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Systems thinking and complexity science–informed evaluation frameworks: Assessment of The Economics of Ecosystems and Biodiversity for Agriculture and Food

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Abstract

Despite the increasing literature, applications, and discussions over the last 15 years, there remain questions about how to bring systems thinking and complexity science (STCS) into evaluation in ways that meaningfully enhance its practice, use, and results. One pathway forward is bridging the gap between the large STCS body of knowledge and evaluation practice by synthesizing STCS insights into actionable frameworks to support the work and role of those engaged in evaluation activities. This chapter aims to contribute to this challenge through two main goals. First, the authors develop an actionable STCS framework comprising ten guiding principles, identified through a review of STCS literature to support evaluation practitioners, researchers, and commissioners to bring STCS into evaluation. Secondly—and to test this STCS principles-based framework—this chapter assesses the extent to which TEEBAgriFood, an STCS-informed food systems evaluation framework, advances STCS into evaluation. Results provide learnings and insights about the use of STCS in evaluation design and practice.

INTRODUCTION

Humanity worldwide is being affected by a combination of socioeconomic and environmental challenges, such as poverty, inequalities, oppression and marginalization, social distress, political unrest, food insecurity and malnutrition, environmental degradation, and climate change (Dury et al., 2019). Fields such as project planning, organizational management, and evaluation, among others, are increasingly acknowledging the inherent complexities of global challenges and, thus, attempting to delineate pathways forward by

drawing on concepts, methods, and tools from systems thinking and complexity sciences (STCS).

In the evaluation field, the linear and mechanistic logic of traditional and mainstream evaluation methods and approaches is being questioned and challenged. In 2006 Gerald Midgley stated: "it is widely recognized (e.g., Zammuto, 1982) that setting narrowly defined goals … and measuring the achievement of these alone, may result in the evaluator missing positive benefits that lie outside the scope of the evaluation. Indeed, perverse behaviors may be generated" (p. 11). Michael Quinn Patton goes further, claiming that evaluation needs to be transformed by embracing STCS to stop perpetuating linear and narrow thinking that hinders the role that evaluation can play in supporting meaningful responses to the challenges we currently face (2019a).

Since the first attempts in the early 2000s, researchers and practitioners have further endeavored to bring STCS into evaluation. Some of these attempts took the form of STCS frameworks designed for specific fields. The Systems in Evaluation Topical Interest Group of the American Evaluation Association developed a system thinking principles–based framework (Systems in Evaluation TIG, 2018) that inspired the STCS framework developed in this chapter.

STCS frameworks help practitioners from different fields overcome barriers to meaningfully bringing STCS into their practice. Some of these barriers are technical language and terms, evolving debates, epistemological discrepancies, or philosophical assumptions underpinning systems thinking and complexity theory. These barriers can derail attempts to enhance evaluation practice through STCS methods, tools, and concepts, so these end up falling into the "prosaic"—and not the "profound"—use of STCS as coined by Bob Williams (2015).

The purpose of this chapter is then twofold. First, the authors propose an STCS principles–based framework that is then applied to the meta-evaluation of an STCS-informed evaluation framework for assessing food systems—TEEBAgriFood.

Proposed STCS principles–based framework

First, this chapter develops a principles-based framework that is based on STCS literature and that intends to (a) provide meaningful guidance on the use of STCS in different evaluation activities and for different evaluation roles; (b) be useful in supporting better decisions in embracing STCS in evaluation; (c) inspire evaluation researchers, practitioners, and commissioners to acknowledge and further explore how STCS can improve their practice; (d) be context-sensitive, adaptable and enduring; (e) be evaluable in whether they are being followed, useful, and effective (Patton, 2018).

Although systems thinking and complexity theory are referred together under STCS in this issue and this chapter, so as by authors such as Reynolds et al. (2016), each of these fields includes a broad set of different theories, concepts, traditions, and considerations to define and address complex situations. These are explored in this chapter to identify synergies and complementarities between systems thinking and the complexity science fields for enhancing evaluation practice.

For the STCS principles–based framework proposed in this chapter, the authors adopt a methodological pluralism approach (Mingers & Brocklesby, 1997), bringing together worldviews from different paradigms into the same framework (Jackson, 2003) at both ontological and epistemological positions. This approach intends to enhance STCS-informed evaluation's capacity to better cope with the complexities of the diverse, context-dependent, and often conflicting situations of interest that evaluation is expected to shed

light on and support. As multimethodological approaches are underpinned by theories about the complementary use of methodologies and paradigms that prioritize one interest or dimension over the others, Brocklesby calls for "being literate across a number of paradigms" to be able to "deal with a broad range of issues and to enter a problem situation with fewer preconceived ideas about how it will be handled" (1997, p. 190). Problem situations and situations of interest are understood here as those systemic issues where evaluation is expected to shed light. The application case comprises diverse food systems–related situations of interest as lack of renewability, resilience, diversity, inclusion, equity, health, and interconnections in global and local food systems, as stated by the Global Alliance for the Future of Food (2020).

Application of the STCS principles-based framework to the meta-evaluation of TEEBAgriFood

As the second objective of this chapter, the authors apply the STCS principles–based framework developed to the meta-evaluation of The Economics of Ecosystems and Biodiversity for Agriculture and Food Evaluation Framework (TEEB, 2018), hereafter referred to as TEEBAgriFood. TEEBAgriFood is an STCS-informed evaluation framework focused on complex challenges related to agriculture, food security, and nutrition that has solid theoretical foundations in STCS and makes explicit use of it as a guiding perspective. Indeed, one previous review of this framework states that TEEBAgriFood "likely constitutes the most advanced, state-of-art model for comprehensive systems evaluation that exists—a multidimensional, integrated, systems-based, and complexity-informed approach" (Patton, 2019b, p. 1).

According to Patton (2018), principles should be evaluable in their meaningfulness, the adherence to them, and the results, consequences, and implications of that adherence—or the lack of it. This application of the STCS principles–based framework to TEEBAgriFood seeks to, on the one hand, test the proposed STCS principles–based framework by critically assessing the adherence and meaningfulness of the proposed principles and learn from using it. On the other hand, this application expects to shed light on the extent to which and how STCS ideas are lived up in actual evaluation practice.

A BRIEF OVERVIEW OF FOOD SYSTEMS ANALYTICAL FRAMEWORKS

Agriculture and food systems are at the center of the increasing debates about sustainability and the multidimensionality and complexity of current global challenges (Allen & Prosperi, 2016; Hubeau et al., 2017; International Panel of Experts on Sustainable Food Systems, 2015; Nguyen, 2018; Zurek et al., 2018). Within the long-standing tradition of research on food issues, the approaches under which these issues are understood and assessed have been evolving over the last years.

Traditionally, food systems were understood as complex sets of activities interacting with each other and with the environment to provide food from farms to consumers (Kneen, 1993; Labianca, 1991). Starting with Ericksen (2008), the last decade's food systems frameworks transcended the traditional linear logic of value creation along the value chain with short-term economic return as the main outcome. They started to adopt a sustainability perspective that placed food security and nutrition as the main expected outcome. These frameworks attempted to tackle the complexity of food systems by exploring different systems' levels and hierarchies, different interrelationships within the system and its

multidimensional context, and incorporating different perspectives to different extents. TEEBAgriFood uses the term "eco-agrifood systems" to highlight the interrelationships between the agricultural sector, as an economic system, and the broader environmental, human and social systems within which it is embedded.

Among all these food systems frameworks, three basic categories can be drawn. Some frameworks only provide a conceptual framework defining key elements, dimensions, and interrelations (Ericksen, 2008; Ingram, 2011; Nguyen, 2018; UNEP, 2016; van Berkum et al., 2018). Other frameworks develop the conceptual aspects into key considerations, recommended steps for food systems analysis, and sometimes proposed methods (IPES Food, 2015). Lastly, some frameworks further develop all the aspects as mentioned earlier into specific applications (Biovision Foundation for Ecological Development & Global Alliance for the Future of Food, 2019; Bortoletti & Lomax, 2019; Hubeau et al., 2017; IOM & NRC, 2015; TEEB, 2018; Zurek et al. 2018). In this last category, IOM and NRC (2015) and TEEB (2018) present a solid STCS theoretical foundation. The first focuses more on complex adaptive systems features attributable to food systems. In contrast, the second includes a review of key aspects of systems thinking and complexity theory and outlines how these considerations apply to eco-agrifood systems. Between these two, TEEBAgriFood explicitly uses systems thinking together with complexity science concepts as the foundational theory for the framework and the bedrock for its subsequent development. Additional reasons for this chapter using TEEBAgriFood as an application case for the developed STCS principles–based framework are detailed below.

TEEBAgriFood: A brief description of the application case

TEEBAgriFood aims to make a case for a paradigm shift in the way food is produced and consumed by increasing the awareness of economically visible and invisible externalities and impacts—both negative and positive—of the value chain activities on the human, social, produced, and natural capitals through a comprehensive system-wide evaluation of the eco-agrifood system (TEEB, 2018). Among its potential uses, TEEBAgriFood is expected to support the identification of pathways for systemic improvement and thus inform the decision-making of farmers, researchers, policy-makers, investors, companies, and other food systems actors. It also allows the comparison between interventions in different systems by providing a common framework for their analysis. Finally, it is expected to be used in an interdisciplinary and participatory way by facilitating engagement and dialogue among stakeholders and allowing the design of socially desirable measures to improve eco-agrifood systems (TEEB, 2018). Different guidance documents and toolboxes are being developed as this chapter is being written in support and enhancement of the use of TEEBAgriFood by these diverse food systems actors.

An additional reason for focusing this chapter on TEEBAgriFood is the fact that two of the co-authors work with the Global Alliance for the Future of Food, which funded the development of TEEBAgriFood through a highly participatory process involving over 150 diverse academics and food systems stakeholders over three years (TEEB, 2018). Besides the aforementioned goals, the authors are interested in supporting the continued evolution, development, and application of TEEBAgriFood by critically assessing it under an STCS approach based on the STCS literature.

TEEBAgriFood core concepts, approaches, and methods are developed in the seminal TEEBAgriFood Scientific and Economic Foundations Report (TEEB, 2018), hereafter referred to as the TEEB report. This report is structured into four segments. The first segment presents system thinking as a guiding perspective in TEEBAgriFood (Chapter 2). The

second segment provides evidence of the need to change the eco-agrifood systems' metrics (Chapters 3–5). The third segment presents the TEEBAgriFood evaluation framework by determining what should be evaluated (Chapter 6), how to carry out the evaluation (Chapter 7), and by presenting case study examples of application (Chapter 8). Finally, the fourth segment aims to explore pathways to reach the expected paradigm shift toward sustainability (Chapter 9) in alignment with ongoing initiatives and processes (Chapter 10).

RESEARCH METHODOLOGY

In this section, we further detail the development of the STCS principles–based framework based on key literature on STCS and its application to the meta-evaluation of TEEBAgriFood.

Proposed STCS principles–based framework

The development of the STCS principles–based framework started with a review of academic and gray literature on the use of STCS in evaluation, which was made through searches in the Scopus and Web of Science bibliographic databases, and the Google Scholar search engine, using a combination of terms on systems, complexity, and evaluation. Additional resources were identified through a snowball technique starting from the reference lists of relevant literature found. The literature reviewed focused on resources providing guiding insights for enhancing evaluation practice through systems thinking and complexity sciences. Resources not exhibiting a clear link with evaluation practice and those focused on specific case studies, methodologies, or interventions without providing theoretical links to STCS were excluded from our review. As a result, we identified 11 documents that addressed systems thinking in evaluation, 12 addressing complexity science in evaluation, and three addressing the implications of using both in evaluation.

The online appendix of this chapter summarizes the information obtained from the literature review and organizes it around three major dimensions to deal with complex situations: exploring the big picture, understanding the dynamics of the system, and acknowledging the role of the agents in framing situations and proposing actions to improve them. We base these three dimensions on the three categories proposed by Ramalingam et al. (2008)—systems, changes, and agency—and on what is known as the three main concepts of systems thinking—interrelationships, perspectives, and boundaries (Midgley, 2006; Reynolds & Holwell, 2010; Williams & Iman, 2006).

Once these three dimensions were defined, we analyzed the 26 references in search of key aspects of STCS to flesh out each of the three dimensions mentioned above, as shown in the appendix. Once these key aspects were identified, the authors needed to decide how to structure the collected information. Among different alternatives, including recommendations and rubrics, the authors considered that the most suitable way to frame the key STCS aspects emerging from the literature review, in response to the purpose of meaningfully informing evaluation practice for diverse evaluation actors, in diverse and complex contexts, is through a principles-based approach (Patton, 2018). According to the GUIDE framework for effective principles (Patton, 2018), principles are expected to provide meaningful guidance on what to do, be useful in supporting choices and decisions leading to desired results, be inspiring by meaningfully evoking a sense of purpose, be developmental—enduring, context-sensitive, and complexity adaptable, and be evaluable

so it can be tracked, documented, and assessed whether they are meaningful, adhered to, and relevant to achieve desired results (Patton, 2018).

The STCS principles–based framework is developed assuming that systems are means of re-presenting phenomena of the real world—ontological nominalism (Reynolds, 2011)—and that knowledge is socially constructed, based upon subjective interpretations, and imbued with human purpose—epistemological constructivism, interpretivism, and critical idealism, respectively (Reynolds, 2011). These positions are aligned with the traditions of the soft and critical system (Reynolds & Holwell, 2010) and with the metaphorical and critical pluralist schools of thought of complexity science (Raisio & Lundström, 2017; Richardson, 2008).

From these ontological and epistemological stances, we apply a multimethodological approach (Mingers & Brocklesby, 1997) that brings together aspects, concepts, and considerations from different paradigms, traditions, and schools and presents them as complementary to better deal with complex situations. Elements from the hard systems tradition (Reynolds & Holwell, 2010) and the neoreductionist school of thought of complexity science (Raisio & Lundström, 2017; Richardson, 2008) could be added to the STCS principles–based framework while attending to paradigm incommensurability issues as described by Jackson (1991) and Mingers and Brocklesby (1997) drawing upon Habermas' theory of knowledge constitutive interests (1984).

The result of this process is an STCS principles–based framework structured around the three aforementioned dimensions and comprising ten overarching principles that address the key guiding insights of STCS for evaluation practice, together with 26 operating principles that provide specific guidance on the implementation, adaptation, and evaluation of the ten overarching principles from conceptual and methodological perspectives. The dimensions and principles of this STCS principles–based framework, together with the references supporting each of the principles, are detailed in Table 1.

Application of the STCS principles–based framework to the meta-evaluation of TEEBAgriFood

In order to test the STCS principles–based framework and learn from its use, the authors applied the STCS principles–based framework to the meta-evaluation of an STCS-informed evaluation framework focused on complex challenges related to food systems—TEEBAgriFood. This application also sheds light on the extent and ways in which STCS theories and methods are realized in evaluation practice.

In this meta-evaluation, the authors assess the adherence and meaningfulness of the operating and overarching principles of the STCS framework in TEEBAgriFood. The evaluation of adherence is based on the extent to which and ways in which each of the operating and overarching principles are addressed in the following sections of the TEEB report (TEEB, 2018): the theoretical justification for using systems thinking as a guiding perspective for TEEBAgriFood (Chapter 2), the conceptual and methodological development of the TEEBAgriFood evaluation framework (Chapter 6 and the introductory section of Chapter 7), and the pathways to reach the expected paradigm shift (Chapter 9). The evaluation of the meaningfulness of the principles comes from reflections and discussions among the authors about the principles with greater potential to meaningfully enhance the TEEBAgriFood framework and its expected impacts.

Principles-focused evaluation (Patton, 2018) states that besides adherence to and meaningfulness of the principles, results from actively engaging with principles should also be assessed. This will be subject to future research as ongoing TEEBAgriFood applications are completed.

TABLE 1 Systems thinking and complexity science principles–based framework: dimensions, principles, and references supporting each principle*

Dimensions	Overarching principles	Operating principles	References
I. Exploring the big picture	1. Acknowledge **multidimensionality** and hierarchical structure of complex systems	1.1 Acknowledge that complex situations are built up of **subunits and elements interrelated** to each other in diverse and often unexpected ways while immersed in a broader and multidimensional context.	Cabrera et al. (2008); CECAN (n.d); Cornell Office for Research on Evaluation (2009); Eppel et al. (2011); Foster-Fishman et al. (2007); Hummelbrunner (2011); Midgley (20016); Iman et al. (2006); Kania et al. (2012); Ramalingam et al. (2008); Reynolds et al. (2016); Rickles et al. (2007); Turner & Baker (2019); Vincent (2012); Walton (2014); Westhorp (2012); Williams & Hummelbrunner (2009).
		1.2 Provide methods and tools supporting the **mapping of the complex situations** including its elements, the interrelations among them, and the interrelations with the context, in order to improve the understanding of the situations.	Checkland & Poulter (2010); Cornell Office for Research on Evaluation (2009).
	2. Engage with **interrelations** and interdependencies	2.1 Enable **understanding the nature, characteristics, properties, and consequences of the interrelations** among elements, dimensions, levels, and scales within the situation and its context.	Burns & Worsley (2015); Byrne & Callaghan (2014); Cabrera et al. (2008); CECAN (n.d); Eppel et al. (2011); Foster-Fishman et al. (2007); Gates (2016); Hummelbrunner (2011); Kania et al. (2012); Midgley (2006); Ramalingam et al. (2008); Reynolds et al. (2012); Reynolds & Holwell (2010); Reynolds et al. (2016); Rickles et al. (2007); Systems in Evaluation TIG (2018); Turner & Baker (2019); Westhorp (2012); Williams & Hummelbrunner (2009).

(Continues)

TABLE 1 (Continued)

Dimensions	Overarching principles	Operating principles	References
		2.2 Provide analytical approaches, methods, and tools that acknowledge **non-linearity and capture feedbacks, delays, and other properties** in analyzing the multiple interrelations.	Burns & Worsley (2015); Foster-Fishman et al. (2007); Gates (2016); Hummelbrunner (2011); Kania et al. (2012); Midgley (2006); Reynolds & Holwell (2010); Reynolds et al. (2012); Westhorp (2012); William & Hummelbrunner (2009).
	3. Address **emergent properties** and unpredictable behavior	3.1 Focus on understanding the situation as a whole (systemically) in order to identify **emergent properties and dynamics that arise from interactions** among system's elements and with the context.	Burns & Worsley (2015); Byrne (2013); Byrne & Callaghan (2014); CECAN (n.d.); Eppel et al. (2011); Midgley (2006); Ramalingam et al. (2008); Reynolds et al. (2012); Reynolds & Holwell (2010); Reynolds et al. (2016); Rickles et al. (2007); Turner & Baker (2019); Vincent (2012); Walton (2014); Westhorp (2012).
		3.2 Provide methods and tools that help **identifying emergent properties and address unpredictable behavior**.	Foster-Fishman et al. (2007); Gates (2016); Kania et al. (2012); Turner & Baker (2019); Williams & Hummelbrunner (2009); Vincent (2012); Walton (2014); Westhorp (2012); Williams & Hummelbrunner (2009).
II. Understanding the dynamics of the system	4. Map the system's movements through the **phase space** to identify underlying **patterns** of change	4.1 **Delimit the phase space of the system** by understanding the possible values that variables and dimensions of the system can theoretically take, in order to enable a better understanding of the system's behavior.	Byrne (2013); Byrne & Callaghan (2014); Ramalingam et al. (2008); Rickles et al. (2007).

(Continues)

TABLE 1 (Continued)

Dimensions	Overarching principles	Operating principles	References
		4.2 Enable an understanding of **systems' patterns of change** by using methods and tools that map the system's trajectory through the phase space.	Kania et al. (2012); Systems in Evaluation TIG (2018)
	5. Understand **how a system changes** between phases or states	5.1 Acknowledge the capacity of complex systems to remain **stable** in a dynamic context by absorbing changes without modifying its fundamental behavior. Also acknowledge **tipping points** where the system modifies its behavior to adapt to or to change the context.	CECAN (n.d.); Eppel et al. (2011); Midgley (2006); Rickles et al. (2007); Vincent (2012); Westhorp (2012).
		5.2 Explore the **control parameters** and their role in triggering the **phase shifts** while acknowledging the limited existence of stability points where the system can move to—known as **attractors**.	Burns & Worsley (2015); Byrne & Callaghan (2014); Eppel et al. (2011); Ramalingam et al. (2008); Rickles et al. (2007); Vincent (2012); Walton (2014); Westhorp (2012).
		5.3 Provide methods and tools that allow: (i) **identifying the attractors or points of stability** in the phase space, and (ii) identifying when the control parameters reach the **tipping points** that triggers phase shifts.	Vincent (2012); Walton (2014).
		5.4 Contemplate a **time horizon** that allows to explore attractors and phase shifts in order to understand systems' patterns of change.	CECAN (n.d.); Kania et al. (2012).

(Continues)

TABLE 1 (Continued)

Dimensions	Overarching principles	Operating principles	References
		5.5 **Be flexible and adaptable** enough with framings, processes, methods, and timelines to cope with the dynamic behavior of the complex situations. Review periodically the purpose and approach to the analysis. Learn from and adapt to as needed.	CECAN (n.d.); Cornell Office for Research on Evaluation (2009); Eppel et al. (2011); Gates (2016); Hummelbrunner (2011); Kania et al. (2012); Midgley (2006); Reynolds et al. (2012, 2016); Systems in Evaluation TIG (2018).
	6. Acknowledge the **path dependence** and **context sensitivity** of complex systems	6.1 Acknowledge that, in complex systems, **results may not be generalizable or transferable** due to the heavy dependency on systems' history and context.	Burns & Worsley (2015); Byrne (2013); CECAN (n.d.); Eppel et al. (2011); Hummelbrunner (2011); Ramalingam et al. (2008); Rickles et al. (2007); Turner & Baker (2019); Vincent (2012); Westhorp (2012).
		6.2 **Map the systems' evolution over time**. Acknowledge the initial state and the path history in order to better understand its dynamics and emergent behavior.	Byrne & Callaghan (2014); Vincent (2012).
III. Acknowledging the role of agents in framing systems	7. Understand **adaptive agents** and the self-organization capacity that arises from the interactions among them	7.1 Acknowledge the self-organization of the complex situations emerging from the interactions among adaptive agents and the system. The dynamic of the situation and the changing context influence and are influenced, through an iterative process, by the learning, knowledge, and way of acting of the agents.	CECAN (n.d.); Checkland & Poulter (2010); Eppel et al. (2011); Hummelbrunner (2011); Kania et al. (2012); Midgley (2006); Ramalingam et al. (2008); Reynolds et al. (2016); Rickles et al. (2007); Turner & Baker (2019); Vincent (2012); Westhorp (2012).

(Continues)

TABLE 1 (Continued)

Dimensions	Overarching principles	Operating principles	References
		7.2 Provide approaches and methods that **capture the links between changes in agents, context, and other situation's components** in order to understand how agents adapt to and coevolve with the situation and its context.	Eppel et al. (2011); Kania et al. (2012); Systems in Evaluation TIG (2018).
	8. Acknowledge diverse **perspectives** as part of a same big reality	8.1 Acknowledge that systems are conceptualizations of complex issues that are rooted on and responding to different and sometimes conflicting perspectives. Therefore, any systemic inquiry needs to **collectively explore these different worldviews and the consequences of them in framing the system and its analysis**.	Cabrera et al. (2008); CECAN (n.d); Checkland & Poulter (2010); Cornell Office for Research on Evaluation (2009); Foster-Fishman et al. (2007); Hummelbrunner (2011); Midgley (2006); Ramalingam et al. (2008); Reynolds & Holwell (2010); Reynolds et al. (2012, 2016); Vincent (2012); Walton (2014); Williams & Hummelbrunner (2009).
		8.2 Actively **engage stakeholders in exploring their motivations, interests, concerns, and values on the situation being explored** in order to identify perspectives concerning how the system is, how it should be, feasible and desirable pathways, and how it conditions to approach the systemic analysis.	CECAN (n.d.); Checkland & Poulter (2010); Cornell Office for Research on Evaluation (2009); Foster-Fishman et al. (2007); Hummelbrunner (2011); Midgley (2006); Reynolds & Holwell (2010); Reynolds et al. (2012, 2016); Systems in Evaluation TIG (2018); Vincent (2012); Walton (2014); Williams & Hummelbrunner (2009).

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TABLE 1 (Continued)

Dimensions	Overarching principles	Operating principles	References
	9. Promote **dialogue and mutual appreciation** among perspectives to decide how to frame the situation	9.1 Promote and enable meaningful **dialogues and exchanges among perspectives** to co-create a common initial understanding from which to negotiate how to frame the situation.	Checkland & Poulter (2010); Cornell Office for Research on Evaluation (2009); Eppel et al. (2011); Foster-Fishman et al. (2007); Hummelbrunner (2011); Iman et al. (2006); Walton (2014).
		9.2 Bring attention to **power relations and structural conditions** that shape how stakeholders share their interests, expectations, and perspectives, how they negotiate the framing of the situation, and the result of those negotiations.	Hummelbrunner (2011); Iman et al. (2006); Midgley (2006); Reynolds & Holwell (2010); Reynolds et al. (2016); Systems in Evaluation TIG (2018); Ulrich & Reynolds (2010); Vincent (2012); Williams & Hummelbrunner (2009).
		9.3 Provide methods and/or tools that enable meaningful dialogues and fruitful exchanges among different perspectives while collectively acknowledging the links between power relations and the prioritization/ marginalization of perspectives and boundary decisions **in search for mutual understanding**.	Cornell Office for Research on Evaluation (2009); Foster-Fishman et al. (2007); Gates (2016); Hummelbrunner (2011); Reynolds & Holwell (2010); Reynolds et al. (2016); Williams & Hummelbrunner (2009).

(Continues)

TABLE 1 (Continued)

Dimensions	Overarching principles	Operating principles	References
	10. Place **boundaries** to manage complexity	10.1 Acknowledge that **placing boundaries is essential on any systemic inquiry** and that not everything can be considered. In fact, boundaries determine what and who is considered relevant for the analysis.	Burns & Worsley (2015); Byrne & Callaghan (2014); Cabrera et al. (2008); CECAN (n.d.); Cornell Office for Research on Evaluation (2009); Gates (2016); Hummelbrunner (2011); Iman et al. (2006); Midgley (2006); Reynolds et al. (2016); Turner & Baker (2019); Westhorp (2012); Williams & Hummelbrunner (2009).
		10.2 Engage diverse perspectives in highly participatory, collaborative, and transparent processes that provide spaces for discussion, mutual appreciation, and equal power, especially when **deciding which perspectives and values to privilege when defining the boundaries of the situation.**	Burns & Worsley (2015); CECAN (n.d.); Cornell Office for Research on Evaluation (2009); Eppel et al. (2011); Foster-Fishman et al. (2007); Gates (2016); Hummelbrunner (2011); Iman et al. (2006); Midgley (2006); Reynolds & Holwell (2010); Reynolds et al. (2012, 2016); Systems in Evaluation TIG (2018); Ulrich & Reynolds (2010); Walton (2014); Williams & Hummelbrunner (2009).
		10.3 Explore the values that sustain stakeholders' perspectives. Support collective critical assessment of the links between the **values that underpin different perspectives and the decisions about the boundaries in the situation**.	Foster-Fishman et al. (2007); Gates (2016); Iman et al. (2006); Midgley (2006); Reynolds et al. (2012); Reynolds et al. (2016); Ulrich & Reynolds; Walton (2014).
		10.4 Acknowledge, explore, and support critical assessment of the **ethical and practical consequences** of the boundaries placed and how the systems are framed. Plan how to address these consequences.	Iman et al. (2006); Reynolds et al. (2016); Ulrich & Reynolds (2010); Williams & Hummelbrunner (2009).

*For each of the references mentioned, additional bibliographical information along with a short summary of main contents can be accessed online in the appendix to this chapter.
Source: The authors, based on the literature reviewed.

RESULTS FROM THE APPLICATION OF THE PROPOSED SYSTEMS THINKING AND COMPLEXITY THEORY PRINCIPLES–BASED FRAMEWORK TO TEEBAgriFood

This section presents the results derived from applying the STCS principles–based framework to the meta-evaluation of TEEBAgriFood. Results are structured and presented according to the three dimensions of the STCS principles–based framework and to the overarching principles (OP) within each dimension. For this meta-evaluation, we assessed how TEEBAgriFood adheres to each of the operating principles, and when possible, we supported it, including examples at conceptual and methodological levels. This adherence assessment allowed us to reflect on the strengths, weaknesses, and possible pathways for the enhancement of TEEBAgriFood as an STCS evaluation framework, which ultimately led the authors to collectively reflect on the meaningfulness of the proposed STCS principles.

Dimension 1: Exploring the big picture

TEEBAgriFood acknowledges the multidimensional and hierarchical structure of the eco-agrifood systems—value chain elements embedded in and interrelated to a multidimensional context composed of four capitals: human, social, produced, and natural—and provides system associated methodologies like causal loop diagrams, Bayesian maps, and mind maps, to map this complexity (OP1). It develops a conceptual framework that helps understand interrelations and interdependencies between eco-agrifood systems' elements by describing the linkages between the value chain and the four capitals; however, it lacks guidance on addressing non-linear features like feedbacks and delays when exploring interrelations (OP2). Finally, it provides methodologies to map the complexity of eco-agrifood systems like life-cycle assessment and propensity scoring methods; and other methodologies to identify and anticipate emergent behavior by modeling interrelationships, like systems dynamics (OP3).

The assessment of this first dimension of the STCS principles–based framework highlights the special attention paid by TEEBAgriFood to the complex structure, elements, and interrelationships of eco-agrifood systems providing comprehensive descriptions of these along with concepts and methods that facilitate their understanding and further exploration.

Dimension 2: Understanding the dynamics of the system

To understand the dynamics of the eco-agrifood systems, TEEBAgriFood maps the patterns of change that emerge from the interrelationships between the system and its context across the phase space. The phase space is indirectly delimited by the variables defined to describe changes in the four capitals that support eco-agrifood systems. Although the proposed methods aim to understand the interrelations at the time of the analysis, they do not pay special attention to the system's historical trajectory through the phase space, which is crucial for exploring and understanding patterns of change (OP4).

TEEBAgriFood defines systems change triggers as those factors and events changing the system's resilience, which is defined as the maintained capacity of capital stocks to provide goods and services. TEEBAgriFood then proposes simulation methodologies and models to explore how interrelations across the system change over time, while it contemplates making regular and ongoing measurements through periods to cope with the system's dynamic

behavior. However, the significance of identifying the control parameters that trigger phase shifts—defined as changes in systems' resilience—is not acknowledged in understanding systems behavior (OP5).

By describing the eco-agrifood systems according to four capitals, TEEBAgriFood indirectly recognizes these systems' sensitivity to their contexts. Besides context-dependence, path dependence is acknowledged in theoretical terms but is not sufficiently referenced in the TEEBAgriFood conceptual and methodological framework (OP6).

The assessment of this second dimension of the STCS principles–based framework shows that TEEBAgriFood can be improved by incorporating concepts and methods related to systems behavior, the conditions that shape that behavior, the ways transformations are triggered, and the enabling conditions for those to happen. To better cope with the dynamic behavior of eco-agrifood systems, the methodological framework of TEEBAgriFood could be reframed as an ongoing, iterative, and adaptable process instead of a snapshot of the system—or a series of them—taken by applying a set of linear steps.

Dimension 3: Acknowledging the role of agents in systems framing

TEEBAgriFood acknowledges that agents in eco-agrifood systems can learn and adapt to changes but does not delve into the system's self-organization capacity nor proposes approaches or methods capable of capturing how agents adapt and coevolve with the system and its context (OP7).

On the other hand, TEEBAgriFood also acknowledges that agents' diversity often involves a diversity of perspectives about how the situation is understood and framed, how the purposes and desired changes are established, and the pathways to achieve those. All of which is encouraged to be explored and appreciated in order to gain a more substantive understanding of the situation. Despite that, TEEBAgriFood does not offer guidance on meaningfully engaging stakeholders in processes, allowing them to explore, understand, and appreciate diverse motivations, interests, concerns, and values engaged in the situation and shape it (OP8).

TEEBAgriFood emphasizes and promotes shared understanding among stakeholders in framing and addressing the situation under analysis. However, methods recommended in this regard—causal loop diagrams—do not pay sufficient attention to how power relations can influence stakeholders' dynamics, even when TEEBAgriFood considers power issues as a critical element of systems transformations toward the common good. Platforms that integrate less powerful voices to redirect structural power are mentioned, but no further theory, concept, or method is included in the framework (OP9).

The facilitation of common understanding among stakeholders through duly embracing power issues and imbalances has at its core the collective definition of the boundaries defining what is relevant for the situation of interest. TEEBAgriFood acknowledges the need to set boundaries for managing the complexity of eco-agrifood systems by promoting dialogues and exchanges among stakeholders in defining the perspective(s) that will be the starting point for the evaluation. Although it promotes efforts in that sense, it does not promote needed reflections on the values, structural underpinnings, and consequences of implicit and explicit boundary decisions (OP10).

The assessment of this third dimension of the STCS principles–based framework shows that TEEBAgriFood acknowledges the importance of engaging with different perspectives and defining boundaries to better understand the situation. However, the STCS principles highlight how TEEBAgriFood could be further enhanced by delving into how the behavior of agents—coevolution and adaptation—and the power relations, dynamics, and issues

can influence the processes of framing and bounding the situation, especially when it comes to deciding whose voices are considered—and whose are not—with what purpose, and with what consequences.

CONCLUSIONS

The application of the proposed STCS principles–based framework to the STCS-informed evaluation framework—TEEBAgriFood—revealed how STCS is brought to life in real evaluation practice. This proposed STCS principles–based framework also generated actionable insights on how STCS can be further applied in evaluation practice.

Regarding application, the STCS principles–based framework clarified TEEBAgriFood's main strengths as well as opportunities for further development. TEEBAgriFood is solid in providing a comprehensive and detailed description of the eco-agrifood system structure—elements, hierarchies, and interrelations—and supporting highly participatory processes in which diverse perspectives are acknowledged and included in defining how to frame and address a situation of interest. On the other hand, TEEBAgriFood's further development, under an STCS perspective, relates to the following three main areas: (1) delving into systems' patterns of behavior, the conditions that shape that behavior, how transformations occur, and the enabling conditions for those to happen; (2) proposing an iterative methodological framework that better copes with the dynamics and highly changing contexts in which the eco-agrifood systems operate; and (3) delving into power relations, dynamics, and issues as critical influencing factors for how any situation is bounded, framed, assessed, and ultimately addressed.

Besides providing insights on TEEBAgriFood's main strengths and pathways for improvement toward a better STCS-informed evaluation framework, the application of the STCS principles–based framework allowed the authors to reflect on the meaningfulness of the STCS principles in guiding and inspiring agents engaged in evaluation practice to draw upon STCS as a meaningful way to better support their responses to the widespread current complex challenges we face.

In that sense, the authors' conclusions about the main contributions of the STCS principle–based framework presented in this chapter follow. First, the STCS principle–based framework offered meaningful guidance on how to engage with STCS in evaluation practice by providing actionable and useful theory-based principles that provide a comprehensive view of both systems thinking and complexity science insights for evaluation under a multimethodological approach. Thus, it helps to transcend the shallow use of some partial mainstream concepts and the misleading application of methods previously decoupled from their critical underlying assumptions.

Besides that, thanks to its hierarchical structure around three dimensions, ten overarching principles, and 26 operating principles—the STCS principles–based framework provides guidance that goes from general to specifics in different contexts and for different purposes. The STCS framework dimensions and the overarching principles act as the backbone. The operating principles provide specific and adaptable guidance from methodological and conceptual perspectives tailored to specific purposes.

There are several possible pathways to further strengthen, develop, and enhance the STCS principle–based framework. The principles should be evaluated—besides their adherence and meaningfulness—for their usefulness and effectiveness in leading to the expected results. To that same end, the STCS principles–based framework should be tested throughout a complete evaluation process that provides enough empirical evidence to assess evaluation objectives, design, implementation, results, and use from an STCS perspective. In that sense, it is advisable to broaden the TEEBAgriFood meta-evaluation scope

by including the implementation and results of its applications once they are available to assess the implications and consequences of the adherence to the STCS principles.

Besides this, the STCS principles–based framework could be improved by strengthening some of the operating principles—to focus on providing specific methodological guidance—through a more extensive literature review that also pays attention to recommendations about the use of specific STCS approaches, methods, and tools in evaluation. This will allow for further assessment of the tools and methods proposed in TEEBAgriFood.

Finally, the STCS framework, by being principle-based, is expected to be used in different contexts, by different agents, and for different purposes. To support this broad application, the principles might need to be further nuanced to support that diversity. For this reason, it is necessary for the STCS framework's applications to transcend the one presented in this chapter.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the chapter.

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