Sustainability **2015**, *7*, 612-633; doi:10.3390/su7010612

OPEN ACCESS

sustainability

ISSN 2071-1050

www.mdpi.com/journal/sustainability

Article

Governing Sustainability Transitions: Multi-Stakeholder Initiatives and Regime Change in United States Agriculture

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Academic Editors: Douglas H. Constance and Maki Hatanaka

Received: 10 October 2014 / Accepted: 30 December 2014 / Published: 7 January 2015

Abstract: Using a case study of US agriculture, this paper examines how governance affects sustainability transitions in socio-technical systems. The multi-level perspective (MLP) has become a leading framework for theorizing sustainability transitions in socio-technical systems. It posits that transitions to more sustainable socio-technical systems are an outcome of external pressure at the landscape level and internal pressure emanating from niches. While the MLP is a robust analytical framework, it under-theorizes the role that governance plays in sustainability transitions. This paper addresses this research gap through examining three multi-stakeholder initiatives (MSIs) that have developed sustainability metrics and standards for US agriculture: Field to Market; LEO-4000; and the Stewardship Index for Specialty Crops. Applying a governance analytical framework, membership selection, decision-making procedures, and access to resources are found to affect the kinds of sustainability metrics developed, as well as their likely implementation. Specifically, the governance processes functioned to channel sustainability metrics towards ones that were congruent with the existing agrifood regime, and marginalize metrics that had the potential to disrupt regime processes. Thus, this article proposes that governance is a key component of sustainability transitions, and that current usage of MSIs in much of environmental governance may function to moderate sustainability transitions.

Keywords: sustainability transitions; governance; food and agriculture; standards and metrics

1. Introduction

Since the formal codification of the idea sustainability with the Brundtland Commission in 1987, sustainability has become an ever-pressing issue. Over the course of the past decade, a growing body of literature as emerged that examines the possibilities for socio-technical systems, such as transportation, energy, and agriculture, to undergo sustainability transitions [1–3]. At the forefront of this research is the multi-level perspective (MLP), which posits that transitions to more sustainable socio-technical systems are an outcome of external pressure at the landscape level and internal pressure emanating from niches [1,3]. Citing increased environmental pressures at the landscape level, such as climate change, increased resource scarcities, and population growth, combined with a proliferation of niche innovations focused on sustainability, MLP scholars contend that many socio-technical systems are in the midst of, or on the verge of, sustainability transitions.

While the MLP is a robust analytical framework for assessing possibilities for more sustainable socio-technical systems, it under-theorizes the role that governance plays in sustainability transitions [2,4,5]. Beginning with the founding of the Forest Stewardship Council in 1993, non-state governance in the form of multi-stakeholder initiatives (MSIs) has become a leading approach for fostering sustainability transitions [6,7]. MSIs are a form of stakeholder governance that uses democratic practices to develop regulatory mechanisms, such as metrics and standards [8,9]. Today, prominent sustainability MSIs include the Forest Stewardship Council, the Marine Stewardship Council, as well as the multiple roundtables sponsored by the World Wildlife Fund (e.g., Roundtable on Sustainable Palm Oil and Roundtable on Responsible Soy). Given the proliferation of environmental governance initiatives over the past two decades, the lack of analysis of governance represents a significant shortcoming in the MLP. This paper addresses this shortcoming through the incorporation of research on standards, metrics, and governance into the MLP.

Using a case study of US agriculture, this paper examines how governance, power, and politics affect sustainability transitions. During the past forty years, US agriculture has come under increasing criticism regarding its negative social, economic, and environmental externalities [10]. While the state has implemented a number of polices and programs to partially address these concerns, today, many of the efforts to increase the sustainability of US agriculture are taking place outside of the state. Since 2007, a handful of MSIs have been established to develop sustainability metrics and/or standards for US agriculture. They include: Field to Market, the Leonardo Academy's LEO-4000 initiative, and the Stewardship Index for Specialty Crops (SISC). Each of the MSIs has developed standards and/or metrics for sustainable agriculture in the US [11].

Using data from interviews and document analysis, a governance analytical framework is used to examine the internal dynamics of the governance processes of each of the three MSIs. This includes analysis of membership selection, decision-making procedures, and access to resources. The analysis finds that the ways that these processes are structured has affected the kinds of metrics developed by each of the three MSIs. Specifically, differences in members, decision-making processes, and resources have resulted in divergences among the metrics of the three MSIs. The metrics developed by both Field to Market and SISC map out a program of "sustainable intensification" in which sustainability is largely equated with ensuring resource sufficiency. In contrast, the metrics developed by LEO-4000 include more robust environmental metrics, as well as social and economic metrics. However, analysis of

LEO-4000's governance process also reveals that its legitimacy is contested and consequently, its metrics may not be widely adopted. Thus, this article finds that governance is a key component of sustainability transitions, and that the current usage of MSIs in much of environmental governance may function to moderate sustainability transitions.

The remaining portions of this article are organized as follows. First, the literature on sustainability transitions is reviewed and applied to the US food and agriculture system. Second, relevant research on standards, metrics, and non-state governance, and the ways that these are imbued with politics and power is discussed. Third, the methods and data used in this paper are outlined. Fourth, an overview of the three agriculture sustainability MSIs and their metrics is provided. Fifth, the kinds of sustainability transitions that the metrics developed by each of the three MSIs might give rise to are examined. Sixth, the ways that the governance processes of each of the three agriculture sustainability MSIs have affected the development of metrics is analyzed. The article concludes with a discussion of the paper's findings for the MLP and the sustainability of US agriculture.

2. Sustainability Transitions

An increasingly influential way of conceptualizing society is as a set of overlapping socio-technical systems. A socio-technical system consists of networks of actors, institutions, cultural practices, knowledge, and technologies [2,12]. Examples of prominent socio-technical systems include agrifood, transportation, and energy. Beginning in the 1990s, a stream of research emerged that examines how these systems transition from a particular set of practices, technologies, and institutions to a new set [12]. More recently, there has been growing interest regarding the extent to which and the ways that socio-technical systems transition to more sustainable structures and practices [1–3].

The MLP has become among the most robust frameworks for examining sustainability transitions in the socio-technical system literature [1,3]. The MLP conceptualizes socio-technical systems as consisting of three analytical levels: niches, regimes, and landscapes. Niches are "protected spaces" through which transitional technologies and practices can develop and be fostered. Thus, niches can include pilot projects, small market segments, and research and development networks [1]. Regimes are the next level and are the key structuring agent of socio-technical systems. Geels [1] defines regimes as "the semi-coherent set of rules that orient and coordinate the activities of the social groups that reproduce the various elements of socio-technical system" (p. 27). In the United States, the automobile-based transportation system and the fossil fuel energy system are examples of socio-technical regimes. The landscape level represents the wider context and includes such things as "demographical trends, political ideologies, societal values, and macro-economic patterns" [1] (p. 28). For example, key landscape forces today include the ongoing processes of globalization and neoliberalization.

In the MLP, socio-technical systems are characterized by tension between stability and change. On the one hand, regimes function to stabilize and lock-in socio-technical systems to specific path dependencies [13]. On the other hand, alternative technologies and practices that challenge existing regimes are continually proliferating in the niches [13]. Thus, innovations by regime actors tend to result in incremental change, whereas "'revolutionary' change originates in 'niches'" [3] (p. 440). Geels [1] (p. 29) has modeled changes in socio-technical systems as occurring through the following three-step process: "(a) niche-innovations build up internal momentum; (b) changes at the landscape level create pressure on the regime; and (c) destabilisation of the regime creates windows of opportunity for niche-innovations". As change is a dynamic process that must be enacted by a variety of actors, MLP scholars note that the outcome of socio-technical transitions are emergent [1,13]. Hence, they can range from transformation to less disruptive outcomes, such as cooptation of niche developments [1,14].

MLP scholars posit that changes at both the landscape and niche levels are fostering sustainability transitions in a number of socio-technical systems. At the landscape level, such factors as global climate change, increased resource scarcities, and continued population growth are widely cited as creating opportunities for sustainability transitions. At the same time, responding to such environmental problems, and the opportunities that they are generating, there has been a proliferation of niche innovations focused on sustainability in many socio-technical systems [15]. The combined result of such landscape pressures and niche developments is increased pressure on regime actors for a sustainability transition in many socio-technical systems.

Applying the MLP to the US food and agriculture system, it appears that the US food and agriculture system is in the midst of a sustainability transition. At the landscape level, several ongoing developments are pressuring actors in food and agriculture to increase their environmental sustainability. The first is global climate change. On the one hand, agriculture is currently a significant contributor to global climate change and thus, producers are facing pressure to lower their production of greenhouse gases. On the other hand, changes in climate conditions threaten the continued sustainability of agriculture globally [16]. For example, parts of US agriculture have faced historical droughts in recent years. Second, agriculture producers also face increased resource scarcities, including land, water, and oil, which threaten their future productivity [10]. Third, global population is projected to continue to grow, which will exert further pressure on agriculture systems. The disruptive character of these developments was witnessed in the food crisis that plagued parts of the world from 2005–2008 [17]. This most recent food crisis illustrated not only the environmental challenges facing agriculture, but also the social challenges as the precarious state of food security in large parts of the world was exposed [18,19]. While some have sought to portray the recent food crisis as a temporary aberration, others argue that it "was not a blip, but creeping normality" [20] (p. 97). Given such challenges, agriculture is argued to be at a "crossroads" in that substantial reforms are necessary to sustainably meet future food needs [21]. In the US, this position has been echoed by the National Research Council [10], which notes that achieving sustainability in US agriculture will entail not only incremental changes but also transformative ones.

At the same time that landscape pressures on the US food and agriculture system continue to increase, niche challenges are also growing. Most notable is the continued proliferation of alternative forms of food and agriculture focused on increasing the sustainability of US food and agriculture. The idea of local food continues to gain in popularity, as the number of farmers markets, community supported agriculture programs, urban gardens, and farm-to-table restaurants all continue to grow. Organics, which many view as a more sustainable form of agriculture [22], continues to gain in acreage and market share [23]. There has also been a proliferation of other forms of potentially more sustainable forms of agriculture and food products, including humanely raised and handled, biodynamic, free range, non-genetically-modified, grass fed, and rBGH-free. Thus, as the proliferation in the number of niches indicates, as well as increases in their market share generally, forms of agriculture that many consider more sustainable are becoming a greater part of the US food and agriculture system.

In the MLP, the combined effect of these dual pressures should be, at least the beginnings of, a sustainability transition in US agriculture. That is, there should be restructuring at the regime level towards practices that are more sustainable. There are several indications that such a transition is indeed taking place. At the retail level, large retailers, such as Walmart and Krogers, are devoting greater shelf-space to more sustainable goods (e.g., organics and fair trade), featuring sustainable goods more prominently in stores, making efforts to source local foods, and developing programs to increase the sustainability of their supply chains [24]. Similarly, many restaurant chains have also made commitments to increasing the sustainability of their supply chains. Many processors and branded food companies are also establishing sustainability programs. Increasingly, large food processors, such as Kellogg and General Mills, are acquiring organic product companies [25]. This indicates that some of the alternative niches are being mainstreamed and becoming part of the US food and agriculture regime. Many input and technology investment companies have also increased research and development on technologies focused on increasing sustainability, such as sensor and information technologies and drought resistant crop varieties [26]. Adoption of practices that may increase the sustainability of their operations, such as the use of integrated pest management, is also increasing by farmers outside of the niches. In sum, a transition towards more sustainable practices appears to be underway in the US food and agriculture system.

3. Governance and Sustainability Transitions

The MLP stresses that sustainability transitions need to be enacted. Smith *et al.* [5] argue that sustainability transitions require "the coordination and steering of many actors and resources" (p. 1492). As such, "the MLP is shot through with agency" [13] (p. 474). However, while the MLP effectively demonstrates the ways that sustainability transitions entail negotiations and compromise among a multitude of actors, it has given little attention to the internal dynamics of such negotiations. In a review of the literature, Markard *et al.* [2] note that the MLP has largely neglected "issues of power and politics" and identify this as a key area of research (p. 962). Similarly, Marsden [4] argues that "how power, both economic and political, is differentially allocated and mediated in the contested and complex levels of landscapes, dominant regimes and socio-technical niches" is under-theorized in sustainability transitions research (p. 132).

Over the course of the past two decades there has been a significant proliferation in private governance initiatives focused on sustainability. Increasingly multi-actor governance in the form of MSIs is being used to develop sustainability standards and metrics [7]. Thus, governance, and especially MSIs, have become a key component of sustainability transitions in most, if not all, socio-technical systems [27]. Given such increasing governmentality of the environment, the lack of analysis of politics and power represents a significant shortcoming in the MLP. Drawing on research on standards, metrics and governance, this gap in the MLP is addressed through examining the ways that governance is mediating a sustainability transition in US food and agriculture.

Standards and metrics have become increasingly prominent regulatory mechanisms [28]. Standards establish a set of criteria that a given actor must comply with, while metrics outline criteria and associated measurements. Whereas standards typically have a cut-off point that must be met, metrics tend to be used for benchmarking. While often formally voluntary, in many economic sectors standards and metrics have become *de facto mandatory* in that market access is dependent on meeting specific standards [29,30]. For example, in food and agriculture, producers often need to adhere to multiple sets of standards, such as GlobalGAP, Safe Quality Food, and organic.

Standards and metrics make people, processes, or objects consistent and uniform through specification of rules, procedures, and/or qualities [28,31]. However, in doing so, standards also generate social and/or ecological change. For example, Timmermans and Epstein [31] argue, "by coordinating people and things in new configurations, standards transform, and their outcome is a transformed world" (p. 83). This means that standards and metrics are imbued with power in that they remake people, society, and/or ecologies when enacted.

Applied to sustainability transitions, research on standards and metrics indicates that these mechanisms will play a prominent role in such transitions. Specifically, standards and metrics will likely be used to define what counts as sustainable, as well as specify the means through which sustainability can be achieved. For example, in her study of the Tanzanian Tea industry, Loconto [32] found that producers in efforts to increase their sustainability were performing prescribed scripts specified in the formal standards. In other words, standards and metrics were being used to produce a sustainability transition through scripting new configurations of actors, institutions, practices, knowledge, and technologies.

Standards and metrics are increasingly developed using non-state forms of governance, as changes at the landscape level have shifted much of governance from the government to the private sphere. Specifically, neoliberalization has resulted in the devolution of authority to non-state actors and consequent re-regulation by such actors of many social, economic, and environmental processes [33–36]. The result has been the advent and proliferation of numerous forms of non-state governance. Thus, in place of government regulations, there are often private standards, metrics, and codes of conduct today [28]. While non-state governance can take many forms [37], increasingly prominent is the use of MSIs [7,8,38].

MSIs are a form of network governance that seeks to bring together representatives of all potentially affected stakeholders [8,9,38–40]. Constructed on normative democratic principles, MSIs seek to use participatory and democratic practices in dialogue and decision-making, reach decisions by consensus, and be transparent [8,9,39]. As a result of such practices, standards and metrics developed by MSIs are often considered to be impartial in the sense that they are not biased towards particular interests. Consequently, they tend to be viewed as more legitimate than other forms of private governance.

However, despite their inclusionary and democratic character, recent research indicates that MSIs in practice are often exclusionary and characterized by power imbalances [8,41]. First, determining who are legitimate stakeholders and thus, who gets to participate in MSIs, is often a politicized process. Second, resource imbalances often exist among stakeholders, as well as competing MSIs. Consequently, some participants and MSIs may be privileged in terms of access to expertise, technologies, and information, and others marginalized. Lastly, the structure and procedures used in decision-making can create biases that favor some stakeholders. Thus, even in instances where governance is designed to be democratic, inclusive, and objective, politics and power affect the process. Given the increasing use of non-state governance in environmental governance, particularly MSIs, analysis of such governance processes is necessary in order to assess the potential and limitations of sustainability transitions.

4. Methods

The findings presented in this paper are based on two sets of data collected between 2011 and 2013. First, 36 in-depth interviews were conducted with (ex-)participants and facilitators in Field to Market, LEO-4000, and SISC, as well as activists focused on sustainable agriculture in general but not formally part of those projects. Interviewees included a range of actors, including representatives from grower associations, agribusiness associations, environmental advocacy organizations, social and community advocacy organizations, and organic agriculture associations; university scientists; third-party certifiers; and a government official. Initial participants were identified through the membership lists of the respective initiatives and attendance at LEO-4000 meetings. A chain referral sampling approach in which participants were asked to recommend potential participants was then used to identify additional participants [42]. Interviews ranged from approximately 45 minutes to three hours and were conducted both in person and by phone. Interviews focused on three primary topics: (1) the ways that the standard- and metric-development processes worked; (2) participants' understandings of sustainable agriculture; and (3) the content of the metrics and standards. Interviews were transcribed verbatim and then coded line-by-line using an open-ended coding scheme that utilized both a priori codes and emergent coding.

Second, content analysis of documentation produced by the three sustainable agriculture MSIs, as well as public letters and media coverage related to the initiatives, was undertaken. Specifically, each of three initiatives has reports and/or webpages outlining their metrics. These were entered into the Nvivo software program and coded according to dimensions of sustainability (e.g., environment, economic, and social). Additionally, analysis was conducted of each initiative's array of documentation on their membership, history, and missions. Lastly, public letters, press releases, and media coverage by trade publications were collected and analyzed.

5. Sustainability Metrics and Standards for United States Agriculture

The ensuing subsections provide overviews of the three MSIs that have developed sustainability metrics for US agriculture: Field to Market, LEO-4000, and SISC. For each initiative, first, its development and history is briefly sketched out. Second, who participates in each initiative and the decision-making procedures are described. Lastly, an overview of the metrics that each MSI has developed is provided.

5.1. Field to Market

Field to Market was convened by the Keystone Center in 2006 to explore the question of sustainability in US agriculture. The initial meetings consisted of 12 representatives from agribusiness and environmental organizations. At these meetings a set of principles were established that would guide the initiative going forward. The principles included, first, a commitment to "technology-neutral" approaches. Second, the processes must be "science-based" in that the initiative's outcomes were to be scientifically justified. Third, the initiative would be collaborative and work to include actors throughout the supply chain. Fourth, the initiative would seek to develop outcome-based metrics. It was also decided that the focus of Field to Market would be commodity crops, namely corn, soy, cotton, and wheat.

Potatoes and rice have since been added. Lastly, at the initial meetings, it was decided that Field to Market would focus on pre-farm gate sustainability, as this is where the founding members believed the most immediate environmental concerns in food and agriculture were located.

When the first metrics were released in 2009, membership had expanded to 28 members, and by 2013 membership in Field to Market had grown to 49 members. According to interviewees, membership is open to any stakeholder as long as they agree with the initiative's principles and are able to meet the financial requirements of the initiative. However, agribusiness stakeholders make up the majority of Field to Market's membership. In addition to agribusiness interests, six environmental advocacy organizations and several university-based research departments are part of Filed to Market. Until 2013 Field to Market was managed by the Keystone Center, after which it became an independent non-profit organization. An executive director and executive committee manage Field to Market. The entire membership meets twice a year in person at plenaries. Additionally, the initiative has a host of subcommittees working on specific issues (e.g., water use and soil loss) [43]. While internal workings are not public, interviewees stated that decision-making is consensus-based.

Field to Market has developed seven metrics to date: land use, conservation, soil carbon, irrigation water use, energy use, greenhouse gas emissions, and water quality. The land use metric measures the efficiency of agricultural land calculating planted area per unit of production. In the 2012 report [44], the soil carbon metric is listed as a measure of soil erosion [45]. The irrigation water metric measures the amount of irrigation water applied using multiple units of analysis (e.g., total, per acre, and per unit of production). The energy use metric measures both direct and indirect (e.g., input production) energy use. The greenhouse gas emissions metric gauges both the direct and indirect production of carbon dioxide. Water quality is a metric that has been developed since the 2012 report. Field to Market has yet to publicly release a definition and criteria for this metric. The 2012 report also outlined a set of preliminary socioeconomic sustainability indicators. These included: debt/asset ratio, returns above variable costs, crop production contribution to national and state gross domestic product, non-fatality injury, fatality, and labor hours [44]. While the environmental indicators are being field tested in a series of pilot studies and have been incorporated into a Fieldprint® Calculator that farmers can use to assess their performance, no further development has taken place with the socioeconomic indicators [46].

5.2. LEO-4000

The LEO-4000 initiative began as an effort by a certifying body, Scientific Certification Systems (SCS), to develop a sustainable agriculture standard for the US. After developing a draft standard, SCS sought an American National Standards Institute (ANSI) accredited standard-development organization to oversee the standard-development process. The Leonardo Academy was chosen by ANSI because it had experience working on environmental sustainability. In September 2007, the Leonardo Academy became officially responsible for managing the development of the standard.

Soon after taking over the management of developing a national sustainability standard for US agriculture, the Leonardo Academy issued a public call for applicants to serve on the standard-development committee. From a large and diverse pool of applicants, the Leonardo Academy selected 58 applicants to serve on the committee based on applicants' expertise, experiences, and role in agriculture. SCS, which initiated the standard, became one of the 58 members. The LEO-4000 initiative also allows observers. While observers do not have voting rights, they can participate in all meetings and provide input on drafts of the standards.

The first standard meeting was held in September of 2008. At this meeting, the draft standard was set aside because some meeting participants, as well as some agricultural stakeholders more generally, perceived it to be biased towards alternative forms of agriculture. The general structure and process of the initiative were also set. This included a chairperson, a plethora of subcommittees, and a schedule of both virtual and in-person meetings. Congruent with ANSI guidelines, consensus would be sought and formal votes would be used in decision-making. The process has also been characterized by a fairly high level of transparency, as many of the initiative documents and meeting minutes were posted on the Leonardo Academy's website.

In April of 2012, the LEO-4000 initiative released a draft standard, which is currently being revised following public comment. The draft standard identifies environmental, social, and economic principles for sustainable agriculture. The draft standard outlines six environmental principles:

- "Minimize, and/or avoid soil, water, and air pollution and degradation;
- Maintain and replenish long-term soil health, fertility and productivity;
- Use renewable and nonrenewable inputs efficiently and minimize waste;
- Maintain or enhance biodiversity and supporting habitats within the farming system and its surroundings;
- Diversified land use on farms that integrate crops and livestock operations;
- Reduce, avoid, offset and/or sequester greenhouse gas emissions" [47] (pp. 14–18).

The draft standard also includes two social principles: labor rights and community rights. The draft standard proposes four economic principles, which include:

- "Sustainable agricultural producers plan and manage operations for short-, mid- and long-term;
- Sustainable agricultural producers use a "triple bottom line" method to plan, manage, and account for economic, social, and environmental results;
- Sustainable agricultural producers plan and manage operations to minimize negative externalities and maximize positive externalities;
- Sustainable agricultural producers plan and manage operations to manage risk and increase resilience to economic, social and environmental stressors" [47] (p. 18).

Each of these three sets of principles has an array of metrics and sub-metrics associated with it (see Table 1). Additionally, the draft standard lays out a four-tiered certification rubric in which producers can get certified at different levels of sustainability.

Table 1. LEO-4000 Metrics [47].

Environment	Social	Economic
Production Systems	Work Agreements	Scope of Business Planning and Reporting
Soil Resources	Wages	Operator Succession
Water Resources	Benefits	Beginning Farmer Development
Air Quality	Working Hours	Farmland Preservation

Table 1. *Cont.*

Environment	Social	Economic
Biotic Resources	Child Labor	Marketing Channel Diversity
Energy Resources	Forced and Compulsory Labor	Crop Diversity
Waste Management	Non-Discrimination Policies and Procedures	Product Diversity
	Equal pay for Equal Work	Social Risk Management Practices
	Freedom of Association	Ecological Risk Management Practices
	Violence and Harassment	Ecosystem Service Markets
	Worker Protection	Long-term Land Tenure
	Health and Safety	Lease Terms
	Workplace Conditions	Food Safety
	Worker Housing	
	Stakeholder and Community Engagement	
	Local Support and Regional Community Support	
	Local and Regional Community Impacts	

5.3. Stewardship Index for Specialty Crops

The Natural Resource Defense Council, Western Growers, and Sure Harvest started the Stewardship Index for Specialty Crops (SISC) in 2008 to develop sustainability metrics for specialty crops (*i.e.*, fruits and vegetables) in the US. Building on their existing relationships and networks, the three founding organizations recruited producers and processors, buyers, and environmentalists to be part of the initiative. The result is a tripartite governance structure that consists of three sets of groups: (1) environmental and public interest groups; (2) growers, suppliers, and trade associations, and (3) buyers and trade associations. Collectively, these three groups make up the coordinating council. In addition to the stakeholder groups, there is a group of experts that are part of the coordinating council.

There is also a steering committee, which consists of two members from each of the stakeholder groups, that oversees the daily activities of the initiative. The coordinating council is responsible for the development and approval of metrics. There is also a metrics technical advisory committee that oversees metric development and refinement, based on pilot data. Lastly, there is a series of metric review committees that consists of external stakeholders and experts that provide input and feedback on proposed metrics. SISC takes the input of these committees into consideration, but is not required to incorporate feedback or recommendations from the review committees. To be approved, a metric needs to have the support of a majority of each of the three member groups.

In 2013, SISC released its first set of metrics [48]. It included five metrics: applied water use efficiency, energy use, nitrogen use, phosphorous use, and soil organic matter. The applied water metric "measures the amounts of applied water to produce a crop" [48]. The energy use metric measures fuel and electricity consumption, as well as indirect energy use, such as energy used in the production of inputs. The nitrogen use and phosphorus use metrics measures the amount of nitrogen and phosphorous applied by farmers. Lastly, the soil organic matter metric is designed to gauge soil quality according to the amount of total organic carbon in the soil. Currently, SISC is working on developing three additional metrics: biodiversity and ecosystem, greenhouse gas emissions, and simple irrigation efficiency.

6. Standards, Metrics, and Sustainability Transitions

This section examines the kinds of sustainability transitions that the metrics developed by the three MSIs might potentially produce. While there is overlap in the metrics developed by each of the three MSIs, there are also some significant differences between them (see Table 2). Thus, there are divergences in how sustainability is being framed across the three MSIs. This indicates that governance processes can mediate sustainability transitions through how they frame sustainability and the practices they specify as necessary to achieve greater sustainability. Hence, while a sustainability transition may be underway in the US, the metrics produced by the MSIs may potentially channel this transition in specific directions. The ways that each MSI is framing sustainability and the implications that this has for a sustainability transition of the US food and agriculture system is examined below.

Table 2. Comparison of metrics [47].

	Field to Market	LEO-4000	SISC
Environment			
Resource Efficiency	X	X	X
Pollution	X	X	
Biodiversity		X	
Economic			
Farmer Profitability	X	X	
Economic Security	X	X	
Risk Management		X	
Social			
Labor	X	X	
Community		X	

First, the environmental metrics by Field to Market and SISC largely measure the productivity and efficiency of agriculture. In doing so, they are advancing a resource sufficiency approach to sustainability in which sustainability becomes a question of ensuring sufficient resources to meet future needs [49]. In contrast, the environmental metrics proposed by LEO-4000 focus on not only resource use, but also ecosystem impacts, such as biodiversity. Thus, they are more in alignment with a functional integrity view of sustainability in which sustainability is conceptualized in terms of the resiliency of socio-ecological systems [49].

Second, social and economic dimensions of sustainability are highly uneven across the three initiatives. On the one extreme, SISC has developed no social or economic metrics. Field to Market has developed a set of preliminary social and economic metrics in their second report, but these have not been operationalized as part of their Fieldprint Calculator [50]. Additionally, they are very shallow measures of social and economic viability and the social impacts of agriculture. For example, there are no metrics for distribution of profitability across supply chains, equal rights, and community capacity and development, all of which are generally part of social sustainability typologies [51]. Unlike Field to Market and SISC, LEO-4000 has proposed more robust social and economic sustainability metrics. For example, LEO-4000 has metrics on labor and community rights as well as economic security.

The above analysis indicates that the sustainability metrics developed by the three initiatives outline two different potential sustainability transitions. On the one hand, the metrics developed by Field to Market and SISC are advancing a program of "sustainable intensification". In short, sustainable intensification represents a continued focus on productivism (*i.e.*, maximizing agricultural output), which was the dominant ordering principle of the food and agriculture system in the post World War II era [4,52]. The difference is that the focus is not just on yield, but resource efficiencies as well. Additionally, the metrics being advanced by Field to Market and SISC do not address key social and economic issues that have been identified as key challenges to the future sustainability and resiliency of the US food and agriculture system. Thus, the metrics developed by Field to Market and SISC are unlikely to produce regime transformation in the US food and agriculture system. Rather, regime reconfiguration in which lead actors adopt "add-ons" to ameliorate landscape pressures (e.g., resource scarcities and climate change) and niche threats (e.g., consumer demand for green goods) is the likely outcome [1].

On the other hand, the metrics proposed by LEO-4000 have the potential to produce a sustainability transition that transforms the US agrifood regime. For example, with its metrics for biodiversity, land use, and water and air impacts, LEO-4000 would require producers to restructure practices to minimize the impacts of their farming operations on surrounding ecosystems. Additionally, in also incorporating economic and social dimensions of sustainability, it takes a more systemic approach that recognizes economic vibrancy, labor issues, and community relations also affect the long-term resiliency of US agriculture. As such, they offer the possibility of an agrifood system characterized by multi-functionality in that efficiency, ecology, and justice are all central characteristics.

7. Politics and Power in Governing US Agricultural Sustainability Transitions

As the previous section demonstrates, the metrics developed by each of the three MSIs map out different sustainability transitions. Building on research on standards, metrics, and governance, this section examines how the dynamics of each MSI have affected the development of sustainability metrics. Specifically, using a governance framework, the ways that membership selection, decision-making procedures, and access to resources has affected the development of metrics, and their potential future adoption, is analyzed.

7.1. Membership and Sustainability Metrics

While MSIs are to include representatives of all potential stakeholders, in practice the construction of MSI committees is often political and strategic. In Field to Market and SISC, the construction of committee membership has taken place through informal practices, as neither one of the initiatives has formal processes through which new members can join. For example, in speaking of SISC, one member noted, "the original members were largely picked from the networks and relationships of the founders". Similarly, interviewees indicated that existing relationships and networks also played a significant role in who became part of Field to Market. The result is that at least some informal screening and selection of applicants have taken place. In the case of Field to Market, interviewees noted that new members "need to be in alignment" with the founding principles, which included metrics that were technology-neutral, science-based, and outcome-based. In particular, the requirement that members be technology neutral excludes many proponents of alternative agriculture, as they tend to be critical of specific technologies such as genetic-modification.

In contrast to Field to Market and SISC, the Leonardo Academy issued a formal public invitation soliciting potential members of LEO-4000. They received a diverse set of applications, including representatives of producers, agribusiness, retailers, environmental and labor organizations, certifying bodies, and academics. The Leonardo Academy then selected 58 applicants to serve on the committee based on applicants' expertise, experiences, and role in agriculture. Committee members were distributed across four categories: producers, users, environmentalists, and general interests (e.g., scientists). While the balance of actors on the committee was contested as to whether it accurately reflected agricultural interests, the diversity of the initial LEO-4000 committee was widely recognized.

The result of the different selection processes produced significant variation in the membership of the three initiatives. Field to Market has the largest representation of actors from conventional agriculture. The majority of its membership is made of agricultural input companies (e.g., Monsanto, BASF, Bayer CropScience, and Syngenta), processing companies (e.g., General Mills, Cargill, Coca-Cola, and Unilever), grower associations, and retailers (e.g., Walmart and McDonald's). As of 2013, only six of Field to Market's 49 members were environmental advocacy organizations, and no community or labor organizations were part of the initiative. Furthermore, the environmental advocacy organizations that were part of Field to Market have a history of working cooperatively with agricultural interests. For example, one interviewee who was a member of Field to Market commented, "Field to Market had the low hanging fruit in terms of NGOs. They had Farmland Trust and people that you can sort of work with. They haven't been your adversaries for 50 years". Thus, while Field to Market is a MSI, in the words of an interviewee, "it was a lot softer landing" for agribusiness than the other sustainability initiatives.

SISC also has significant agribusiness representation on its membership. However, in contrast to Field to Market, it has excluded agricultural input companies from direct participation. Compared to Field to Market, and SISC, LEO-4000 had the most diverse membership of the three initiatives initially in that it included not only representatives from conventional agriculture and environmental organizations, but also stakeholders from community and labor organizations (e.g., International Labor Rights Forum and Oxfam America), as well as alternative agriculture (e.g., Organic Trade Association and Rodale Institute) [53].

Incorporating analysis of who participates in the development of sustainability metrics in the MLP shows that participation can affect the kinds of metrics developed. The memberships of Field to Market and SISC both have a significant number of actors that benefit from the current structure of the food and agriculture system. Additionally, Field to Market contains almost no niche actors, while in SISC a clear minority of actors come from niches. Given the importance of niche actors for spurring sustainability transitions in the MLP, the absence of such actors in each of these initiatives indicates that they are constrained in their capabilities to foster a sustainability transition. This indeed appears to be the case, as both Field to Market and SISC are advancing a program of sustainable intensification that is congruent with the existing agrifood regime with their metrics. In contrast to Field to Market and SISC, LEO-4000 includes a significant number of actors from the niches. As the MLP theorizes that transformative change tends to emerge from the niches, the presence of niche actors on LEO-4000 would indicate the greater likelihood that its metrics are potentially transformative. This is indeed the case, as the initial standards released by LEO-4000 would potentially produce substantial changes in the current food and agriculture system if widely implemented. In sum, our findings demonstrate that who gets to participate in metric development affects the content of sustainability metrics and thus, sustainability transitions.

7.2. Decision-Making and Sustainability Transitions

Procedural practices have been identified as influencing the outcome of governance processes in that they might produce biases that favor some stakeholders. Additionally, requirements for consensus may also lead to weaker metrics [54]. While each of the three MSIs adheres to democratic decision-making procedures, there is variation in the ways such procedures are structured. While Field to Market's governance process is not publicly available, interviewees who are part of the initiative stated that the process was highly participatory and that the approval of a new metric required consensus by all members. The decision-making structure of SISC requires that 50 percent of each stakeholder group (Environment and Public Interest Groups; Growers, Suppliers and Trade Associations; and Buyers and Trade Associations) must approve a metric. Among the three initiatives, SISC's governance procedures are unique in that they are structured to prevent two sets of stakeholders from overruling the third stakeholder group. Decision-making in LEO-4000 originally required majority support by members, but in 2011 was changed to 60% of members.

The effects of the procedural practices on the metrics of the three initiatives are most evident in the cases of SISC and LEO-4000. In its original vision, SISC proposed to develop a wide-ranging set of metrics that included environmental, social and economic dimensions of sustainability that were applicable throughout agricultural supply chains (see Table 3). However, to date, the outcome has only been five environmental metrics focused on farm-level practices. Interviewees indicated that there were extensive discussions among members of social and economic metrics, particularly labor and fair practice metrics. For example, speaking of the discussion of a fair price metric, one interviewee commented, "In the end, the group said we can't possibly talk about that. This largely came from the buyers who were concerned about anti-trust and restraint of trade. Again, you have a situation where the individual immediate interests of the parties derailed what would clearly be a societal interest in actually assuring that farmers got a fair price". Thus, with SISC's tripartite decision-making process, stakeholder groups, working to protect their self-interest, were able to prevent the development of some metrics.

The LEO-4000 initiative since nearly its inception has been embroiled in controversy. Prior to the first full membership meeting, letters were sent by the Biotechnology Industry Association and the US Department of Agriculture objecting to both the draft standard and the selection process of committee members [55,56]. For example, in May 2008 and June 2008, the US Deputy Secretary of Agriculture, Mr. Charles F. Conner, expressed "serious concerns" regarding the process in two letters to the Leonardo Academy. Specifically, he critiqued the Leonardo Academy for excluding "modern biotechnology, synthetic fertilizers, or other technologies" that "are well within sustainable agriculture as defined by the law" in its initial framing of sustainable agriculture [56]. The US Department of Agriculture also filed a complaint with ANSI objecting to the committee selection process by the Leonardo Academy. They asked ANSI to de-accredit the Leonardo Academy [57].

Table 3. Stewardship Index for Specialty Crops (SISC)'s original vision [48].

Metric	Farm	Processing	Distribution	Retail/Food Service
People				
Human Resources	X	X	X	X
Community	X	X	X	X
Planet				
Air Quality	X	X	X	X
Biodiversity and Ecosystems	X			
Energy Use	X	X	X	X
GHG Emissions	X	X	X	X
Nutrients	X			
Packaging	X	X	X	X
Pesticides	X	X	X	X
Soils	X			
Waste	X	X	X	X
Water Quality	X	X	X	X
Water Use	X	X	X	X
Profit				
Green Procurement	X	X	X	X
Fair Price/Incentives	X	X	X	X

When LEO-4000 began in 2008, under the ANSI process, standard-development could either begin with a draft standard or from scratch. Responding to the public controversy, and also the requests of some committee members, the draft standard developed by SCS was set aside at the first standard meeting. This meant that the committee had to start from scratch. At the third annual meeting of the standard committee in 2010, there was a series of close votes on the guiding environmental, social, and economic principles that would undergird LEO-4000's standards. Interviewees indicated the votes were largely split between regime (*i.e.*, conventional agriculture) and niche (*i.e.*, alternative agriculture) actors, and that the principles that were passed tended to favor proponents of alternative agriculture.

On 18 October 2010, ten committee members that represented conventional agriculture, including the National Corn Growers Association, the American Soybean Association, the American Farm Bureau, and the United Fresh Produce Association, resigned from LEO-4000. In their public resignation letter, which was co-signed by 46 national agriculture organizations, they stated that the LEO-4000 was "biased against a balanced and open analysis of modern agriculture" [58]. Soon thereafter, on 9 February 2011, three more committee members from conventional agriculture resigned, similarly claiming that "the current committee make-up and established process" would not "lead to the intended outcome of a National Standard acceptable to agricultural businesses" [59]. The controversy has resulted in questionable legitimacy for the LEO-4000 initiative, as the continued questioning and protests of the initiative have led it to having little credibility in the eyes of many regime actors in food and agriculture.

In sum, the above analysis indicates that the procedural practices used can affect the kinds of metrics developed and thus, sustainability transitions. As demonstrated by SISC, the requirement of agreement across different stakeholder groups has resulted in a very limited set of metrics. In the case of

LEO-4000, the inability to develop agreement across its diverse set of stakeholders led to the resignation of many non-niche actors. While this has resulted in a more stringent and encompassing set of sustainability metrics, it has also weakened the legitimacy of LEO-4000 from the perspective of regime actors. Thus, the above findings indicate that governance practices that require consensus or majorities may function to moderate sustainability transitions, particularly when a diverse range of stakeholders is involved.

7.3. Resources and Sustainability Transitions

Governance requires resources. Holding meetings, hiring staff, and gathering information, and producing reports all require significant resources. Thus, access to resources can affect the kinds of metrics that are developed, as well as those that are implemented. Analysis of the three sustainable agriculture MSIs finds that resources are unevenly distributed across them.

Interviewees that were part of Field to Market, as well as those that were part of other initiatives indicated that Field to Market was the most resource endowed. Members of Field to Market are required to pay annual fees to participate [60]. Given the presence of many leading agribusiness companies in Field to Market, this has resulted in Field to Market having significant resources to work with. For example, speaking of Field to Market's resources, one interviewee, who was a member of multiple initiatives, commented:

> I mean Keystone has four people working on it almost full-time and then they've got a number of consultants that basically have to do all the algorithms and stuff—so the level of sophistication of what Field to Market has done has been pretty impressive. … They're the ones that have had the money to bring the researchers and wildlife experts in and really start—they've done the cutting edge stuff in measurement or quantification or ways to talk about farmers' impacts and positive and negative in those areas.

Thus, given its funding structure, and the significant resources of many of its members, Field to Market has been able to have a comparatively stable and large staff and contract with outside experts as necessary.

SISC was originally funded through a USDA conservation innovation grant, and grants have continued to constitute a significant source of SISC funding. Outside of grants, procuring external funding support has been problematic for SISC. For example, when asked about funding, an interviewee associated with SISC commented, "I remember one member rather emphatically saying at one meeting, 'it would be easier for me to raise money to kill the Stewardship Index than it would be for me to get support for it'". Thus, funding has been a constraint for SISC, as there has been concern over the kinds of metrics it would develop by some agricultural interests. While SISC now has one full-time staff member, originally it staff support came from the three founding members. As one interviewee noted, "compared to the scale of the ambition, the funding was never adequate". Only recently have members agreed to pay annual fees to maintain the initiative.

LEO-4000 has also been chronically underfunded. LEO-4000 does not require a membership fee and thus, has relied on donations from members and the agricultural community. However, given the negative view of LEO-4000 by many leading agrifood regime actors, and the constrained resources of many advocacy and alternative agrifood organizations, securing sufficient resources has been difficult for LEO-4000. For example, in discussing the funding difficulties for LEO-4000, one interviewee commented:

> Why would people who don't support the project put any money forward? I think it became very meaningful for them [conventional agriculture] but at the same time it would be just like slitting your own throat, for lack of a better word, if they were contributing money to this process and it ended up having really negative impacts on American producers or certain agribusiness industries. … And then the flip side of that is the people who did support it were already giving so much of their time, or they came from universities that can't give money to processes like this, or they came from consulting firms that just don't have money.

The lack of funding has contributed to a turnover and loss of support staff, shifting meetings from in-person to virtual, as well as questions regarding whether LEO-4000 is going to be able to complete the process.

In addition to affecting the development of metrics, access to resources can also affect their adoption and implementation. Given the presence of many lead actors from the current agrifood regime on their memberships, Field to Market and SISC are at an advantage in the adoption and implementation of their metrics. Specifically, many of the lead actors that are part of these initiatives, such as input companies, grower associations, processors, and retailers, can drive the implementation of sustainability metrics through their business practices. In the case of Field to Market, Coca-Cola, Monsanto, and Walmart, as well as other agribusiness companies have already spearheaded several pilot projects using the metrics. In contrast, the absence of lead regime actors as part of LEO-4000 puts its metrics at a disadvantage in terms of adoption. For example, when asked about the potential impact of the LEO-4000 initiative, several interviewees associated with conventional agriculture argued that the standard will be a "niche" standard at best, or "irrelevant".

The above analysis indicates that differences in resources affect both the development of metrics, as well as their adoption and implementation. On the one hand, access to resources allows for more meetings, greater continuity, and the ability to bring in outside experts. On the other hand, financial and network resources are crucial to facilitating the adoption of sustainability metrics. Thus, funding can affect the role that MSIs play in sustainability transitions. Specifically, the better funded an MSI, the more likely it is to play a lead role in a sustainability transition. However, at the same time, our findings indicate that the most resource-endowed MSIs may also develop the most conservative metrics, given the large presence of lead regime actors and limited participation of stakeholders from the niches. Thus, access to resources may have the effect of moderating sustainability transitions.

8. Conclusions

In the MLP, sustainability transitions are a result of a combination of external pressures and internal forces. Currently, the food and agriculture sector in the US faces both of these. Agriculture's continued negative environmental impacts and increased concern on behalf of much of the public has created pressures to increase the environmental sustainability of US agriculture. At the same time, lead regime actors in food and agriculture are facing increased pressure from the niches, as market shares of alternative forms of agriculture continue to grow. In the MLP, the combined effect of these dual pressures should be, at least the beginnings of, a sustainability transition in US agriculture.

Addressing a gap in the MLP, this article argues that governance is a key component of sustainability transitions. Examining three MSIs that have developed sustainability metrics for US agriculture, this article's findings indicate that governance processes and the politics embedded in them are affecting a potential sustainability transition in the US food and agriculture system. First, the presence of lead regime actors in MSIs, combined with the use of democratic and consensus decision-making processes, may constrain the kinds of metrics produced. Second, MSIs that have better access to resources are often at an advantage in both the development and implementation of standards. As regime actors tend to have more resources than niche actors, this may result in MSIs with a significant number of regime actors being privileged. Lastly, MSIs that contain a significant number of niche actors and/or develop metrics that threaten to disrupt the existing regime may face opposition from regime actors. Thus, the findings on the three agriculture sustainability MSIs suggest that governance processes may channel sustainability transitions towards the interests of regime actors.

For the US food and agriculture system, the outcome of governance processes thus far appears to be a channeling of a potential sustainability transition towards a conservative path in which there are modest increases in sustainability, but in a way that does not disrupt the political economic structure of the current regime. Hence, while MSIs appear to have the ability to produce some sustainability gains in terms of increases in the efficiency of resource use and pollution reduction, they do not seem to have the capability to restructure the food and agriculture regime. The implication is that the control of food and agriculture by input companies, processors, and retailers, the neoliberalization and globalization of food and agriculture, and the spread of meat-based and processed food diets will all continue. As these have all been widely argued to be significant contributors to the unsustainability of food and agriculture, the possibility for the current governance of food and agriculture to produce a sustainable agrifood system is questionable.

In sum, this article's findings demonstrate the need for the MLP to incorporate analysis of governance processes and ways that politics and power operate in them into its framework. Doing so will improve theorizations of the possibilities and obstacles to sustainability transitions. Furthermore, as exemplified by the three agriculture sustainability MSIs, such analysis also problematizes sustainability itself. Given that different conceptualizations of sustainability can produce different sustainability transitions, such analysis is an important addition to the MLP [61].

Acknowledgments

The author would like to thank the special edition editors, Maki Hatanaka and Douglas Constance, as well the 2 anonymous reviewers, for their comments and suggestions.

Conflicts of Interest

The author declares no conflict of interest.

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