encourage farmers to adopt conservation practices on their land. CRP offers lease payments to farmers to remove land close to waterways from production and to establish plant species that will improve environmental quality (USDA 2013a). EQIP's National Water Quality Initiative covers the cost of adopting conservation practices such as buffer strips, cover crops, and nutrient management (USDA 2013b). However, programs such as CRP and EQIP have limited ability to solve agricultural pollution problems due to a lack of coverage. High commodity prices in recent years have made lease prices under CRP relatively unattractive to farmers (Secchi et al. 2009).

The lack of success of current approaches to address externalities of modern agricultural production has raised interest in approaches to influence agricultural producers through pressure in the market. In the past couple of decades, private certification and supply chain standards for farms and agricultural products have emerged as a new form of governance, with implications for the adoption of sustainable agricultural practices. In this review, we refer to certification as

voluntary labeling schemes originating outside the supply chain and refer to supply chain standards as procedures that large retail firms require their suppliers to follow as a precondition for doing business.

The logic of certification is to reward producers for favorable management practices rather than to prohibit or penalize unfavorable practices (Cashore et al. 2004, de Boer 2003, Horne 2009). Certification, which originates outside the supply chain, typically involves the use of labels to indicate to consumers that the product is associated with favorable practices. However, lessons from successful consumer labeling and certification schemes suggest that such schemes work only under certain limited conditions and often cover only very small portions of the relevant market. For example, fair trade coffee is one of the most widely known certification schemes, but only 17% of coffee production worldwide is compliant with fair trade or similar sustainability standards (Potts et al. 2010). There is an emerging consensus that consumer-oriented product certification cannot drive transformation of production practices toward greater environmental sustainability (Barry et al. 2012, SustainAbility 2011).

The logic of supply chain standards (sometimes referred to as private standards) is that corporations that control a large enough share of the market dictate terms that their suppliers must follow (Henson & Reardon 2005, Reardon et al. 2000, Tallontire 2007). Supply chain standards focus on business-to-business transactions, for example, between a producer and a retailer, and tend to be established in support of the retailer's profit motive. Supply chain standards also help firms avoid occurrences that could severely damage their reputation or prompt government regulation, for example, an outbreak of food poisoning linked to their products or evidence that the workers who produced the products were mistreated. Such standards can raise production costs substantially and sharply constrain which producers are capable of being part of the supply chain (Michelson 2013, Reardon et al. 2000). These standards become prerequisites for gaining market access, even if they are not legal requirements.

In the text that follows, we explore the drivers of demand for existing certification and supply chain standards, recent changes in agrifood governance, elements of effective certification and supply chain standards, and barriers to introducing certification and supply chain standards for commodity crops. On the basis of the requirements for successful certification and supply chain standards and the ways in which these commodity crops are consumed, produced, and marketed, we conclude that consumer-oriented certification has virtually no prospects for success in reducing pollution by corn and soybean production and that supply chain standards will also face grave challenges.

DRIVERS OF DEMAND FOR EXISTING AGRIFOOD CERTIFICATION AND SUPPLY CHAIN STANDARDS

The main sources of motivation that stimulate consumer interest in supply chain standards are (*a*) consumer well-being, including food safety and health; (*b*) producer well-being, including fair earnings and labor rights; and (*c*) environmental protection. Various other forms of social responsibility and ethical behavior also interest certain consumers. These factors underlie the risks that firms face in terms of their reputation, the reliability of their supply chain, and the risk that new regulations will be imposed, and as such these factors are the key sources of demand for supply chain standards.

Consumer well-being in the agrifood context refers primarily to food safety, which involves both short- and long-term concerns. Food contamination that can cause short-term illness is of primary concern to businesses and perhaps the single most important source of demand for agrifood standards. For example, an outbreak of hepatitis A that killed four people helped shut

down Chi-Chi's restaurant chain (Salin et al. 2006), and an *Escherichia coli* outbreak traced to the Jack in the Box restaurant chain nearly bankrupted the company (Nestle 2010). Closely related standards and certifications are for organically produced food and food that does not use genetic modification, both of which represent food safety concerns for some consumers.

To some extent, advances in traceability of food through the supply chain allow one to easily identify either the source of pathogens that sicken consumers or the presence of ingredients that consumers want to avoid. Research has demonstrated that traceability is important to consumers and that they are willing to pay more for traceability assurance (Dickinson & Bailey 2005, Hobbs et al. 2005). At the same time, the increasing complexity of supply chains in which products from multiple farms are aggregated makes traceability more challenging (DeLind & Howard 2008). Consumers have neither the technology nor the time to determine whether everything they purchase is safe, so they rely on measures such as standards, inspection, and labels.

For longer-term food safety concerns (e.g., carcinogens, pesticides, herbicides, and certain chemicals), traceability is much weaker, thus reducing business risk and the extent to which self-interest alone would stimulate a business to implement a standard. Such a risk does not disappear, but it is less immediate.

Producer well-being and labor well-being, including paying producers and laborers fairly, not exposing them to toxins or hazards, and not employing child labor, are the focus of another category of standards and certifications. At the heart of this driver of demand are both equity from the perspective of the consumer and reputational risk for businesses. The issue of producer well-being can be a driver of demand when labor is drawn from countries where labor laws are not as well defined as they are in the global north or where global commodity prices give producers very low prices.

Environmental protection as a driver of demand refers to (*a*) aspects of the natural resource base that are essential to the production process in question or (*b*) effects of the production process on the natural resource base. Environmental standards in the agrifood supply chain are based either on consumer willingness to pay (WTP) for environmental protection or on firms' and growers' desire to minimize environmental risk to their production processes. Efforts based on consumer WTP usually involve a label that guarantees to the consumer that the product was produced in a certain way that minimizes environmental externalities; for example, the production process reduces deforestation or protects birds or other wildlife.

A number of other factors can be of interest to some consumers, for example, treating animals ethically, buying locally, or investing in other ways in the local community. In the certification and standards hierarchy, the more individualized concern of food safety is the most important driver of demand, and other factors rank much lower because fewer consumers are interested in them. For example, in a study looking at consumer preference for apples, consumers chose organic over ecolabeled apples because of the perceived health benefits (Loureiro et al. 2001). The attitude-behavior gap, wherein even those consumers who possess knowledge, awareness, and concern might not always display prosocial behavior (e.g., Kollmuss & Agyeman 2002, Vermeir & Verbeke 2006), is also relevant here.

NEW GOVERNANCE IN THE AGRIFOOD SUPPLY CHAIN

In the United States, consumers and the private interest groups that represented them were traditionally thought to have little influence over food companies or government regulators. Schweikhardt & Browne (2001) cite three major changes in the structure of the food economy in the late-twentieth century that changed the ability of consumers and private organizations representing them to affect food policy. First, traditional legislative channels became congested

because a proliferation of interest groups meant that separate, temporary coalitions had to be rebuilt for every legislative battle, with high transaction costs and low returns. Second, the rising affluence of consumers led to increased demand for products characterized by specific attributes. Third, increased concentration of food markets, with a small number of firms dominating different parts of the market, left them easily identifiable and increasingly susceptible to consumer pressure. These changes have given rise to an agrifood political system in which pursuing political objectives directly through the market rather than through legislative channels is both advantageous and feasible for consumers and the private interest groups representing them.

The involvement of these new actors and interest groups in directly pressuring the private sector to promote practices that are important to them has been referred to as a "new form of governance" (Steering Committee of the State-of-Knowledge Assessment of Standards and Certification 2012) and as a "new politics of food" (Schweikhardt & Browne 2001). Supply chain pressure from private interest groups is now common in the agrifood industry, and the number of labels, certifications, and standards to promote favorable production practices continues to grow.

This new governance of the agrifood supply chain has changed the involvement of actors both inside and outside the supply chain. We discuss various certification programs and supply chain standards, the institutional arrangements they follow, and how actors leverage pressure to reach their goals. We cite examples of actors who impose pressure from outside the supply chain, actors and actions inside the supply chain, and collaborative arrangements consisting of actors both inside and outside the supply chain.

Pressure from Outside the Supply Chain

Organized interests such as nongovernmental organizations (NGOs) have become ubiquitous in the new politics of food. NGOs can influence the market in two main ways: (*a*) by establishing certification schemes outside the supply chain to try to reward producers for adhering to certain objectives they set and (*b*) by leveraging corporate risk to pressure corporations to change their own supply chain standards. Ultimately, both approaches aim to encourage corporations to change their own standards.

Certification. Labels certifying prosocial production processes date back to at least 1978, when the government of the Federal Republic of Germany established the Blue Angel ecolabel in support of manufactured goods that embodied proenvironmental production practices (Jordan et al. 2003). By 1993, the Forest Stewardship Council (FSC) had introduced certification and labeling for timber products, showing that private interest groups could also set standards for industry to follow, with verification by independent third parties that the standards had been met. The idea was to generate enough demand for standards-compliant products that certification would become a de facto condition for market access (Barry et al. 2012). Certification is successful when the most ecologically advantageous products become the industry standard (Blue Angel 2013).

Following FSC, there have been numerous examples of third-party NGOs directly rewarding producers for socially beneficial behavior. One of the best known is Fairtrade, which indirectly rewards producers through higher prices on the basis of its labeling scheme guaranteeing consumers that the producer earns a fair return and pays fair wages. The Fairtrade label combines the efforts of FLO-CERT, a for-profit company that inspects, certifies, and assists producers in gaining and maintaining certification, and Fairtrade International (FI), an NGO that develops the standards and licenses organizations (Fairtrade International 2013). FI is an association of producer networks, national labeling initiatives, and marketing organizations that promote and market the Fairtrade Certified label for a range of products in developing countries.

More recently, the Working Landscapes Certificate (WLC) demonstrated that one could certify a product without actually tracing it through the supply chain (IATP 2013). Established in 2006 by the nonprofit advocacy group Institute for Agriculture and Trade Policy (IATP), WLC is a voluntary certification offset program in which corn growers meet environmentally sustainable production criteria for corn used in the production of bioplastics. IATP pays farmers to guarantee that a specified quantity of acreage meets a set of standards, but it does not trace which corn is actually used to produce bioplastics.

Governments have moved from a purely regulatory role to developing and managing certifications and standards themselves, with the intention of improving environmental outcomes. In addition to the case of Germany establishing Blue Angel, many other European governments and the European Union also sponsor ecolabels (Jordan et al. 2003). In the United States, examples include the National Organic Program (NOP) administered by the US Department of Agriculture (USDA), which maintains national standards for organically produced agricultural products. NOP develops the laws that regulate the creation, production, handling, labeling, trade, and enforcement of all USDA-certified organic products on the basis of input from a federal advisory committee comprising a variety of stakeholders (USDA 2013c). Any certified operation in violation of the regulations is subject to financial penalties or to suspension/revocation of the organic certificate. Energy Star is another example of a US government–administered certification program. It is administered by the US Department of Energy and Environmental Protection Agency to rate the energy efficiency of various appliances, electronics, and other equipment, with the goal of creating more environmentally oriented supply chain dynamics (US EPA 2013).

Another approach to improving environmental outcomes is to certify producers rather than products. For example, the Michigan Agriculture Environmental Assurance Program (MAEAP) works directly with farmers, certifying farms that implement resource-conserving practices. MAEAP is a voluntary program that facilitates the prevention and mitigation of agricultural pollution risks through nutrient management for farms of all sizes and commodities (MDARD 2013). It is administered by the Michigan Department of Agriculture and Rural Development in consultation with an advisory council, but it was established by a coalition of farmers, commodity groups, state and federal agencies, and environmental conservation groups. The primary motivation for producers to gain MAEAP certification is to mitigate risk from existing and potential environmental regulations, and additional sources of motivation are good stewardship and technical assistance in managing nutrients (Vollmer-Sanders et al. 2011). Other states have similar programs; one example is New York's Agricultural Environmental Management program (NYSDAM 2013).

Leveraging corporate risk. Another form of pressure originating outside the supply chain is when interest groups bring attention to unfavorable corporate practices in a way that threatens a corporation's reputation. For example, in 1999 Greenpeace questioned the use of genetically modified organisms (GMOs) in baby food processed by Gerber Foods, prompting Gerber immediately to take steps to remove all genetically modified corn and soybeans from all its products (Schweikhardt & Browne 2001). Similarly, through its McCruelty campaign in 1999, People for the Ethical Treatment of Animals (PETA) successfully pressured McDonald's to improve its animal welfare and sustainability practices (De Blasio 2008). McDonald's responded with its Animal Welfare Initiative. In collaboration with the US Animal Welfare Council, McDonald's designed standards for quality, safety, efficiency, and sustainability of its supply chain for meat products (McDonald's 2013).

To leverage corporate risk in order to influence practices within the supply chain, NGOs have also used a variety of other methods, such as environmental scorecards. Scorecards are derived

and solicit data in a range of ways. Scorecards such as WWF's Palm Oil Buyers' Scorecard are administered by NGOs that take publicly available company data, invite firms to contribute more data, and then rank companies on the basis of these data. Other scorecards work with specific corporations that share internal data; McDonald's participates in this way in Conservation International's environmental scorecard. Field to Market, facilitated by the Keystone Center, takes another approach by developing environmental indicators and publishing industry-wide data to create a peer incentive for firms to improve their practices across the whole industry (Field to Market 2013).

Pressure from Within the Supply Chain

Pressure from within the supply chain generally comes from downstream actors. Consumers are the most downstream actors, and they can informally impose pressure on suppliers through their purchasing power. Stolle et al. (2005) describe political consumerism as a way in which consumers try to influence markets through practices such as boycotts or "buycotts." By intentionally avoiding or purchasing products consistent with a certain principle to be upheld, consumers use the market to vent concerns or vote for values or ethics through their purchases. Hadwiger & Browne (1978) trace the popularity of this approach back to the 1960s, with boycotts against grapes and lettuce in support of better treatment for migrant farm workers. However, because normally it is prohibitively costly for individuals to self-organize, given their diffuse interests and large numbers (Olson 1971), their participation is often facilitated by NGOs that operate outside the supply chain as described above.

The real power inside the supply chain lies with the large retailers. In contrast to consumers, large retailers can be particularly effective in achieving supply chain goals because they are organized and their decisions about whom to purchase from can have significant influence in the market. As a result, retailers can put pressure on actors further upstream, particularly producers but also processors and distributors. To the extent that retailers represent consumers' interests, for example, in assuring food safety, they can act on consumers' behalf, but only to the extent that such action is consistent with consumer demand.

In the new agrifood policy arena, retailers are greatly concerned about risks to their operations in terms of both reputation and regulation (WWF 2011). Mitigating reputational risk can be a very significant driver of environmental change. Food safety outbreaks, socially unfavorable practices associated with environmental damage, and mistreatment of workers or animals have the potential to severely harm a company's reputation and thus reduce its sales, affecting its bottom line. Regulatory risk concerns the possibility that if industry does not act in a socially responsible way, the government may step in and impose regulations. The threat of additional government regulations and their associated costs can create significant pressure for firms to pursue socially responsible practices (Barry et al. 2012, Lyon & Maxwell 2004, Vogel 2008).

In the agrifood industry, the main form of reputational risk concerns food safety because a serious food safety outbreak can gravely threaten a company's survival. Concern about food safety risk is a critical driver of supply chain standards designed to minimize such risk. Demand for minimization of food safety risk is what makes GLOBALG.A.P. a powerful player in the agrifood business. GLOBALG.A.P. was created by supermarket chains and their major suppliers to set standards for agricultural practices that are required for supplying the supermarket chains and their suppliers worldwide (GLOBALG.A.P. 2013). GLOBALG.A.P. is the most widely implemented supply chain standards scheme in the world and is used by the world's largest supermarket chains, with independent third-party auditing at each step of production. GLOBALG.A.P. is able to mandate adherence to standards because it represents the most important buyers and

because integrating food safety into the supply chain is a competitive strategy for producers by which to protect their reputation and mitigate risk (Bain 2010). Because GLOBALG.A.P. vertically integrates the value chain for food safety, certified producers are the first to be cleared for business after a food safety outbreak. Tallontire (2007) distinguishes between private collective standards like those of GLOBALG.A.P., which involve multiple actors in an industry, and private company standards, which are set and monitored by an individual corporate actor.

Driven in part by pressure from external actors as described in the previous section, individual corporate actors now impose supply chain standards in support of various social benefits ranging from animal welfare to the environment and human rights (Maloni & Brown 2006). As mentioned above, McDonald's established its Animal Welfare Initiative in response to threats to its reputation, and today these programs are recognized as industry leaders for driving ethical, environmental, and economic responsibility (SustainAbility 2011). Wal-Mart has also imposed extensive sustainability standards within its supply chain as much to bolster its reputation as to cut costs and meet consumer demands (Humes 2011). Large retailers like Wal-Mart and McDonald's have sufficient market power that suppliers must comply as a condition for the health of their business. Because supply chain standards have become the most important driver of production practices worldwide, large retailers have led the mass transition toward food safety certification and have significantly contributed to pollution reduction (Reardon et al. 2000).

Collaborative Efforts at Agrifood Governance

Multistakeholder groups, or roundtables, comprising myriad representatives across the industry have emerged as an institutional arrangement combining actors both internal and external to the supply chain. Firms have an incentive to participate in order to mitigate various forms of risk, such as the risk of reputation loss, as discussed above, whereas NGOs, universities, and other actors participate to achieve environmental or other socially desirable outcomes.

Examples of multistakeholder groups include the Roundtable on Responsible Soy (RTRS) and the Roundtable on Sustainable Palm Oil (RSPO), both of which focus on improving the public credibility of their respective commodity. RTRS members include large agribusinesses with private sector and nonprofit partners. Membership requires adherence to the Standard for Responsible Soy Production, which governs aspects of production ranging from community relations and labor conditions to environmental responsibility (RTRS 2013). Similarly, RSPO's members represent all parts of the palm oil industry as well as nonprofit partners; it is designed to develop and implement global sustainability standards for palm oil, including labor conditions, community relations, and various environmental factors (RSPO 2012). RSPO differs from RTRS in that it is based on a certificate trading program in which producers earn a premium for producing sustainable palm oil. Both RTRS and RSPO were created by agribusinesses that have been criticized for using them to seek market power as opposed to seeking sustainability goals (García-López & Arizpe 2010, Schouten & Glasbergen 2011).

Multistakeholder groups driven by NGOs tend to receive better reviews in terms of achieving environmental change. The Alliance for Water Stewardship (AWS) is a partnership of NGOs and public-private initiatives to promote and reward sustainable water use through a voluntary certification program with third-party verification. AWS designed the International Water Stewardship Standard, a set of criteria and indicators to ensure that water use is environmentally, socially, and economically sustainable (AWS 2013). Other differences between AWS and the commodity roundtables are that AWS uses a verification process for performance against the standard and that AWS is a member of the International Social and Environmental Accreditation and Labeling Alliance.

Specialized interest groups such as grower associations represent producers inside the supply chain, but they operate externally. Grower associations relay benefits to their producer members through promotion, marketing, and lobbying, which are funded by income generated by checkoff programs. In recent years, such associations have become interested in introducing sustainability measures to improve their reputation. For example, the National Corn Growers Association uses the Keystone Alliance for Sustainable Agriculture's (Keystone Alliance's) Fieldprint calculator so that producers can monitor and document sustainability and changes in sustainability. The Keystone Alliance includes major agribusinesses and processors, the American Farm Bureau Federation, national grower associations, NGOs, and universities. The Keystone Alliance works with commodity growers and collects data from them. It does not explicitly set goals or offer any incentives for producers to meet sustainability goals other than reporting on sustainability trends for various commodities at the national level.

WHAT MAKES AN EFFECTIVE AGRIFOOD CERTIFICATION OR SUPPLY CHAIN STANDARD?

In a simple sense, standards are effective if they result in improvements in social, environmental, and economic practices. The question also arises as to whether certification or supply chain standards can be the means by which to achieve socially optimal levels of change toward desirable practices. Existing literature tends to focus on the question of what effects certification and standards have, and that question is our focus in this section. We return briefly to the question of achieving social optimality in the next section, but this area requires additional research.

Distinguishing an effective certification or standard from an ineffective one is challenging. In a meta-analysis of the impact of standards and certification, Blackman & Rivera (2010) find a lack of evidence that ecocertification benefits the environment. Of the 37 studies they identify, only 14 use methods likely to generate credible results, and only 6 find that certification generated environmental or socioeconomic benefits. In part, this finding supports concerns that not all labels and standards are truly intended to effect change but that some of them are mere greenwashing, or giving a false impression of meaningful environmental change in the pursuit of market share (TerraChoice 2009).

In a review of standards and certification programs, Barry et al. (2012) find evidence of improvements in social, environmental, and economic practices resulting from certification at the site level in particular cases but find limited evidence of longer-term impacts. Similarly, many studies included in this review do not use research tools sufficiently robust to attribute outcomes to the certification program. Empirical evidence is a major stumbling block to establishing whether sustainability certification programs have successfully contributed to sustainability objectives. Below we identify several key criteria that can help evaluate the effectiveness of standards and certification efforts on the basis of studies cited above and criticism of existing examples discussed.

Effective Certification and Supply Chain Programs Are Meaningful and Measurable

Some standards are based on very specific mandates and targets with figures and projected outcomes, whereas others lack concrete indicators. To mitigate selection bias and to have the largest impact, standards must be established in such a way that there are no free riders (no certified producers who do not meet the standard). For a standard aimed to limit non–point source water pollution by commodity agriculture, an outcome-based approach rather than an input-based approach would be ideal. To the extent possible, farms must show that they are not contributing

to pollution as opposed to simply undertaking practices that are known to limit runoff of nutrients and other pollutants.

For reducing agricultural pollution from commodity crops, the biggest constraint on an outcome-based approach is the difficulty of measuring actual pollution incidence. Verifying that a farm is using pollution prevention practices is much easier than knowing whether it is actually contributing to pollution. Some fields are more prone than others to nutrient runoff, depending on their location, soil type, slope, cropping systems, and other factors. This is particularly true for phosphorus and sediment. For nitrogen runoff from tile-drained areas, a practice-based approach may be suitable because nitrogen delivery to water bodies in these watersheds is uniformly distributed across all fields (Iowa State University 2013). Better assessment tools are needed to effectively identify where to prioritize practices to control sediment and nutrient runoff. Tools already exist to identify broadly where to target investments to reduce agricultural pollution from commodity crops (e.g., Bosch et al. 2013), but continued progress is needed to sharpen such tools for use at a much finer scale. Current research is addressing this need, taking advantage of new technology and data to model sediment and nutrient loading (LimnoTech 2013).

Verification of Producer Changes Must Be Independently Evaluated

Certification and supply chain standards vary in the extent to which they utilize independent third-party auditing and verification, and this information influences how consumers perceive the certifier (Roe & Teisl 2007). Type I labels are third-party certified, whereas type II labels are self-declarations by manufacturers, importers, distributors, or retailers, with no third-party verification (Horne 2009). Examples of type I labels include Blue Angel, FSC, and WLC (Green Harvest), whereas examples of type II labels include CFC-free and recycled content (Horne 2009). FI has two separate organizations under one umbrella with distinct functions: administration of the label and certification of compliance.

The perceived independence of the institutional structure has implications for consumer trust. Gertz (2005) finds that consumers are most willing to trust labels administered by consumer or environmental organizations, whereas they are less likely to trust labels administered by third-party independent bodies and even less likely to trust labels administered by governments; retailers ranked as the least trustworthy. The proliferation of voluntary labels has led to consumer distrust over claims made by retailers (Horne 2009) and to an increase in the popularity of third-party labeling. Both the inclusion of multiple stakeholders and independent verification contribute to the public credibility of the label (Hicks 2012).

Standards Must Be Stringent Enough to Cause Environmental Change

Large retailers have a strong incentive to maintain stringent food safety standards because of the harm that a food safety outbreak could do to their reputation. Their incentives to maintain stringent standards may be weaker for sustainability and other objectives besides food safety.

Certification initiatives are often faced with the predicament of whether to expand the coverage of the label at the expense of the stringency of the label requirements. In 2011, Fair Trade USA split from FI over the question of whether to broaden standards to include corporate entities or to remain small but with more stringent standards. Fair Trade USA chose to become more inclusive and hence increase coverage, whereas FI decided to retain a more narrowly defined set of guiding principles. Raynolds et al. (2007) describe this tension as a question of whether fair trade is an avenue of corporate reform, basically upholding the values and institutions of the market, or an avenue for transforming market values and institutions by promoting social justice concerns.

Placing administration of the certification under the jurisdiction of the government may also threaten the level of stringency. After the USDA overtook management of organic certification, a loss of local control and market flexibility (Fetter & Caswell 2002) and a dilution of standards, transparency, and civic engagement (DuPuis & Gillon 2009) ensued. Shifting the management of the NOP to the federal government effectively allowed the influence of external actors such as retail lobbyists to decrease the original sustainability content of the standard toward an emphasis only on the safety aspects (Jaffee & Howard 2009). Designing an effective standard to protect against agricultural pollution would require resisting the influence of external actors, including commodity interest groups and agribusiness firms.

Cost-Effectiveness Is Central to Widespread Adoption of Certification and Standards

An effective certification or standard must meet its objectives with minimal cost to be economically viable. Many sources contribute costs, such as the costs of using production practices that meet a standard and the transaction costs of demonstrating that the standards are met. For example, meeting GLOBALG.A.P. standards can require costly, capital-intensive investments, putting small farmers at a competitive disadvantage. Farms that can adopt the standards at a low cost will do so, whereas other farms with higher costs will not (Campbell 2005). Similarly, Bacon (2005) finds that, although access to fair trade and organic markets provided coffee producers in Nicaragua with higher prices and reduced their livelihood vulnerability, their production costs exceeded their average sales price due to the high cost of quality assurance and other factors. For nonpolluting commodity crop production, an outcome-based approach could limit costs by avoiding unnecessary adoption of conservation practices by farms that are not contributing to pollution. Achieving this cost-effectively will require continuing improvements in technology to better identify the most important sources of pollution and runoff, as discussed above.

The other side of cost-effectiveness concerns how well an effort actually achieves its objectives. A study by SustainAbility (2011) finds limited effectiveness of certification schemes attempting to generate consumer demand for sustainable practices through labeling and greater success in business-to-business schemes. The SustainAbility report points out that, whereas labeling for consumers may initially play the important role of originating a system to promote and demonstrate favorable production practices, it eventually becomes impossible to label every favorable aspect of production, and consumers are less likely to notice labels and pay extra for them as they proliferate. In cases in which separate firms within an industry set their own internal standards, if they can build a recognizable identity for good behavior, there is no need for a special label.

A Focus on Continuous Improvement Can Be More Effective Than Just Setting Minimum Standards

Creating an incentive for continuous improvement as opposed to simply setting a permanent minimum level for producers to meet can lead to better outcomes (Barry et al. 2012). Tiered programs, such as Leadership in Energy & Environmental Design (LEED) certification for building sustainability and ratings-based programs like Energy Star for household appliances, encourage competition among producers to reduce pollution. Providing an incentive for continuous improvement such as a ratings or tiered system based on implementation of various measures to reduce runoff can have a greater impact on water pollution than simply setting minimum tolerance levels. In a voluntary scheme, such an incentive would encourage participation of high-polluting farms that would not initially meet a high standard but that could gradually improve their performance. In a mandatory scheme, an incentive would allow such producers

the opportunity to stay in business while learning to meet gradually tightening standards. In contrast, programs like MAEAP (introduced above), that certify farmers who reduce their regulatory risk by meeting a fixed standard, run the risk that such an incentive will create an obstacle to larger changes that might be needed to meet social goals.

BARRIERS TO INTRODUCING CERTIFICATION AND SUPPLY CHAIN STANDARDS FOR COMMODITY CROPS

A number of factors influence (*a*) the benefits that businesses can gain from introducing environmental sustainability into the supply chain and (*b*) the cost and ease of doing so. In this section, we examine three key factors: how the product is consumed or used, how it is produced, and how the supply chain is organized. Each of these factors contains several components that we outline. We then discuss the potential for application of certification and supply chain standards to commodity crops and the commodity crop supply chain by comparing the product and market attributes of these products with the factors identified.

Because environmental sustainability has niche market appeal, businesses do not face much pressure to incorporate sustainability attributes relative to an attribute like food safety that sharply and directly concerns every consumer. Therefore, environmental sustainability is an important motivator for some but not necessarily most consumers, and the way in which the consumer relates to the product in question determines the feasibility of the sustainability initiative.

Consumption Properties

The way in which a product is consumed has the potential to affect consumers' interest in the product's links to environmental sustainability, and this interest can affect a business's profitability of investing in environmental sustainability. Thus, a critical factor in determining whether a certification program can succeed relates to consumer-side characteristics of the good. Three relevant consumption properties are (*a*) whether the attribute sought is valued by consumers as a public good or a private good, (*b*) whether the good is an intermediate good or a final good, and (*c*) the degree of distinguishability of the good from products that are not certified.

Attributes of the good are private goods as opposed to public goods. Clean public waterways and other environmental goods are often referred to as public goods because they are nonexcludable and nonrival (Samuelson 1954). An attribute like food safety could be considered a private good in the sense that a unit of safe food is rival and excludable. Private goods tend to obey the laws of supply and demand, whereas public goods often result in market failure and externalities. Consumers are free to consume a product with a higher level of food safety if they are willing to pay for it, but efficient provision of a public good such as clean water via a product with environmental benefits is not an important motivator for all consumers. Consequently, there are many free riders who want cleaner water but are not willing to pay more for a product that contributes to clean water. Even if a good meets certain environmental standards and achieves some environmental change, such change is likely not the socially optimal level of change.

RSPO's GreenPalm certificate trading program offers a vivid example of the challenges of achieving socially optimal levels of environmental improvement through a voluntary certification scheme. RSPO reports that it certified 15% of global palm oil produced in 2012–2013, but the demand for sustainable palm oil came almost entirely from the United States and Europe, which consume ~13–14% of the total global supply of all palm oil. In contrast, there is virtually

no demand for certified palm oil in China, India, and Indonesia, which together consume considerably more than half of the world's palm oil (Watson 2012, 2013). RSPO cannot have any real impact on palm oil production if buyers in these countries are not willing to pay a premium for sustainable production.

The good is a final product as opposed to an intermediate product. One important concern with respect to a product's consumption properties is consumer consciousness of the product—more specifically, whether it is a final product or an intermediate product. A final product—for example, a piece of fruit—is consumed directly, whereas an intermediate product is an input into a final product. Nearly 100% of corn and soybeans are consumed as intermediate products. In the case of corn, 40% is used as animal feed, 39% goes to ethanol, and nearly all of the rest is used for various food processing and industrial uses (Wisner 2013). Approximately 85% of soybeans are pressed for soybean meal and soybean oil, and again virtually all soybeans are consumed indirectly (Soyatech 2013). When an intermediate product is invisible in this way, merely being conscious of consuming it (Pollan 2006), let alone being concerned about social factors related to its production, takes effort. Intermediate goods such as corn and soybeans potentially have a lower demand for sustainability standards than do final products, given this additional step in the supply chain.

Profiling farmers on product packaging is one way firms have tried to market the connection between the consumption of a product and the specific farmer, practice, or community where the product is produced. Examples of this marketing approach are increasingly commonplace and can be found on cartons of organic milk and bags of fair trade coffee. This approach is impossible for corn and soybeans when they appear only as an ingredient in processed foods. The WLC program addresses the intermediary nature of its target products by tailoring the certification specifically to packaging for processors who use plastics rather than processors who might use corn as a food ingredient.

A related example concerns McDonald's Animal Welfare Initiative. Beef is an obvious input to the final product—hamburgers—and consumers will easily make the connection to animal welfare. McDonald's also uses large quantities of corn and soybean products directly or indirectly as ingredients in its food products, but it does not have initiatives for these commodities. Possible reasons for the lack of such initiatives are the length of the supply chain, the indirect nature of consumption, and even the stigma attached to processed corn and soybeans. McDonald's may prefer that consumers not be very conscious of the presence of such ingredients in its food products. Also, one cannot ignore the social construction of the problems that drive standards. In the arenas model, in which only a limited number of problems can garner sufficient attention to effect change (Hillgartner & Bosk 1988), cruelty to animals is relatively easy for consumers to envision and evokes strong emotional reactions, thereby generating media attention and supply chain pressure. Water pollution from commodity crops is unlikely to generate enough attention to compete in this arena, particularly against animal welfare and immediate consumer health concerns.

The product being certified is distinguishable from a noncertified product. Another relevant property related to consumption is whether the certified product is easy to distinguish from alternative products. Typically, a certified product is a credence good, one that is not easy to distinguish from alternatives through the use of the senses. For example, sensory inspection of a fair trade banana does not make apparent whether the workers who produced it received fair wages, nor can one detect through visual inspection whether a GLOBALG.A.P.-certified product is devoid of pathogens or a tomato was produced organically. With credence goods, the consumer

must trust the label that indicates that the product has been produced according to applicable standards.

Production Properties

How a product is produced affects its cost of production and the cost of ensuring that it is produced according to certain standards. Adhering to a standard can raise the cost of production per unit of output relative to the default method of production; otherwise the standard would probably be the default. Obviously, if adhering to a standard raises costs substantially, it will not be attractive to producers unless it yields higher revenue or improves market access. Theoretically, if a standard is too stringent, producers will exit the portion of the market that the standard covers or will choose to supply the unlabeled product in a voluntary label setting. This scenario suggests that the production properties of a good that make a voluntary certification program or supply chain likely to succeed include the following: (*a*) Meeting the standard is cost-effective, and (*b*) compliance verification is cost-effective.

All polluters can meet the standard cost-effectively. For a standard focused on pollution, a large percentage of the problem often comes from a small number of polluters, which may undermine a voluntary certification effort. For example, Carpentier et al. (1998) find that only 7 dairy farms of the 237 studied accounted for 75% of the nitrogen delivered to the Lower Susquehanna watershed. In such a situation, producers who contribute little to the problem are likely more interested in becoming certified than producers who contribute a great deal and would face high costs of minimizing pollution. Such a certification program would have little or no environmental impact. Targeting the largest polluters would potentially have the biggest environmental impact with the lowest compliance costs, and an approach other than certification would likely have a greater impact. Given variation in the levels of polluting, outcome-based rather than input-based standards are important for targeting high polluters and for avoiding the imposition of unnecessary costs on nonpolluters.

Compliance verification is cost-effective. Whether compliance with a standard is visible can affect the costs of verification. If the difference in the production process between meeting a standard and not meeting it is invisible, third-party verification will be required and will be more expensive than if the production process were visible. For runoff from field crops, differences in production processes are sometimes visible and sometimes invisible. Cover crops and especially buffer strips to reduce runoff and the concentration of nutrients in runoff water are highly visible and are thus cheaper to monitor. In contrast, it is more expensive to monitor whether a farmer reduces the amount of nutrients applied to a field or reduces application in certain parts of that field prone to erosion, because these practices are invisible in most cases. A possible exception is the case of precision agriculture, whereby inputs are applied to fields by using software- and GPS-enabled equipment. In many cases, input application is contracted out to a private party; in such cases, monitoring the production process to verify that it adheres to a certain standard has almost no additional cost. Of course, this approach is applicable only if precision agriculture is cost-effective and if the farmer is willing to share the data.

Supply Chain Properties

Various characteristics of the supply chain for corn and soybeans and the products that they become limit the feasibility of using certification and supply chain standards to reduce the agricultural pollution associated with their production. We discuss these characteristics below.

The product can be traced easily. Traceability refers to the ability to trace a product through the supply chain, for example, to trace a given bushel of corn from its final use through the production process and back to where it was produced. The ease of traceability of a product through the supply chain has implications for environmental certification of the product's production. A generic supply chain for a crop such as corn or soybeans involves a grower selling to a local grain elevator where the grains are aggregated and then separated according to certain grades. After cleaning and sorting, corn is then taken to a miller or grinder and made into cornmeal or corn oil; soybeans are taken to a soybean crusher and made into soybean meal or soybean oil. From there, the oil is further processed into a vast range of food and nonfood uses, whereas the meal is consumed directly by livestock as filler or for protein. Corn that reaches the retailer (*a*) is in the form of cornmeal or corn syrup, which is used in breakfast cereals, corn chips, and beverages; (*b*) is in meat from animals that consumed corn; and (*c*) has industrial uses such as ethanol and bioplastics.

Traceability particularly matters when meeting a production standard affects the condition of the good to be consumed. Food safety is an obvious case in which the production standard affects the condition of the good to be consumed. In contrast, consumers who are greatly concerned about preventing water pollution may be more concerned that the industry as a whole is contributing to reduced pollution than whether they can trace the corn that they consume back to its production process. In such a situation, the WLC's environmental standards for bioplastics and the GreenPalm standard for palm oil do not rely on traceability. Instead, by assuring that a certain volume of production meets certain environmental standards, an offset market can be established such that a buyer of palm oil or bioplastics can pay a premium to help cover the extra cost of the environmentally friendly production. An offset program such as GreenPalm or WLC that makes segregation unnecessary could be attractive for commodity crops because tracing the origins of certified commodity grains would be extremely costly due to the aggregation of the product from different farms at the local grain elevator. Corn farmers also have a choice of numerous elevators to sell to, which further complicates segregation.

One exception to aggregation is non-GMO corn, which is segregated in the supply chain. Many processors have developed their own private standards for non-GMO crops and for other products that these processors source (Konefal & Busch 2010). Increasing differentiation of the market for corn and soybeans has been concurrent with the spread of GMO corn and soybeans. According to Konefal & Busch (2010), processors are increasingly specifying particular varieties (such as waxy and high oil or protein content), traits (such as non-GMO), and production practices (such as organic). This differentiation of varieties of corn and soybeans is focused on demand from end users, which has been a huge driver of supply chain dynamics in this way.

Given the segregation in the market for non-GMO corn and soybeans, the question arises as to whether nonpolluting and non-GMO corn and soybeans could be bundled together and sold through a single marketing channel. Several questions arise for such an approach. Would buyers interested in paying for one trait also be interested in the other? Is the amount of non-GMO corn or soybeans produced in a given region sufficient such that growing them with less pollution would affect water quality? Does non-GMO corn and soybean production even have favorable water quality implications? Adoption of Roundup Ready cropping systems is closely associated with expansion of reduced tillage (Givens et al. 2009), which in turn reduces erosion and can potentially protect water quality. It would be necessary to explore the compatibility between non-GMO corn and soybeans and improvement in water quality before proposing that they be bundled in the supply chain.

Market power is concentrated. The extent of market power is another important characteristic of a supply chain that can determine the feasibility of supply chain standards. As discussed above,

firms with sufficient market power can require that suppliers comply with a given standard as a condition for entering the market. Even if a firm does not control the whole market, its standard can become the industry standard if it controls a large enough market share.

The wide diversity of uses of corn and soybeans implies that farmers have many sales options. However, with the concentration of uses, the largest buyers could join together to insist that production patterns change to protect water sources. Whether this approach is feasible is not known.

CONCLUSION

The characteristics of corn and soybeans that we discuss above—complex distribution systems, product mixing, and the indirect way in which consumers use these commodities—mean that a consumer-focused certification scheme does not have a realistic possibility of successfully inducing farmers to adopt practices that will reduce pollution. The limited correlation between farmers' production practices and actual negative environmental events in any given year further reinforces this conclusion.

Environmental NGOs such as The Nature Conservancy, the World Wildlife Fund (WWF), and the Environmental Defense Fund are already active in trying to create demand for environmental protection. They can continue to help make consumers conscious of the connection between agricultural management and the condition of water resources and to put pressure on the government and industry to take action. Regulations to control agricultural runoff are not likely to be imposed in the foreseeable future.

The most realistic opportunity, even if it faces major challenges, is to work with major buyers of corn and soybeans to convince them to require that these crops be produced with less agricultural pollution. One key challenge in this case lies with the indirect consumption of corn and soybeans. Some of the businesses that use these products do so indirectly, and others that use them are invisible to most consumers. As a result, these firms are not easy targets of consumer pressure. For example, firms that sell meat indirectly use a great deal of corn (they purchase meat from big direct purchasers of animal feed made from corn). These firms may be well known, but it may be difficult for consumers to make the connection between the meat these firms sell and agricultural pollution. Firms that produce animal feed, in contrast, use corn and soybeans directly but are relatively unknown to the general public. They are not likely to be the subject of direct consumer pressure, and they have little reason to impose pressure on farmers. The buyers of the ultimate product, in particular large retailers like McDonald's and Wal-Mart, are more likely to be the source of such pressure.

An additional challenge to working with major retailers to promote environmentally sustainable corn and soybean production is that the market for these commodities is not vertically integrated, and thus growers have many outlets to which to sell their crop. Therefore, if one buyer demands that suppliers use more costly environmentally sustainable production practices, growers may simply decide to sell elsewhere. In addition, because grains from different sources tend to be combined into a single stream at the elevator, any given retailer will have difficulty ensuring that it is buying only sustainably produced corn or soybeans. Of course, setting up a separate distribution of corn and soybeans is possible, although costly.

Another, possibly more feasible alternative is to mimic the offset approach of WLC and GreenPalm, whereby commodity buyers purchase shares in the sustainably produced commodity to ensure that it is produced, even if it does not necessarily end up in their own supply chain. Such an approach would be far more cost-effective because it would eliminate the costly process of segregating different commodity streams, although how it would work is not clear. In contrast,

although WWF supports GreenPalm as an interim measure, it argues that sustainable palm oil ultimately requires a traceable supply chain (Watson 2012, 2013).

SustainAbility (2011) suggests that the most promising future for the use of standards to promote the adoption of sustainability practices is precompetitive standards to which all actors in the supply chain adhere such that competition among firms is based on other attributes of production. Consumer labels, segregation of the supply chain, and competition among different grain buyers would play no role in a system in which the entire industry adhered to the same standard. As such, a precompetitive standard would rate highly on all the criteria listed above for evaluating a standards scheme. According to SustainAbility (2011), such an approach would be characterized by collaboration between corporations, civil society, and government "to embed standards into business models and to transform supply chains." Further development and participation in multistakeholder groups designed to meet the criteria outlined here would likely be components of any effective standard.

A current initiative by Kellogg's, the producer of breakfast cereals, and Bunge, a large agribusiness firm that buys corn from farmers and sells it to Kellogg's and others, illustrates a possible road toward a precompetitive supply chain standard that could reduce agricultural pollution (Fatka 2013). Kellogg's and Bunge are working with Field to Market to examine the carbon and water footprint of the corn that is used in Kellogg's Frosted Flakes. Although just a pilot project that does not specifically address agricultural pollution, it represents the kind of approach that could be undertaken. To be effective, it would require that major corn buyers work together to insist on more sustainable production practices as a precondition for entering the market. It would also require accurate and cost-effective methods to implement an outcome-based assessment of measures to reduce agricultural pollution.

The SustainAbility (2011) recommendation of a precompetitive standard is a target to be aimed for, not a solution to the challenges related to stimulating demand for an effective approach to set standards for commodity corn and soybean production systems that protect water quality. SustainAbility (2011) offers the clear idea of putting in place a set of practices that all players in the supply chain can agree to, but how to actually achieve a precompetitive standard is unclear. In particular, what are the best options for encouraging industry to agree to such standards; for example, under what conditions might threats to firms' reputations and the threat of regulation be viable sources of pressure? Given the indirect nature of consumption, what are the most effective ways to generate interest by consumers in demanding agricultural practices that limit pollution of waterways? What approaches can keep costs manageable; for example, are viable approaches likely to require or not require segregation in the supply chain?

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