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Signs of agricultural sustainability: A global assessment of sustainability governance initiatives and their indicators in crop farming

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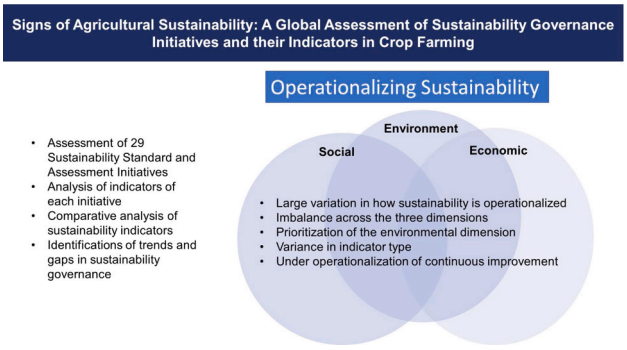
HIGHLIGHTS

- This paper analyzes both assessment and standard initiatives in crop production.
- It analyzes the operationalization of sustainability in crop farming globally.
- Imbalances are found across environmental, social, and economic sustainability themes covered.
- Variation in the use of practice, target, and performance metrics can be recognized.
- Continuous improvement is not widely incorporated into sustainability governance.

GRAPHICAL ABSTRACT



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ABSTRACT

CONTEXT: To address sustainability challenges in agriculture, private and multi-stakeholder initiatives increasingly use sustainability indicators to monitor the sustainability impact of farms. These indicators can be part of standards for certification or assessment tools to measure farm performance. While these initiatives play an important role in navigating the sustainability transition, insight in how these governance initiatives operationalize sustainability in crop farming is lacking.
OBJECTIVE: This paper examines how private and multi-stakeholder governance initiatives, which increasingly regulate the sustainability of a sizeable portion of agriculture globally, operationalize the concept of sustainability. It provides understanding into which sustainability themes are commonly included in sustainability initiatives, and those that are not, which can give insight into the direction these initiatives are steering crop production worldwide.
METHODS: We developed an overview of governance initiatives using databases and existing research on sustainable agriculture initiatives. Documentation about these initiatives was gathered and used to systematically review descriptive and institutional characteristics of the 29 sustainability assessment and standard initiatives. Moreover, we analyzed the kinds of indicators (i.e., performance, practice, and target) and the themes that are prioritized in the environmental, social, and economic dimensions of sustainability.

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RESULTS AND CONCLUSIONS: The analysis shows that the 29 initiatives are very diverse in their characteristics. While some specifically focus on one crop or country, others operate across production chains and at a global scale. Within specific sectors or countries, certain standards are quite influential, for instance, the Better Cotton Initiative covers 22% of global cotton production, while in Ireland, 70% of horticulture farmers are Origin Green certified. Globally, 2% of the crop land is certified under one of the 14 standards that reported land use. Our analysis of sustainability themes show an imbalance across environmental, social, an economic sustainability, with environmental sustainability being prioritized. In particular, social themes such as quality of life, food sovereignty and fair trading practices were less often included (38, 24 and 21% respectively).
SIGNIFICANCE: Sustainability standard and assessment initiatives govern a substantial and growing portion of global cropland. They play a central role in determining what is considered sustainable and thereby influence which farming practices are applied worldwide. The impact of these initiatives is likely to continue to grow as sustainability assessments and standards become more widely adopted. In examining a large sample of standard and assessment initiatives, this study presents a comprehensive overview of the current state of sustainability indicators for crop farming globally.

1. Introduction

It is widely acknowledged that agriculture faces a series of challenges and that it has to become more sustainable to meet the needs of future generations. While government programs and policies remain integral to improving the sustainability of food and agriculture, many of the initiatives focused on increasing agricultural sustainability are taking place outside of the government (Ponte, 2014). Since the start of the millennium, there has been a proliferation of non-state governance initiatives with the aim of transitioning agriculture towards increased sustainability (Bain et al., 2013; Daviron and Vagneron, 2011; Mol and Oosterveer, 2015). Consequently, today, there are a range of private and multi-stakeholder sustainability governance initiatives that cover near all facets of agriculture globally. These initiatives typically take one of two forms: assessment or standard. Sustainability assessment initiatives develop tools that farmers can use to measure and assess their sustainability performance (Marchand et al., 2014; de Olde et al., 2016). Sustainability standard initiatives set sustainability requirements that farmers must comply with and typically entail third-party certification (Hatanaka et al., 2005; Loconto and Busch, 2010).

Both approaches have in common the use of indicators. Indicators are "measurable variables" for evaluating the performance of something (de Olde et al., 2016). Generally, indicators are part of a larger sustainability framework, which includes dimensions (e.g., environment, economic, and social) and themes (e.g., waste and greenhouse gas emissions) (de Olde et al., 2016; Kouchner et al., 2019). In both standard and assessment initiatives, indicators are the mechanism through which sustainability is operationalized in that they translate the various themes into measurable variables. Specifically, in assessment initiatives, indicators define the aspects of sustainability that farmers are to measure, and how they are to measure them. In standard initiatives, indicators delineate the sustainability practices, plans, and measurements farmers need to implement in order to be certified as sustainable.

Given the crucial role that private and multi-stakeholder governance initiatives play in sustainability transitions in agriculture, there is substantial research that examines them. This includes the legitimacy of such initiatives (Hallström and Boström, 2010), the ways they are influenced by market dynamics (Mol and Oosterveer, 2015), the processes through indicators are developed (de Olde et al., 2017), efforts to implement assessment tools (Whitehead et al., 2020), and the efficacy of certification (Milder et al., 2015; Oya et al., 2018). However, there is a dearth of research on the content of the indicators that have been developed by sustainability assessment and standard initiatives. While there are a handful of case studies that examine a small sample of private governance initiatives (de Olde et al., 2016, 2018; Marchand et al., 2014; Slätmo et al., 2017; Smith et al., 2022; Verburg et al., 2022), there is no study that provides a comprehensive overview of the ways that governance initiatives operationalize sustainability in crop farming.

This paper addresses this research gap and seeks to identify the ways that sustainability governance initiatives operationalize sustainability in crop farming. Generally, sustainability remains a contested idea with competing conceptualizations (Béné et al., 2019; Bonisoli et al., 2018; Rasmussen et al., 2017; Thompson, 2017). Among the most common approaches is the three interconnected dimensions to sustainability: environment, social, and economic (Purvis et al., 2019). While the tripartite approach has become the "common view" of sustainability (Giddings et al., 2002), considerable variation persists regarding the operationalization of each dimension as well as the relationship among the three dimensions (Purvis et al., 2019; Thompson, 2017; van der Linden et al., 2020). For example, despite the environmental dimension receiving substantial attention from researchers, there remains considerable disagreement as to how to operationalize different environmental themes (Moldan et al., 2012). The social and economic dimensions are characterized by even greater conceptual ambiguity and disagreement. Research finds that the meaning of social sustainability continues to be "conceptually elusive" and it remains "unclear what *social* means in the context of sustainability" (Boström, 2012; Janker et al., 2019, p.1674), and the economic dimension is the least conceptually developed of the three-dimensions (Latruffe et al., 2016).

Given this conceptual looseness, governance initiatives have considerable leeway in terms of how they operationalize sustainability which can result in a skewed understanding of sustainability (de Olde et al., 2018; Osmundsen et al., 2020). This paper examines how private and multi-stakeholder governance initiatives, which increasingly regulate and steer the sustainability of a sizeable portion of agriculture globally, operationalize this elusive idea of sustainability. In doing so, it contributes to the "clear and urgent need to clarify more carefully what is precisely meant by sustainable food systems" (Béné et al., 2019: 127). Identifying how sustainability is being operationalized is crucial to comprehend the current sustainability governance landscape, as well as the challenges facing efforts to transition agriculture systems towards greater sustainability. More specifically, it provides understanding into which sustainability themes are commonly included in sustainability initiatives, and those that are not, which can give insight into the direction these initiatives are steering crop production worldwide.

To examine how sustainability is being operationalized, 29 sustainability governance initiatives for crop farming from throughout the world are analyzed. This study is unique in that it is the first to jointly examine both assessment and standard initiatives. As this sample is representative of private and multi-stakeholder sustainability governance initiatives for crop farming, this paper presents a systematic analysis of the ways that sustainability is being operationalized in crop farming.

In addressing the research gap on how governance initiatives are operationalizing sustainability, this study provides data on how sustainability is being implemented in much of crop agriculture globally. This includes, first, how the three dimensions of environment, social, and economic sustainability are being operationalized through more specific sustainability themes, and how priorities and gaps within and between these dimensions are managed. Second, trends and differences

in the kinds of indicators (i.e., performance, practice, and target) being using are identified. Lastly, the extent to which continuous improvement is being operationalized is analyzed. Our findings also highlight variation between assessment and standard initiatives as well as geographical differences in how sustainability is operationalized.

The remaining portions of the paper are organized accordingly. First, we provide an overview of the data collection and analysis processes. Second, we present our results. This includes data on the initiatives (e.g., crops applied to and geographical scale), kind of indicators, and the operationalization of the environmental, social, and economic dimensions of sustainability. Third, we discuss the implications of our findings for governance and agricultural sustainability. In concluding, we discuss challenges to using sustainability assessments and standards to transition agricultural systems towards increased sustainability.

2. Methods

This paper is based on a systematic review of private and multi-stakeholder sustainability governance initiatives for crop farming. The first step of data collection and analysis entailed identifying assessment and standard initiatives focused on sustainability in crop farming. This was done using a two-step process. First, we conducted a review of relevant databases (e.g., Sustainability Map) and existing research on sustainable agriculture initiatives to compile a list of initiatives that have been studied. Second, we undertook Google searches using the following terms: "Sustainability metrics agriculture," "sustainable agriculture indicators," "sustainable agriculture standards," "multi-stakeholder sustainability index for agriculture," and "multi-stakeholder sustainability metrics for agriculture." The result was a list of 58 private and multi-stakeholder sustainability assessment and standard initiatives for agriculture.

The second step of the data collection and analysis process entailed a preliminary review of the initiatives. This included examination of each initiative's publicly available information (e.g., documentation on indicators) and key characteristics of each initiative, such as geographical scope and crops covered (see Table 1).

Out of the 58 initiatives that we originally compiled, we eliminated initiatives from the study for the following reasons: not currently or never have implemented their indicators (10); information of the content of indicators was not available (15); and information was provided in a language other than English (4). The result was a sample of 29 initiatives, which included seven assessment and 22 standard initiatives (see Table 2; see appendix 1 for list of initiatives excluded from the study). The focus of this study is on initiatives that claim to be focused specifically on sustainability. Organic and fair-trade initiatives were excluded from the study. Although organic and fair-trade initiatives focus on aspects of sustainability, their respective objectives are narrower (i.e., promoting a particular form of agriculture or economic welfare of farmers and farm workers).

Table 1
Initiative key characteristics.

Criteria	Definition
Available Information	Information on the indicators publicly available or not.
Language	In which language information on indicators is available.
Developer	Who developed the indicators (e.g., individual organization, multi-stakeholder initiative, or certifying body).
Geographical Scope	The geographical scope in which the indicators are applied (e.g., national or global level).
Crop/Agricultural System	At which crops or production systems does the initiative apply.
Indicator	A variable to evaluate the performance on a certain sustainability theme. There are different kinds of indicators: performance, practice, and target based indicators.
Sustainability Dimensions	The dimensions of sustainability for which the initiative has indicators (e.g., environmental, economic, and/or social).
Assessment	The kind of assessment system associated with the initiative.
Development Stage	Where the initiative is at in the development and implementation of initiative.

Table 2
Sustainable governance initiatives.

Initiative	Abbreviation
Better Cotton Initiative	BCI
Bonsucro	
Canadian Field Print Initiative	CFPI
Cotton Made in Africa CmiA	CmiA
Ethical Tea Partnership	ETP
Field to Market	F2M
Food Alliance Sustainability Standard	FASS
Freshcare	
Global Coffee	4C
GLOBAL Good Agricultural Practice	GlobalG.A.P.
Indicateur de Durabilité des Exploitations Agricoles	IDEA
International Sustainability and Carbon Certification	ISCC
Leaf Marque	
National Sustainable Agriculture Standard	LEO4000
Origin Green	
SustainFARM Public Goods Tool	PG
Protected Harvest	
ProTerra	
Rainforest Alliance	
RedTractor	
Roundtable on Sustainable Biomaterials	RSB
Roundtable on Sustainable Palm Oil	RSPO
Roundtable for Responsible Soy	RTRS
Sustainability Assessment of Food and Agriculture systems	SAFA
Farmer Self Assessment 2.0	SAI
Sustainably Grown Certified	SCS
Sustainable Intensification Research Platform	SIP
Stewardship Index for Specialty Crops	SISC
Sustainable Wine Growing New Zealand	SWNZ

Relevant documents, such as indicator and governance documents, for each initiative were downloaded and saved as PDFs. As indicators change over time, documents for each initiative were downloaded on April 23 and 24, 2018. This included documents pertaining to indicators (e.g., guides, development procedures, and implementation guidelines), initiative governance (e.g., membership, governance procedures, and accreditation), and the implementation of indicators.

Third, we developed a three-part coding scheme to conduct a systematic review of the 29 sustainability assessment and standard initiatives. The coding scheme included descriptive, institutional, and sustainability dimensions codes. Descriptive codes focused on each initiative's history, mission statement, and verification system (e.g., self-assessment or third-party certification). Institutional codes examined the organizational structures and practices of each initiative and their indicator development processes. Institutional codes were developed based on existing research on private and multi-stakeholder governance (Beisheim and Dingwerth, 2008; Cheyns and Riisgaard, 2014; Hallström and Boström, 2010). The codes included the following characteristics, which are commonly identified as important to effective governance processes: inclusivity, participatory, transparency, and accountability.

The sustainability dimensions component of the coding scheme used the *SAFA Sustainability Assessment of Food and Agriculture Systems Guidelines* (FAO, 2014) as its foundation. Developed using a multi-stakeholder process, the SAFA Guidelines are designed to provide "a harmonized taxonomy" and "clear and common language" for assessing sustainability (FAO, 2014, 5). The purpose of the SAFA Guidelines is to serve as "an international reference document" for sustainable agriculture (FAO, 2014, 4). As it is designed to serve as a reference document for developing agricultural sustainability indicators, the SAFA guidelines provides a framework for analyzing sustainability themes and indicators for agriculture.

The sustainability dimensions codes are adapted from the environmental, economic, and social themes and sub-themes developed by SAFA. In most instances, as the SAFA sustainability themes are very

broad (e.g., atmosphere and water), the more specific sub-themes were used. Using the indicator level of the SAFA guidelines as a reference proved to be too detailed to analyze the indicators included in each initiative as several initiatives did not provide a sufficiently detailed description of the indicator to decide which specific SAFA indicator would be covered by that particular indicator. For instance, several initiatives required farmers to 'minimize greenhouse gas (GHG) emissions', which could be covering the SAFA indicator 'GHG reduction target' or 'GHG mitigation practices'. Deciding on which SAFA indicator would indeed be covered would require a lot of assumptions. For that reason, a combination of theme and sub-theme level, from now on referred to as theme level, was considered most appropriate. As the focus is exclusively on crop agriculture, the themes were accordingly adapted to be pertinent to crop production. The result was a set of ten environmental, ten social, and five economic themes (see Table 3, and Appendix 2 for an overview of SAFA indicators included in each theme). Additionally, the type of indicators (i.e., practice, performance, or target) used by each initiative was also coded.

Lastly, each initiative was coded using the three-part coding scheme of descriptive, institutional, and sustainability dimensions codes. Following the coding of each initiative, the indicator codes were compiled in spreadsheets and analysis was conducted of trends and gaps among the 29 initiatives. The results are presented in the next section.

3. Results

Five sets of results are presented. First, data on the 29 initiatives' governance procedures, geographical scope, crops, number of hectares and farmers covered is provided. Second, data on the kinds of indicators used by the sustainability assessment and standard initiatives is presented. This is then followed by the analysis of the environmental, social, and economic indicators of the 29 initiatives.

3.1. Global crop farming sustainability initiatives

We identified 29 sustainability governance initiatives (7 assessment and 22 standard) used in crop production across the world (Table 4) The history of the initiatives shows that many initiatives started in the 1990's and 2000's. The oldest standard is that of the Rainforest Alliance, which launched their initial standard in 1992. The most recent is LEO4000, which came into effect in 2014. Initiatives have sometimes changed over time, merged, reorganized, and changed names.

Most of the governance initiatives have a global scope and are used worldwide, whereas twelve initiatives focus on specific regions or countries such as North America, Africa, or Ireland. In terms of crop products, the majority of initiatives apply to crop production in general, while eleven assessments and standards focus on one or more specific crops such as coffee, tea, cotton, soy and fruits. Generally, most assessments and standards are updated on a regular basis (e.g., every 1–3 years). Several standards specify criteria based on the farm type (e.g., smallholder, small or large farm [e.g., Rainforest Alliance]).

In most of the standard initiatives, compliance to the standards is audited by a third party, often after a self-assessment by producers using the indicators. Several standards, such as the FASS and SAI, specify that their standard can also be used as a self-assessment tool for farmers. For 18 of the 22 standard initiatives, certified products can be recognized by consumers through a label on the products. On the other hand, the seven assessment tools have been specifically developed to function as a self-assessment instrument for farmers, farm advisors, or trained auditors to gain insight into a farm-level performance across a wide range of sustainability issues. As a result, consumers are not able to distinguish the products that are grown on farms that are using assessment tools.

In implementation, the existing standards are widely used to certify farmers around the world. Some standards are used in one country, while others are applied in up to 130 countries (GlobalG.A.P.). For fourteen standards, data on the number of certified farmers (including

Table 3
Sustainability codes.

Sustainability Dimension	Code	Definition
Environment	Greenhouse Gases	Indicators related to the emission of greenhouse gases.
	Air Quality	Indicators related to air pollution and air quality.
	Energy Use/ Efficiency	Indicators related to energy use and efficiency.
	Water Use	Indicators related to water use, efficiency, and irrigation.
	Water Quality	Indicators related to water quality and water pollution.
	Soil Quality	Indicators related to soil quality, such as soil organic matter and organic carbon.
	Soil Erosion	Indicators related to soil erosion and loss.
	Biodiversity	Indicators related to maintaining biodiversity, including ecological, species, and/or genetic.
	Material Use	Indicators related to material use, such as nutrient balance and pesticide use.
	Waste Reduction/ Disposal	Indicators related to the reduction of waste and/or disposal of hazardous waste.
Economic	Investment and Profitability	Indicators related to the profitability of the farm/operation and investing/planning for long-term success.
	Vulnerability	Indicators related to the long-term resiliency of the farm/business. Ability to overcome economic, social, and environment shocks. Includes indicators on product and market diversification, access to capital, and risk management.
	Food Safety	Indicators related to food safety; control of contamination of food.
	Food Quality	Indicators related to quality requirements and/or the requirement of quality control mechanisms/systems.
	Local Economy	Indicators related to local economic value creation. May include such things as local procurement and employment.
Social	Quality of Life	Indicators related to producers and/or employees' quality of life. May include indicators for living wage, adequate diets, time for family and rest.
	Capacity Development	Indicators related to producers and/or employees' opportunities to acquire skills and knowledge.
	Access to Means of Production	Indicators related to producers having access to the means of production, including equipment, capital, and knowledge.
	Fair Trading Practices	Indicators related to producers receiving a fair price. A fair price includes the ability to pay a living wage, cover cost of production, and maintain a high level of sustainability.
	Labor Rights	Indicators related to the rights of employees, including contracts, labor laws, and bargaining rights.
	Equity	Indicators related to equity and non-discrimination, including support of vulnerable groups.
	Safe Work	Indicators related to safe and hygienic workplaces.
	Public Health	Indicators related to public health, such as measures relating to avoiding polluting of local communities.
	Cultural Diversity	Indicators related to maintaining cultural diversity, including both intellectual property rights and lifestyle.
	Food Sovereignty	Indicators related to the right to culturally appropriate and healthy food and the right for people to define their food and agricultural systems.

Table 4
Sustainability governance initiative characteristics.

Name	Type	Crops	Assessment	Farmers certified	Hectares certified	Geographical Scope	Countries	Started	Current version	Label on product
BCI	Standard	Cotton	Mixed methods Third Party Certification	2,100,000	5,700,000	Global	23	2005	2020	No
Bonsucro	Standard	Sugarcane	(TPC) Self-Assessment	.	1,320,000	Global	51	2005	2016	Yes
CFPI	Tool	Crops	(SA)	.	.	Canada	1	.	2016	No
CmiA	Standard	Cotton	SA and TPC	886,000	1,657,000	Africa	11	2005	2015	Yes
ETP	Standard	Tea	TPC	.	.	Global	.	1997	2016	No
FASS	Standard	Crops	TPC or SA	111	.	North America	3	1994	2018	Yes
F2M	Tool	Crops	SA	.	.	North America	2	2006	2020	No
Freshcare	Standard	Crops	TPC	3000	.	Australia	1	2000	2019	Yes
4C	Standard	Coffee	TPC	400,000	970,000	Global	24	2003	2020	Yes
IDEA	Tool	Crops	SA	.	.	Global	>5	2000	2019	No
ISCC	Standard	Crops	TPC	3842	.	Global	100	2006	2019	Yes
Leaf Marque	Standard	Crops	SA and TPC	936	358,455	Global	27	1991	2019	Yes
LEO4000	Standard	Crops	TPC	.	.	US	1	2014	2014	Yes
Origin Green	Standard	Crops	TPC	53,000		Ireland	1	2012	2017	Yes
PG	Tool	Crops	SA	.	.	Global	>9	2005	2019	No
Protected Harvest	Standard	Winegrapes, citrus, flowers	SA and TPC	.	24,281	US	1	2001	2017	Yes
ProTerra	Standard	Crops	TPC	.	1,220,000	Global	22	2005	2019	Yes
Rainforest Alliance	Standard	Crops	TPC	2,000,000	5,000,000	Global	76	1990	2020	Yes
RedTractor	Standard	Crops	TPC	46,000	.	UK		2000	2020	Yes
RSB	Standard	Biomaterials	TPC	.	16,841	Global	24	2007	2016	.
RSPO	Standard	Palm oil	TPC	159,954	3,150,000	Global	98	2004	2018	Yes
RTRS	Standard	Soy	TPC	7099	1,265,254	Global	6	2006	2017	Yes
SAFA	Tool	Crops	SA	.	.	Global	>30	2009	2014	No
SAI	Standard	Crops	TPC or SA	102,000	25,347	Global		2002	2018	No
SCS	Standard	Crops	Audit by SCS	.	.	Global		2012	2020	Yes
SIP	Tool	Crops	SA	.	.	UK		.	2017	No
SISC	Tool	Fruits, nuts, and vegetables	SA	.	.	US		2008	*	No
SWNZ	Standard	Wine	TPC	.	38,338	New Zealand	1	1997	.	Yes

* Versions are theme specific and released on different dates.

smallholders and businesses) was found. The two largest include BCI (2.1 million farmers) and Rainforest Alliance (over 2 million farmers). In total, nearly 6 million farmers are certified under one of these fourteen initiatives. For another 14 standards, the hectares of land certified could be identified, with a total of 25 million hectares (approximately 2% of global land used for crop production). Within specific sectors or countries, certain standards are quite influential, for instance, the BCI covers 22% of global cotton production, 6% of global sugar cane land is certified by Bonsucro, in Ireland, 70% of horticulture farmers are Origin Green certified and 96% of New Zealand's vineyard producing area is SWNZ certified.

In the standard initiatives, the compliance or performance of farms is evaluated using a list of indicators. Nevertheless, specific scoring systems substantially vary across initiatives. Generally, many standards divide their requirements into two or three categories from critical/major to optional/recommended criteria with compliance percentages per category (e.g., GLOBALG.A.P.). Some standards use a scoring system with points per criteria to evaluate compliance of a farm (e.g., FASS and Protected Harvest). Some standards identify different levels of compliance (e.g. bronze, silver, gold (SAI-FSA)), based on the type of criteria met. More recently, we observe recognition among some standard initiatives as to the need for measuring continuous improvement. For example, recent updates of the Rainforest Alliance and 4C standards emphasize the importance of identifying criteria that should be addressed over time, in which compliance levels are determined by the years involved in the standard.

3.2. Performance, practice, and target indicators

In operationalizing the concept of sustainability, initiatives have to decide on which sustainability themes and indicators to include and how to evaluate producers' compliance to sustainability objectives. Generally, there are three kinds of sustainability indicators: performance, practice and target (FAO, 2014). Performance indicators directly measure the performance or impact of certain farming practices using data from measurements, observations and calculations (e.g., the impact on surface water quality, or energy use). Practice and target indicators relate more to the management of a farm. More specifically, practice indicators focus on evaluating whether certain farming practices are adopted, or certain tools and systems are in place. Practice indicators are therefore also commonly referred to as prescriptive or process indicators (FAO, 2014). Examples include "actions taken to protect water resources" or "practices in place to increase fertility of the soil." Target indicators focus on the presence of plans, policies or monitoring of certain sustainability themes with associated targets (FAO, 2014). Common examples of this type of indicator are "a soil management plan" and "records of water usage."

All three kinds of indicators are used across the 29 sustainability initiatives. Notably, it is quite common for initiatives to use more than one type of indicator. Of the three, target indicators are the most common, with 22 initiatives having such indicators. The next most common kind is practice indicators, with 15 initiatives using them. Lastly, 11 initiatives have performance indicators. The most prevalent combination is the use of both practice and target indicators, with 13 of the initiatives having this combination. Less common is the use of all three kinds of indicators, as only three initiatives use practice, performance, and target indicators. Additionally, there is a difference in the kinds of indicators between assessment and standard initiatives. Specifically, we found that assessment initiatives tended to use more performance indicators. Of the seven assessment initiatives, five of them use performance indicators solely. In contrast, standard initiatives primarily adopt target and then practice indicators. Quite common is the use of both

target indicators that specify required management plans and practice indicators that outline particular practices. Only four standard initiatives included performance indicators, and they tended to be confined to selected areas, such as greenhouse gas emissions.

Nearly all the indicators in the 29 initiatives are designed to be used at the farm-level. That is, they designate practices, set management plans, or measure performance at the farm-level. While some assessment initiatives, such as F2M, have performance indicators that measure farmer performance at the field-level, these are the exception.

3.3. Sustainability dimensions

Using the *SAFA Sustainability Assessment of Food and Agriculture Systems Guidelines* as a reference, we evaluated to what extent the 29 initiatives have indicators related to ten environmental, ten social and five economic themes. Overall, initiatives tend to cover most of the environmental themes, while social and economic themes are less often covered (Fig. 1). In the sections below we further elaborate on the findings per sustainability dimension.

Our analysis shows that the 29 initiatives vary largely in the extent to which they cover themes within each dimension (Fig. 2). While initiatives such as SAI, SCS and SIP include indicators across the majority of sustainability themes, most initiatives only cover approximately half of the themes.

3.4. Environmental sustainability

Our analysis found that the 29 initiatives have indicators across the majority of the ten environmental themes. Of the 29 initiatives in the study, 15 have indicators for all ten environmental themes and six additional initiatives have indicators for at least nine of the ten environmental themes. Only five initiatives have indicators for less than eight of the environmental themes (See Table 5). They include three assessment initiatives (CFPI, F2M, and SISC) and one standard for citrus and flowers that are focused exclusively on North America. The other initiative is CmiA, which is a standard initiative for cotton grown in Africa.

The environmental themes that are most often covered in initiatives are greenhouse gases and soil quality, both of which all 29 initiatives have developed indicators for. The next most common environmental themes are soil erosion (97%), water use (93%), material use (93%) biodiversity (90%), and water quality (90%). The least common are energy use and efficiency (79%) and air quality (70%). Generally, in all of the environmental themes identified by SAFA, we found a high prevalence of indicators across the 29 sustainable agriculture initiatives. This indicates that sustainability initiatives for crop farming have largely developed indicators that address the key dimensions of environmental sustainability.

The initiatives tend to also be consistent in how they interpret the environmental themes. However, one exception is material use, which is quite broad, as it includes a range of inputs (e.g., fertilizers and pesticides). On the one hand, the majority of initiatives have similar indicators focused on fertilizer use and nutrient balance. On the other hand, there is considerable variation in indicators focused on pest management and the use of pesticides. Specifically, there is a divide across the initiatives as to whether they include integrated pest management as part of their pest management indicators. In 12 out of the 22 initiatives that have pest management indicators, the indicators only include the proper use of pesticides, such as the use of only legal pesticides. In contrast, in ten initiatives, the pest management indicators include the use of integrated pest management or require producers to have a comprehensive pest management approach. Thus, there is a divide in terms of whether there is an emphasis on the reduction chemical use versus the proper use of chemicals.

While the 29 initiatives have indicators for a majority of the ten environmental themes, there is variation as to whether growers are required to demonstrate improvement. On the one hand, there are initiatives whose environmental indicators only require growers to measure performance, have a management plan, or implement specific practices. On the other hand, some initiatives specify that growers should "minimize" or "improve" their environmental performance. SCS' greenhouse gas and air quality indicators is an example of this approach, as producers "must take steps to reduce" emissions of greenhouse gas emissions and air pollutants. However, in such cases where producers are required to work towards improving their environmental sustainability, the extent of improvements required tends not to be designated. In other words, no thresholds or specific requirements are specified with respect to the improvements growers are expected to make. Thus, while growers may be required to make efforts to reduce their greenhouse gas emissions, they tend not to need to meet any specific reduction targets.

3.5. Social sustainability

Analysis of the 29 sustainability initiatives found that there is considerable variation across the initiatives in the ways that they operationalize social sustainability. Only two initiatives have indicators covering all ten themes (SAFA and SIP), and four initiatives have no indicators for social sustainability. Over half the initiatives (55%) have

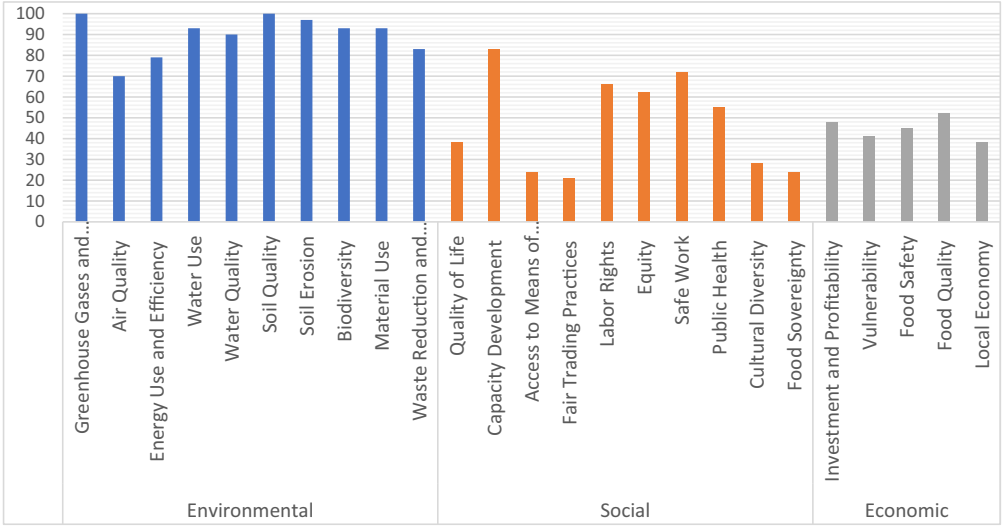

Fig. 1. Percentages of initiatives that have indicators related to each theme within the three sustainability dimensions.

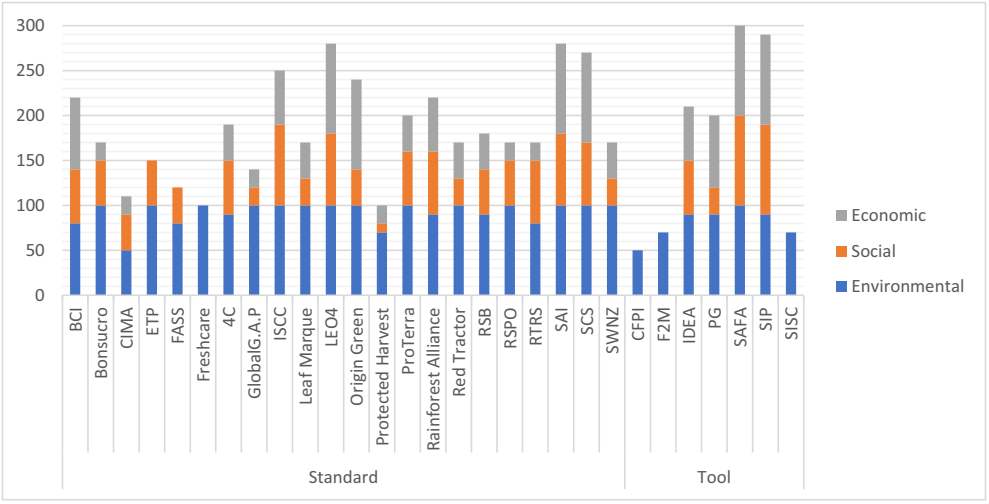

Fig. 2. Total percentage of environmental, social and economic themes that are covered by each of the initiatives (standards on the left, tools on the right).

Table 5
Sustainability governance initiatives environmental dimensions of sustainability (x indicates covered by indicators in the initiative).

	Greenhouse Gases and Climate Change	Air Quality	Energy Use and Efficiency	Water Use	Water Quality	Soil Quality	Soil Erosion	Biodiversity	Material Use	Waste Reduction and Disposal	% themes
BCI	x			x	x	x	x	x	x	x	80
Bonsucro	x	x	x	x	x	x	x	x	x	x	100
CFPI	x	x	x			x	x				50
CIMA	x			x		x	x		x	x	50
ETP	x	x	x	x	x	x	x	x	x	x	100
F2M	x		x	x	x	x	x	x			70
FASS	x			x	x	x	x	x	x	x	80
Freshcare	x	x	x	x	x	x	x	x	x	x	100
4C	x		x	x	x	x	x	x	x	x	90
GlobalG.A.P	x	x	x	x	x	x	x	x	x	x	100
IDEA	x		x	x	x	x	x	x	x	x	90
ISCC	x	x	x	x	x	x	x	x	x	x	100
Leaf Marque	x	x	x	x	x	x	x	x	x	x	100
LEO4	x	x	x	x	x	x	x	x	x	x	100
Origin Green	x	x	x	x	x	x	x	x	x	x	100
PG	x		x	x	x	x	x	x	x	x	90
Protected Harvest	x	x		x	x	x		x	x		70
ProTerra	x	x	x	x	x	x	x	x	x	x	100
Rainforest Alliance	x		x	x	x	x	x	x	x	x	90
Red Tractor	x	x	x	x	x	x	x	x	x	x	100
RSB	x	x		x	x	x	x	x	x	x	90
RSPO	x	x	x	x	x	x	x	x	x	x	100
RTRS	x	x			x	x	x	x	x	x	80
SAFA	x	x	x	x	x	x	x	x	x	x	100
SAI	x	x	x	x	x	x	x	x	x	x	100
SCS	x	x	x	x	x	x	x	x	x	x	100
SIP	x	x	x	x	x	x	x	x	x		90
SISC	x		x	x		x	x	x	x		70
SWNZ	x	x	x	x	x	x	x	x	x	x	100
% initiatives	100	70	79	93	90	100	97	93	93	83	

indicators for 50% or less of the social themes (See Table 6).

The most common social sustainability themes covered are the following: capacity development (83%), safe work (72%), equity (62%), labor rights (62%), and public health (55%). The themes where indicators are least common are cultural diversity (28%), access to the means of production (24%), food sovereignty (24%), and fair-trading practices (21%). Thus, similar to the recent study by Janker and Mann (2020), our findings indicate that there is a divide between indicators focused on labor rights and conditions and those focused on more transformative social practices. The most common social sustainability indicators are ones that are in alignment with national laws or international policies related to worker rights, training, and safety. Significantly less common are indicators that incorporate the more normative dimensions of social sustainability, such as democratization and empowerment.

Our findings indicate that there is regional variation in the extent to which sustainability initiatives have developed social sustainability indicators. Specifically, initiatives for just North America tended to have a lower level of social sustainability indicators. Three of the four initiatives with no social indicators are sustainability assessment tools for North America (CFPI, F2M, and SISC). While the two North American sustainability standard initiatives, FASS and LEO4000, include some

Table 6
Sustainability governance initiatives social dimensions of sustainability.

	Quality of Life	Capacity Development	Access to Means of Production	Fair Trading Practices	Labor Rights	Equity	Safe Work	Public Health	Cultural Diversity	Food Sovereignty	% Themes
BCI		X			x	x	X	x	x		60
Bonsucro		X	X		x	x	X				50
CFPI											0
CIMA		X			x	x	X				40
ETP	x	X			x	x	X				50
F2M											0
FASS		X			x	x	X				40
Freshcare											0
4C		X	X	x	x	x	X				60
GlobalG.A.P		X					X				20
IDEA	x	X		x				x	x	X	60
ISCC	x	X	X	x	x	x	X	x	x		90
Leaf Marque		X					X	x			30
LEO4	x	X			x	x	X	x	x	X	80
Origin Green		X			x	x	X				40
PG		X			X					X	30
Protected Harvest		X									10
ProTerra	x	X			x	x	X	x			60
Rainforest Alliance	x	X	X		x	x	X	x	x		70
Red Tractor		X					X	x			30
RSB					X	x	X	x	x	X	50
RSPO		X		x		x	X	x			50
RTRS	x	X			X	x	X	x	x		70
SAFA	x	X	X	x	X	x	X	x	x	X	100
SAI	x	X	X		X	x	X	x	x		80
SCS	x	X			X	x	X	x		X	70
SIP	x	X	X	x	X	x	X	x	x	X	100
SISC											0
SWNZ		X			X			x			30
% initiatives	38	83	24	21	66	62	72	55	28	24	

social sustainability indicators, these standards do not appear to be widely implemented at this time.

For some social sustainability themes, there is a large degree of consistency in how sustainability initiatives operationalize them. This tends to be the case in areas such as safe work, equity, and public health. Safe work focuses on the health and safety of workplaces, equity on discrimination, and public health tend to focus on local pollution. However, for other themes there is considerable variation in how they are operationalized. For instance, although labor rights is a relatively common theme, initiatives differ in how they operationalize it. Of the 18 initiatives that have labor right indicators, 11 of them explicitly referenced the right to collective bargaining in their indicators. For those initiatives that do not include collective bargaining, their labor right indicators tend to focus on the use of written contracts or specify that national labor laws need to be adhered to. A second area with considerable variation is quality of life. The most common quality of life indicators included in the initiatives focus on the right for workers to have time off from work. Some initiatives add a second dimension and also include the right of workers to living wages. Lastly least common are quality of life indicators that incorporate non-work dimensions, such as the right to culturally appropriate and nutritious diets, and time and opportunities for family and cultural activities. Only three initiatives have quality of life indicators that include non-work dimensions.

Our findings indicate that in some instances, there is a gap between the SAFA social sustainability themes and the indicators that have been developed by many sustainability initiatives for crop farming. This is particularly evident with respect to the theme of capacity development, which is the most common social sustainability theme. In its guidelines, SAFA includes both training necessary for workers and farmers to complete their required tasks, but also "resources to provide for further training and education for themselves and members of their families" (FAO, 2014, 180). However, of the 24 initiatives that have capacity development indicators, only four have indicators that include opportunities for additional professional development. For the majority of initiatives, these indicators are limited to ensuring that workers and farmers have the required training in such areas as safety and equipment use and the documentation of such training.

3.6. Economic sustainability

Indicators for economic sustainability were the least common with less than half of the 29 sustainability initiatives having indicators for these five themes. Of the five economic sustainability themes, food quality is covered most often (52%) among the 29 initiatives, followed by investment and profitability (48%), food safety (45%), vulnerability (41%) and local economy (38%) respectively (See Table 7).

Seven initiatives have no indicators at all for economic sustainability, five cover only one theme, and six only two themes related to economic sustainability. In contrast, six initiatives cover all five themes. Initiatives with no indicators related to economic sustainability tend to focus on North America and Australia (the global ETP is an exception), while initiatives that cover five themes tend to be global or European (the US-oriented LEO4000 being the exception here). Of the seven assessment initiatives, three have no economic sustainability indicators while one covered three themes, one four and two covered five themes. Hence, we found no clear difference between the assessment and standard initiatives.

In terms of operationalization, the theme investment and profitability is scored with essentially two key indicators: (short term) profitability of the farm and (long term) viability of the farm. The score depends on whether records are kept (SCS), profits are made (cf. PG) and long-term plans exist (cf. RSPO). The theme vulnerability is operationalized in a much more diffuse way, including the presence of diversification, prognosis of future market development, active monitoring of operations and financial performance, risk mitigation strategies and access to additional resources. The third theme, food safety, is

Table 7
Sustainability governance initiatives economic dimensions of sustainability.

	Investment and Profitability	Vulnerability	Food Safety	Food Quality	Local Economy	% Themes
BCI	X		x	X	X	80
Bonsucro				X		20
CFPI						0
CmiA				X		20
ETP						0
FASS						0
Field to Market						0
Freshcare						0
4C	X			X		40
GlobalG.A.P.			x			20
IDEA	X	X		X		60
ISCC	X	X	x			60
Leaf Marque	X	X				40
LEO4000	X	X	x	X	x	100
Origin Green	X	X	x	X	x	100
PG	X	X		X	x	80
Protected Harvest				X		20
ProTerra			x		x	40
Rainforest Alliance	X		x	X		60
Red Tractor			x	X		40
RSB		X			x	40
RSPO	X					20
RTRS					x	20
SAFA	X	X	x	X	x	100
SAI	X	x	x	X	x	100
SCS	X	X	x	X	x	100
SIP	X	X	x	X	x	100
SISC						0
SWNZ		X	x			40
% initiatives	48	41	45	52	38	

operationalized more straightforward through the presence of a farm management plan for food safety with clear instructions and whether the necessary expertise is available. SWNZ only required proof for compliance to the relevant laws and regulations. Food quality, the fourth theme, is operationalized through the presence of a plan, the practice and the monitoring of quality management. Sometimes continuous quality improvement is added. PG requests the presence of a food quality certificate and SAFA has an interesting and quite precise tool which is "the share of the total volume of production that meets the quality standard." Finally, the fifth theme, local economy, is operationalized in three ways. First, by requiring a contribution to the local economy through partnerships or the valorization of local resources, second by encouraging labor opportunities for the local population (including vulnerable groups and gender diversity), and finally through processing on farm.

Overall, these findings show several interesting ways in which economic sustainability is measured in the different initiatives. However, they also illustrate the relatively little interest given to operationalizing this dimension of sustainability compared with the environmental dimension in particular, and the social dimension to a lesser degree.

4. Discussion

In the sections above, we presented an overview of sustainability governance initiatives and examined the indicators for 29 initiatives for crop farming. Specifically, we analyzed the extent to which sustainability initiatives for crop farming have developed indicators for the environmental, social, and economic dimensions of sustainability. In the sections below, we discuss three findings that emerge from our analysis: (1) prioritizations and gaps in the operationalization of the three dimensions of sustainability, (2) the selection of indicator type, and (3) the operationalization of continuous improvement.

4.1. Prioritizations and gaps in the operationalization of sustainability

This study examined a global sample of crop farming sustainability governance initiatives: seven assessment and 22 standard initiatives. Despite disagreement regarding its usefulness (Purvis et al., 2019), the tripartite approach of environmental, social, and economic sustainability is the norm in terms of how initiatives structured their indicators. Of the 29 initiatives in our study, only six did not have some indicators for all three dimensions of sustainability. However, there is unevenness in how the three dimensions are operationalized. Specifically, the environmental dimension tends to be prioritized over the other two.

Consistent with existing research (Béné et al., 2019; de Olde et al., 2018; Janker et al., 2019; Osmundsen et al., 2020), environmental indicators are the most prevalent throughout the 29 sustainability governance initiatives. All 29 initiatives have some environmental indicators, and 21 of the initiatives have indicators for nine of the ten environmental themes identified by SAFA. In contrast to environmental sustainability, the 29 initiatives do not have a high level of indicators across the ten dimensions of social sustainability, or the five dimensions of economic sustainability identified by SAFA.

The higher prevalence of environmental themes covered indicates that sustainability governance initiatives have tended to prioritize the dimension of sustainability in which public awareness is greatest (Rueda et al., 2017). Research finds that consumers tend to think about sustainability primarily in terms of the environmental dimension, and that they are less knowledgeable of the other two dimensions (Choi and Ng, 2011; Sánchez-Bravo et al., 2021). As retailers and branded food companies are, partly, reacting to consumer concerns (Oosterveer, 2012), this suggests that they may also prioritize the environmental dimension. Furthermore, within the environmental dimension, certain environmental issues may receive more attention from consumers, and thus retailers and branded companies. For example, climate change is an issue that is of significant concern to many people and is receiving substantial media attention in much of the world. In our study, it is one of only two themes across all the dimensions in which a 100% of initiatives have indicators. Thus, given the leading roles that retailers and branded food companies play in sustainable agriculture governance initiatives (Freidberg, 2017, 2020), their concerns and priorities may be partly driving the greater emphasis on environmental sustainability and

particular environmental issues.

The prioritization of the environmental dimension of sustainability may also be an outcome of greater consensus by stakeholders and experts. There is general agreement across experts and stakeholders that agriculture regarding the environmental impacts of agriculture (Campbell et al., 2018; Godfray et al., 2010). In contrast, there is less agreement among both experts and stakeholders as to the social and economic dimensions of agricultural sustainability (Boström, 2012; Hale et al., 2019; Janker et al., 2019; Latruffe et al., 2016). One the one hand, Janker et al. (2019: 1686) note that there is insufficient conceptual knowledge and research on the social dimension and, as a result, there is not consensus regarding appropriate indicators. On the other hand, developing indicators for social and economic sustainability is also complicated in that they both have normative dimensions. For instance, social and economic sustainability is often connected with issues of ethical and distributive fairness, on which there are divergent perspectives (Janker et al., 2019; Kirwan et al., 2017).

Mirroring these differences in agreement regarding the appropriate themes and indicators of each dimension of sustainability is variation in the quantification of the three dimensions of sustainability. Environmental issues tend to be more amenable to quantification than the social and economic dimensions of sustainability (de Olde et al., 2018; Hale et al., 2019; van der Linden et al., 2020). For instance, Janker et al. (2019) observe that there is tremendous variation in social conditions globally, and thus suggest the development of standardized indicators for the social dimension of sustainability is quite difficult. As sustainability assessment and standard initiatives tend to operate across multiple agricultural systems and/or countries, this poses challenges for them. In part, this may explain the relative dearth of social and economic indicators, and why many of the social and economic indicators that have been developed tend to reflect existing public policies.

Lastly, the more developed state of environmental indicators may also reflect the extent to which environmental challenges are capable of being addressed vis-à-vis social and economic ones. Currently, an array of practices and technologies exist that farmers can utilize to lower their environmental impacts (Bacco et al., 2019). In contrast, such technological fixes largely do not exist for the social and economic challenges facing agriculture. Rather than being able to adopt technological innovations, addressing social and economic challenges tends to entail changes in supply chain relations and market structure. Not surprisingly, these are often more difficult than adopting new technologies or on-farm practices, and may face resistance from downstream actors that are part of many sustainability initiatives. There may also be greater financial incentives to address certain environmental issues. For example, reducing water and energy use can also lead to cost reductions, whereas addressing the social and economic dimensions may lead to additional costs and lessen efficiencies. In sum, a variety of factors likely contribute to the greater development of environmental indicators in sustainability initiatives for crop agriculture.

4.2. The selection of indicator type

Our findings indicate that there is variation in the kinds of indicators used by sustainability governance initiatives. Target indicators are the most prevalent and performance indicators the least. Furthermore, there is divergence in indicator preference by the type of initiative. Practice and target indicators are more common in standard initiatives and performance indicators in assessment initiatives.

The prevalence of practice and target indicators in standard initiatives may be a result of two factors. First, these types of indicators have a longer history of use in agriculture. For example, organic standards, which predate sustainable crop farming standards, use practice indicators. Early sustainability standards in other sectors, such as the Forest Stewardship Council, also use practice and target indicators. Additionally, food safety standards also tend to use practice and target indicators (e.g., HACCP), and some initiatives encompass both food safety and sustainability (e.g., GlobalG.A.P.). Thus, many sustainable crop farming standards follow the model of practice and target indicators that was already prevalent in both agriculture and sustainability standards. Furthermore, in many instances, the same stakeholders are involved in multiple sustainability initiatives, which may have led to the diffusion of target and practice indicators as the preferred approach. For instance, the World Wildlife Fund was a founding member of the early sustainability standards (i.e., Forest Stewardship Council and Marine Stewardship Council), and is involved in several sustainable crop farming initiatives examined in this study.

In contrast to the long use of practice and target indicators, the use of performance indicators in sustainable agriculture is a newer development. Most assessment initiatives, where performance indicators are most common, were developed more recently than many standard initiatives. With time, performance indicators are gaining increased support from both experts and various stakeholders (Freidberg, 2014). For instance, Hatanaka et al. (2022) describe the ongoing shift in sustainable governance from practice-based standards to performance-based, data-driven, assessment tools in US crop agriculture. This shift was largely initiated by the leading food companies and brands that were seeking to demonstrate the sustainability of their supply chains. Hence, the higher prevalence of performance indicators in assessment initiatives may reflect shifts in sustainability governance towards measure and manage approaches and the growing use of digital technologies.

Second, target and practice indicators appear to be more user-friendly for growers than performance indicators. Target indicators often only require a plan to be in place. Therefore, with target indicators, farmers only need to develop a plan in order to comply with a sustainability standard. While practice indicators may entail changes in their practices, to be in compliance with a standard, farmers often just have to demonstrate the use of a given practice. In comparison, performance metrics tend to require the collection of fairly detailed data by farmers on their management practices and outcomes, and might even involve on-farm measurements and observations. The collection and reporting of such data may result in additional work for farmers and auditors and may require farmers to invest in technological upgrades, such as digital technologies (Klerkx et al., 2019). As a result, performance indicators can be more time consuming and costly, which may inhibit farmer adoption of standards or assessments that use them. Moreover, as the data gathered with the use of performance indicators is increasingly incorporated into large data sets and digital technology programs, farmers are concerned as to who has ownership and access to such data (Rotz et al., 2019). Such concerns may also generate resistance to the use of performance indicators.

4.3. Continuous improvement

A key component of current sustainability approaches is the idea of continuous improvement (Bush et al., 2013; NRC, 2010). In much of current thinking, sustainability is viewed as an ongoing process, as opposed to a fixed outcome. Applied to agriculture, this means that farmers are to be working to continually improve the sustainability of their operations. While the idea of continuous improvement is a foundational part of current conceptualizations of sustainability (Ammenberg et al., 2002; ISEAL, 2021;), our findings indicate that it tends to be under-operationalized by private sustainability governance initiatives for crop farming.

Standard initiatives tend to require farmers to use specific practices and/or have management plans in place. In most instances, if they have implemented particular practices and management plans, this is sufficient for certification. Additionally, in most standard initiatives, farmers are not required to demonstrate continuous improvements in their sustainability. This includes requirements to adopt additional practices over time, develop more rigorous management plans, or demonstrate measurable changes in sustainability. Thus, many standard initiatives tend to be structured in such ways that require farmers to meet the

specified requirements, but do not necessarily incentivize continuous improvement. This finding supports case studies of certification initiatives that find such programs are often accounting systems that record whether farmers are in compliance with technical requirements (Amundsen, 2022; Guthman, 2014). However, it needs to be noted that there are some exceptions. For example, the Rainforest's Alliance sustainability standard has indicators that push farmers to continuously improve their sustainability.

A key driver behind the development and use of performance indicators is their capability to drive continuous improvement (Freidberg, 2017; Hatanaka et al., 2022). As they have the potential to provide farmers with detailed measurements of specific components of sustainability performance, farmers can understand and assess their sustainability outcomes and document measurable improvements over time. Additionally, downstream actors, such as retailers and branded food companies, can use such data to make claims as to improvements in the sustainability of their supply chains. However, the extent to which such performance data results in improvement is highly dependent on the motivation and incentives of farmers to act (de Olde et al., 2018). In other words, while the use of performance metrics enables the potential for continuous improvement, there needs to be incentives for farmers to use the data to make ongoing improvements. Although there is a growing push in some places to compensate farmers for improvements in their sustainability performance, at this point in time, farmers tend not to be compensated for such improvements. Thus, research finds that there are often insufficient incentives for growers to continually improve their sustainability (Konefal et al., 2019; Hatanaka et al., 2022; Slattery et al., 2022).

5. Conclusion

Sustainability standard and assessment initiatives govern a substantial and growing portion of global cropland. They play a central role in determining what is considered sustainable and thereby influence which farming practices are applied worldwide. The impact of these initiatives is likely to continue to grow as sustainability assessments and standards become more widely adopted. In presenting a comprehensive overview of the current state of sustainability indicators for crop farming globally, this study addresses a research gap on the ways that sustainability is being operationalized by non-state governance initiatives.

Reflecting the conceptual looseness of the idea of sustainability, our findings show that sustainability is operationalized in divergent ways. Presently, there is little harmonization in how sustainability is operationalized in crop agriculture. Rather, indicators reflect the current multitude of perspectives on sustainable agriculture. Congruent with other existing research (van der Linden et al., 2020; Osmundsen et al., 2020), we also find that environmental sustainability is bring prioritized. Furthermore, within the environmental dimension certain themes are also receiving greater attention and facing pressure to demonstrate actual improvements, such as reductions in greenhouse gases. This prioritization of some aspects of sustainability puts integrated approaches to sustainability at risk, as a limited set of themes may garner the bulk of resources.

Our findings highlight several challenges facing governance initiatives working to transition crop agriculture towards greater sustainability. First, for a variety of reasons, the social and economic dimensions of sustainability tend to be under-operationalized in governance initiatives for crop agriculture. Hence, a key challenge going forward is the development of robust social and economic indicators for agricultural sustainability and greater attention to the potential trade-offs between sustainability themes (Kanter et al., 2018; Smith et al., 2022). Whereas environmental themes such as climate change and biodiversity loss are key challenges for agriculture, improvements on those themes should not come at the expense of the welfare of farmers and local communities.

A second challenge for sustainability governance initiatives is the appropriateness of different kinds of indicators to each of the three dimensions of sustainability and variations in agricultural systems. Currently, sustainability initiatives for crop agriculture use a variety of kinds of indicators, with target and practice indicators being the most common in standard initiatives and performance indicators in assessment tools. Although there is a growing push towards "measure and manage" approaches to sustainability that use performance indicators (Freidberg, 2014; Rosin et al., 2017), the use quantitative metrics may not be appropriate for all dimensions of sustainability and in all contexts. This is particularly the case for the social and economic dimensions of sustainability, which tend to be "context-dependent and locally embedded" (Janker et al., 2019: 1689). Thus, going forward, agriculture sustainability initiatives will need to continue to grapple with balancing the applicability of indicators across diverse agricultural, environmental, and political-economic landscapes with the capability to account for such diversity (Amundsen, 2022; Béné et al., 2019).

A third challenge for sustainability initiatives is developing indicators that promote continuous improvement. Presently, continuous improvement is not widely incorporated into agricultural sustainability governance. Consistent with research by Bush et al. (2013), the sustainability initiatives in this study stress accessibility over continuous improvement. Put differently, for most initiatives, the primary emphases are on getting their standards or assessment tools adopted (i.e., accessibility by farmers) and ensuring the credibility of their efforts. Hence, as sustainability governance initiatives further mature, they will need to work to develop indicators that can account for and promote continuous improvement. This may entail shifting from viewing indicators as a set of criteria that farmers need to comply with (Amundsen, 2022), to indicators that emphasize capabilities and capacity-building that equip producers with the knowledge and tools to make their operations more sustainable (Samerwong et al., 2020).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Parts of the data are made available in the supplement. Others, available on request.

Appendix 1. Initiatives excluded from the study

Agrarumweltindikatoren
Agro-Environmental Sustainability Information System
Committee On Sustainability Assessment
Cool Farm Tool
DIAgnostic Liant Environnement et Contrat Territorial d'Exploitation
DIAgnostic Global d'Exploitation
DLG - Zertifikat Nachhaltige Landwirtschaft

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Environmental management for agriculture
Equitable Food Initiative
Framework for Assessing the Sustainability of Natural Resource Management Systems
Indicator of Sustainable Agricultural Practice
Kriteriensystem Nachhaltige Landwirtschaft
Module Duurzaam Akkerbouw Bedrijf
Multiscale Methodological Framework
New Zealand Sustainability Dashboard
Response-Inducing Sustainability Evaluation 2.0
Sustainability Assessment of Farming and the Environment
Sustainability Flower Quick Assessment
Sustainability Monitoring and Assessment RouTine

Appendix 2. SAFA sustainability dimensions, themes and indicators considered in this study

Sustainability Dimension	Theme	Related SAFA indicators (FAO, 2014)
Environment	Greenhouse Gases	GHG reduction target
		GHG mitigation Practices
		GHG balance
	Air Quality	Air Pollution reduction target
		Air Pollution Prevention Practices
		Ambient concentration of air Pollutants
	Energy Use/Efficiency	Renewable energy use target
		Energy Saving Practices
		Energy consumption
		Renewable energy
	Water Use	Water conservation target
		Water conservation Practices
		Ground and Surface water withdrawal
	Water Quality	Clean water target
		Water Pollution Prevention Practices
		Concentration of water Pollutants
		Wastewater Quality
	Soil Quality	Soil improvement Practices
		Soil Physical Structure
		Soil chemical Quality
		Soil biological Quality
		Soil organic matter
	Soil Erosion	Land conservation and rehabilitation Plan
		Land conservation and rehabilitation Practices
		Net loss/gain of Productive land
	Biodiversity	Landscape/marine habitat conservation Plan
		Ecosystem enhancing Practices
		Structural diversity of ecosystems
		Ecosystem connectivity
		Land use and land cover change
		Species conservation target
		Species conservation Practices
		Diversity and abundance of key Species
		Diversity of Production
		Wild genetic diversity enhancing Practices
		Agro-biodiversity in-situ conservation
		Locally adapted Varieties and breeds
		Genetic diversity in wild Species
		Saving of Seeds and breeds
	Material Use	Nutrient balance
		Hazardous pesticides
	Waste Reduction/Disposal	Waste reduction target
		Waste reduction Practices
		Waste disposal
		Food loss and waste reduction
	Investment and Profitability	Internal investment
		Community investment
		Long term Profitability
		Business Plan
		Net income
		Cost of Production
		Price determination
Economic	Vulnerability	Guarantee of Production levels
		Product diversification
		Procurement channels
		Stability of Supplier relationships
		Dependence on the leading supplier

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Sustainability Dimension	Theme	Related SAFA indicators (FAO, 2014)
		Stability of market
		Net cash flow
		Safety nets
		Risk management
	Food Safety	Control measures
		Food contamination
	Food Quality	Food quality
		Product labelling
		Traceability System
		Certified Production
	Local Economy	Regional workforce
		Fiscal commitment
		Local Procurement
	Quality of Life	Right to Quality of life
		Wage leve
Social	Capacity Development	Capacity Development
	Access to Means of Production	Fair access to means of Production
	Fair Trading Practices	Fair Pricing and transparent contracts
		Rights of Suppliers
	Labor Rights	Employment relations
		Forced labour
		Child labour
		Freedom of association and right to bargaining
	Equity	Non discrimination
		Gender equality
		Support to Vulnerable People.
	Safe Work	Safety and health trainings
		Safety of workplace, operations and facilities
		Health coverage and access to medical care
	Public Health	Public health
	Cultural Diversity	Indigenous knowledge
	Food Sovereignty	Food Sovereignty

Appendix 3. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.agsy.2023.103658.

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