Inviting Community into the Development of Globally Sustainable Food Systems
Acknowledgements

There is so much to be grateful for. The circles of gratitude are a bit like the rings rippling outward on a lake, after the surface is broken. They do not really stop. And so, it is impossible to name all of the people and contexts that have allowed me to pursue such a privileged thing as doctoral studies. The lake is big. But to name a few, I extend gratitude…

To my supervisors, Göran and Edith, who provide experience, guidance and a lot of good ideas; to Edith, for inviting me to work with you on these ideas; to Göran, TISU, and BTH, for providing the opportunity for transdisciplinary doctoral studies, and the institutional supports to do so.

To my family, immediate, who make space for me to pursue my ideas, and my children, who remind me daily that efforts to shape a future full of life and wonder are the most important thing.

To my colleagues at Acadia University who supported me to pursue doctoral studies concurrently to my role on campus, in particular, Barb Anderson, Peter Williams, Jeff Hooper, Tom Herman, Ray Ivany. To my colleagues at Acadia, BTH, as well my nutrition and dietetics colleagues around the world, who affirm for me that the ideas are worth pursuing.

To the project assistants along the way (Anne, Jesper, Jacob, Bekki) that have supported much of the work, which I could not have done alone.

To the Social Sciences and Humanities Research Council of Canada who funded part of this research through their Connections program, and Acadia University who has supported parts of this research through the 25.55 research fund.
To the scholars from many disciplines who are also grappling with these issues, and have taught me about the many ways you can examine this story.

To my family, extended, who value education, and brought me into a place where I had access to it.

To my fellow paddlers, morning swimmers, explorers, who seek to connect their human experience to the natural environment. Some concepts can only be known through the body.

To my fellow food lovers, who share my passion that there must be a better way to do this, and that food is worth our effort.

November 1, 2019

Liesel Carlsson
Abstract

Food systems and human diets contribute to unsustainable socioecological conditions, which in turn negatively affect human health. These driver-impact relationships span multiple scales, prompting international governance bodies, nations, and communities alike to grapple with solutions for a better food future. Collaborative action across scales and sectors is necessary; however, how communities can align contributions with efforts at broader scales is unclear.

The aim of this research is to develop theoretical and procedural supports for community engagement in globally sustainable food systems (SFS), and to provide concrete results relevant to one case community.

The community of nutrition and dietetics professionals was chosen as the case community given its history of engagement with SFS, its integration throughout food system sectors, and because dietary shifts have significant potential to contribute to SFS. Furthermore, the researcher’s position as a member of this community supported the case study work.

The research uses transdisciplinary methods guided by the Framework for Strategic Sustainable Development (FSSD) and Community Development theory. The FSSD provides a concrete definition of sustainability and includes methodological supports for co-creation of sustainability transitions. Community Development theory supports participatory approaches and welcomes different knowledge cultures in such co-creation. The Delphi Inquiry method was used to facilitate data collection and community engagement. For measurement-specific elements of the research, causal loop diagrams (CLD) informed by the Cultural Adaptation Template (CAT) theory were used, and Critical Dietetics was used as a framework for dietetics-specific analysis.
High level insights include that: (i) participatory and multidimensional approaches are important to facilitate community engagement in SFS development; (ii) objective parametres for defining sustainability are critical to guide concerted action and can provide an innovation space that invites creative and diverse solutions within; (iii) systems thinking and related tools help simplify the complexity of food systems without disregarding broader context, and support assessment in the absence of all data. Specifically in relation to the case community explored, insights include that, (i) integrating an SFS lens into existing roles and activities is important, because dietitians already work across sectors and scales, making them well positioned to contribute in diverse ways; (ii) a shared language based on transdisciplinary understandings of SFS is required; (iii) engaging in activities that facilitate SFS knowledge development within the profession, prior to integrating it into roles and activities, is an important first step; (iv) collaborative and reflexive approaches to continued knowledge development and practice are important, such that in the end sustainability becomes integrated into a cultural way of thinking about food.

Based on these insights, this dissertation outlines a procedure for collaborative community work for globally SFS. The procedure is adaptable to various community settings. The dissertation also provides specific guidance for how dietitians could utilise their strategic positions throughout food systems to contribute to SFS development.

**Keywords:** Sustainable Food Systems, Sustainable Community Development, Strategic Sustainable Development, Nutrition, Dietetics.
Disposition of the Dissertation

This is an article-based dissertation. It comprises an overview of the research and the following appended papers:


The papers have been reformatted to fit the format of this dissertation, but the content is unchanged from the published or submitted versions.
Works Additional to the Dissertation

Articles


Conference Proceedings


Reports


# Table of Contents

Acknowledgements ........................................................................................................................................i
Abstract .................................................................................................................................................. iii
Disposition of the Dissertation .................................................................................................................. v
Works Additional to the Dissertation ....................................................................................................... vi
1. Introduction ............................................................................................................................................. 1
   1.1. Sustainable Food Systems and Sustainable Diets ................................................................. 1
   1.2. Local to Global Gap ...................................................................................................................... 2
   1.3. Research Aims and Questions ................................................................................................... 2
2. Background ............................................................................................................................................. 4
   2.1. Food Systems Paradigms ............................................................................................................ 4
   2.2. Food Systems as Complex Systems ............................................................................................ 4
   2.3. Foundations of Sustainability and Sustainable Development ................................................ 5
   2.4. Community Development Approaches ...................................................................................... 9
   2.5. Sustainable Food Systems and Nutrition and Dietetics ............................................................ 10
   2.6. Critical Dietetics ......................................................................................................................... 12
3. Methodology .......................................................................................................................................... 13
   3.1. Ontology ....................................................................................................................................... 13
   3.2. Epistemology ............................................................................................................................... 14
   3.3. Position of the Researcher .......................................................................................................... 14
   3.4. Research Design & Methods ...................................................................................................... 15
   3.5. Establishing Transdisciplinarity ............................................................................................... 21
   3.6. Establishing the Quality of the Research ................................................................................... 21
4. Summaries of Appended Papers ........................................................................................................... 24
   4.1. Paper 1 ......................................................................................................................................... 24
   4.2. Paper 2 ......................................................................................................................................... 26
   4.3. Paper 3 ......................................................................................................................................... 27
   4.4. Paper 4 ......................................................................................................................................... 29
   4.5. Paper 5 ......................................................................................................................................... 30
5. Main Results and Discussion ................................................................................................................. 33
   5.1. Response to Research Question 1 .............................................................................................. 33
   5.2. Response to Research Question 2 .............................................................................................. 41
   5.3. Limitations and Future Research Directions ............................................................................. 43
References .................................................................................................................................................. 45

Paper 2. Food System Sustainability across Scales: A Proposed Local-To-Global Approach to Community Planning and Assessment .................................................. 101
Paper 4. Assessing Community Contributions to Sustainable Food Systems .................................................................................. 159
Paper 5. Critical Dietetics and Sustainable Food Systems ................................................................................. 201
1. Introduction

This chapter briefly introduces the main issues in focus, and the aim and research questions of the dissertation.

1.1. Sustainable Food Systems and Sustainable Diets

Sustainable food systems (SFS) are defined in various ways depending on sector and geography (i.e., depending on priorities), and generally by an overarching, values driven goal to provide humans with access to food in perpetuity\(^{(1-3)}\). The most commonly accepted and used definition comes from the High Level Panel of Experts on Food Security and Nutrition, that define “a sustainable food system [a]s a food system that delivers food and nutrition security for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised”\(^{(4 \text{ p.1)}}\).

A related term relevant to this dissertation is sustainable diets (SD). “Sustainable Diets are those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources\(^{(5 \text{ p.7)}}\). Sustainable diets contribute to and are supported by SFS\(^{(6)}\). And as such, for brevity, in this dissertation SFS is used to represent these interrelated concepts as one, unless otherwise noted.

There is growing consensus that food systems and human diets are major contributors to environmentally unsustainable conditions. This includes: greenhouse gas emissions and thus climate change\(^{(7-10)}\), destructive land use practices\(^{(11,12)}\), and high levels of freshwater withdrawals\(^{(13)}\) in a time when water insecurity\(^{(14)}\) is a growing concern. Food systems are also
major contributors to socially unsustainable conditions, such as through structural obstacles to health, precarious working conditions\(^{(15)}\) and systematic social injustices with respect to food access between individuals and nations\(^{(16-19)}\).

Clearly, changes to food systems and diets must be made to live up to the above definitions. Much work has been done to date to support this effort, including research and supports for sustainable food policy\(^{(20-24)}\). Like the above definitions, the work tends to be national or global in scale, and not designed to invite or guide community contributions.

1.2. Local to Global Gap
Much of the day-to-day reality of food systems manifests at the community level: in local and regional networks connecting producers and consumers\(^{(25-27)}\), institutions\(^{(28)}\), urban agriculture\(^{(29,30)}\), communities of professionals\(^{(31)}\), and in the foods on the table\(^{(32)}\). How to align these contributions to broader, global goals, remains unclear.

An ability to assess how community level actions align with global goals could support local-to-global alignment. However, indicators for assessing SFS also exist primarily at the national level\(^{(33-36)}\), are heavily data dependent, and often not derived from a full system sustainability perspective. Approximately 80% of the sustainable diets literature focuses solely on carbon dioxide equivalents\(^{(37)}\); a good start, but inadequate proxy for a sustainable food future. There is a need for multidimensional, and multiscalar ways of assessing SFS\(^{(37-39)}\).

1.3. Research Aims and Questions
The aim of this dissertation is to combine a Strategic Sustainable Development approach\(^{(40)}\) with a Community Development approach\(^{(41,42)}\) to: (i) advance methodological supports for community-based engagement and work for globally SFS, and (ii) provide concrete results relevant to the
work of a case community. The research is guided by two main research questions.

1. *How can SFS be conceptualised and assessed in a way that invites community level participation in the development of globally SFS?*

2. *How can the nutrition and dietetics community contribute to the development of globally SFS?*

A community can be defined by a geographic boundary or as a system of influence (e.g., a professional community). In this dissertation, the focus community is nutrition and dietetics professionals, where the emerging methods have been applied to explore professional practice to answer the second question.

A number of sub-questions are presented and addressed in the appended papers.
2. Background

This chapter gives a background of the main fields involved in this dissertation.

2.1. Food Systems Paradigms
Many of the sustainability challenges today can be linked back to a dated paradigm driving food systems. The “productionist” paradigm\(^{(43-45)}\) that has steered the past hundred years of food system governance in North America, Europe, Australia, and many of their trading partners, identified insufficient food availability as the cause of food insecurity and focused on more food as a solution. The productionist paradigm is characterized by globalization, regional specialization and efficiencies of scale, which over time have created distance between consumer and producer\(^{(46,47)}\) and resulted in significant concentration of power in the system\(^{(48)}\). While the increased availability of food is positive, this approach alone, in a world of finite resources\(^{(49)}\), is now broadly recognized as misaligned with sustainability\(^{(43,49)}\).

2.2. Food Systems as Complex Systems
In an effort to reconceptualize food systems that are sustainable, new ways of thinking have emerged that place food systems as part of and dependent on socioecological systems. The use of socioecological systems theory to conceptualize food systems is establishing\(^{(33,43,49,50,52)}\), and the use of Complex Adaptive System (CAS) theory in analyzing food systems is emerging\(^{(53-55)}\).

Complex Adaptive Systems theory emerged out of complexity theory, and is set apart by its focus on the capacity of the system to adapt to changes and maintain certain functionalities. “Complex Adaptive Systems (CAS) are made up of interacting components (the system) whose interactions may be complex (in the sense of nonlinear), and whose components are
dive \textit{re}se and/or have a capa\textit{ti}y for learning that generates reactive or proactive adaptive behavior\textsuperscript{*}(56 p.2). Food systems can be thought of as CAS in that they are networks of interconnected actors (e.g., producers, processors, distributors, consumers, etc.) and factors (e.g., ecological system services) across geographic regions. The relationships between these actors and factors are complex, and when conditions change anywhere in the system, other actors are forced to adapt (e.g., if a crop fails in one part of the world, processors will source a food product from another location, thus adapting to the change).

The CAS perspective is suited to food system sustainability research at a time when there are rapid and potentially significant changes in the social (e.g., globalization\textsuperscript{(57)}) and ecological (e.g., climate change) systems\textsuperscript{(58,59)}. Unlike reductionist science that underpins the productionist paradigm, a CAS perspective considers more comprehensively the socioecological actors and factors within human food systems, and the nature of their interdependencies, to understand problems and solutions.

This positioning of our food system as one part of a greater socioecological whole reframes the parameters\textsuperscript{1} of the challenge. If the purpose of food systems is to provide access to food for all people, systems theory frames that purpose within the system boundaries of the society and the ecosystem. These boundaries delimit how to provide food to all people.

2.3. Foundations of Sustainability and Sustainable Development
To address the research questions in the context of complex adaptive systems, a unifying definition of sustainability is needed that describes the boundaries, or parameters, of a sustainable socioecological system, and is compatible with CAS theory. The definition of sustainability of the Framework for Strategic Sustainable Development (FSSD) is well suited

\textsuperscript{1} As per Paper 1, the term “parameters” is used for concepts defining system limits, and rules of operation in a system.
for this need. This definition is laid out in the form of basic principles based on negations of first order destruction mechanisms for the social and ecological systems. These principles have been developed and refined since the early 1990s in an iterative consensus process among academic researchers and sustainability practitioners\(^{(60-63)}\). The aim has been to find principles that are necessary and sufficient for sustainability, that is, to find the “boundary conditions within which society can continue to function and evolve, outside of which it cannot”\(^{(40,p.23)}\). Other desired criteria for the principles have been for them to be general, to be applicable in all contexts and scales, and thereby facilitate cross-disciplinary and cross-sector collaboration, concrete, to guide innovation, and non-overlapping, to facilitate comprehension and development of indicators\(^{(40)}\). The current phrasing of the Sustainability Principles (SPs)\(^{(40,62)}\) is as follows.

*In a sustainable society, nature is not subject to systematically increasing …*

1. *… concentrations of substances extracted from the Earth’s crust.* This means limited extraction and safeguarding, so that concentrations of lithospheric substances do not increase systematically in the atmosphere, the oceans, the soil or other parts of nature; for example, fossil carbon and metals;
2. *… concentrations of substances produced by society.* This means conscious molecular design, limited production and safeguarding, so that concentrations of societally produced molecules and nuclides do not increase systematically in the atmosphere, the oceans, the soil or other parts of nature; for example, nitrogen oxides and chlorofluorocarbons;
3. *… degradation by physical means.* This means that the area, thickness and quality of soils, the availability of fresh water, the biodiversity, and other aspects of biological productivity and resilience, are not systematically deteriorated by mismanagement, displacement or other
forms of physical manipulation; for example, over-harvesting of forests and over-fishing;

_and people are not subject to structural obstacles to ..._

4. ... _health_. This means that people are not exposed to social conditions that systematically undermine their possibilities to avoid injury and illness; physically, mentally or emotionally; for example, by dangerous working conditions or insufficient rest from work;

5. ... _influence_. This means that people are not systematically hindered from participating in shaping the social systems they are part of; for example, by suppression of free speech or neglect of opinions;

6. ... _competence_. This means that people are not systematically hindered from learning and developing competence individually and together; for example, by obstacles for education or insufficient possibilities for personal development;

7. ... _impartiality_. This means that people are not systematically exposed to partial treatment; for example, by discrimination or unfair selection to job positions;

8. ... _meaning-making_. This means that people are not systematically hindered from creating individual meaning and co-creating common meaning; for example, by suppression of cultural expression or obstacles to co-creation of purposeful conditions.

From a Strategic Sustainable Development (SSD) perspective, SFS are those that do not contribute to society’s violation of the SPs. Within the SPs, myriad possibilities exist for how SFS can manifest.

The FSSD also provides a supportive theoretical structure, as the framework includes two helpful components designed to support application of the SPs in sustainable development research and practice;
namely, Backcasting from SPs and the Five Level Model (5LM). These are described in Chapter 3.

Other frameworks and definitions of sustainability exist; they provide useful context, but were insufficient to support the aims of this research. Some examples are given below.

The United Nations report, Our Common Future (more commonly known as the Brundtland Report), defines sustainable development as that which “meets the needs of the present without compromising the ability of future generations to meet their own needs” (p.16). While aspirational and something most people probably agree with as a high level values statement (for what we want for humanity), the definition is not concrete enough to guide day-to-day action at the community level, and lacks procedural supports to do so.

The “Triple Bottom Line” approach to sustainability is intended for guiding sustainable decision making through ‘balancing’ economic, social and environmental priorities. This could in principle, be useful to guide community contributions to globally SFS; however, it neither clearly defines success, nor what is sustainable within each of the three dimensions. It also encourages trade offs between the dimensions (so-called weak sustainability) and between competing interests rather than cooperation.

The Planetary Boundaries approach to conceptualizing sustainability seeks to define a safe space for humanity through certain limits for certain variables of the planetary ecosystem. It is one approach to environmental assessment and has been used to develop guidelines for globally healthy and environmentally sustainable diets. However, it is less helpful than the FSSD for guiding community-focused research, as the scale remains global, the social dimension of sustainability is not covered,
and it does not provide any procedural support for co-creation of strategic transitions.

The FSSD is a good fit as a foundation for sustainability, as it is not exclusive of incorporating research based on other theories, such as the planetary boundaries\(^{(71)}\) and methods used in sustainable food systems research (e.g., Ecological Footprint, Life Cycle Assessment)\(^{(72)}\). These are useful supports for sustainable development and strengthened when framed by a strategic sustainable development approach. Therefore, the FSSD provides a solid overarching framework that is best suited to frame this research.

### 2.4. Community Development Approaches

According to the United Nations, the term Community Development refers to “a process where community members come together to take collective action and generate solutions to common problems”\(^{(73 \text{ para. 22})}\). A Community Development approach to research therefore requires involving the community in informing the research, and is often applied through participatory research approaches, which emphasise collaboration, relationship building, and a focus on ownership of the results by, and utility to, the community\(^{(41)}\).

Participatory Community Development approaches have been used in the field of nutrition and dietetics in particular, where social or ecological determinants (e.g., injustices) are barriers to nutritional health\(^{(74,75)}\). In line with participatory approaches to research, some Community Development theorists might propose that (in the context of research question two) nutrition and dietetics professionals are obligated to work toward food systems that self-perpetuate, in the sense that knowledge and power in food systems be returned to community ownership through involvement, learning and knowledge sharing\(^{(76)}\). With respect to SFS, this would mean nutrition and dietetics professionals work with a community to weave
sustainability knowledge and competence into the fabric of the community (and broader) food systems.

2.5. Sustainable Food Systems and Nutrition and Dietetics

From a historical perspective, issues of sustainability have long been a part of the nutrition and dietetics field, though the level of focus has waxed and waned. The scholarly and practical field of nutrition and dietetics shares disciplinary roots with home economics, human ecology, and medicine. One of the earliest (and best documented) “ecological nutritionists” was Ellen Swallow Richards, who examined water quality and public health outcomes during an industrializing era in North America\(^{(77)}\). Though she referred to her domain as ecology, her career trajectory led her toward a more culturally (of the time) “feminine” domain of home economics, or the management of the home, which was influenced by her background in socioecological systems.

Richards’ early influence is evidence for a long existing ecological perspective, which resurfaced in the literature in the late 1980s as proposed dietary guidelines for sustainability\(^{(78)}\), and later as the New Nutrition Science Project\(^{(79)}\) and ecodietetics movement\(^{(80)}\), both of which frame nutrition and dietetics within interconnected environmental, social, cultural, economic and political systems. Ecological nutrition is a term now also used to capture a multidimensional and systems approach increasingly considered necessary to achieving *sustainable diets*\(^{(81)}\).

It is important for context to include that in the transition from home economics toward nutrition and dietetics, the field has become increasingly biomedically driven, and so, ecological nutrition has maintained a foothold, not a stronghold. This is well reflected in dietetic curricula that focus on biomedical and human behavioural aspects of nutrition and healthy eating.
Today, there is (again) growing public interest in sustainable eating, and calls for dietitians to support food systems and sustainability literacy\(^{(82)}\). The nutrition and dietetics community has broad leverage across many different entry points in food systems, and thus is well situated to respond to food related sustainability challenges (Figure 1). Nutrition and dietetics scholars and professionals occupy various roles depending on the systems and cultures of a country. Generally, the role or field they occupy is defined by a specific competence: generating and applying the science of food and nutrition to promote health, prevent and treat disease, and to optimise the health of individuals, groups, communities and populations. In many nations, this means active engagement with the social determinants of health\(^{(83)}\), and less commonly, competence related to the ecological determinants of health\(^{(84)}\).

![Figure 1. Nutritionists’ and Dietitians’ Roles Across the Food System](image)

Figure 1. Nutritionists’ and Dietitians’ Roles Across the Food System Adapted from the Nourish Food System Map\(^{(85)}\).

The term *roles* refers to the job or position that nutritionists and dietitians hold, combined with the issues and activities that they focus on. Figure 1 shows places of employment (e.g., public health, food industry) within which they are working on issues (e.g., food security, food literacy, healthy eating) and through activities (e.g., nutrition care, education, marketing,
behaviour change) roles, there are many different approaches that can be used. The outer circle (green) represents the ecological system. Embedded within is the social system (yellow circle), and within that, five subsystems important to food systems are represented as circles.

Figure 1 presents a simplified schematic of food systems adapted from the Nourish Food Systems Map(85). It is not a comprehensive examination of food systems, but highlights the breadth and extent of integration of nutritionists’ and dietitians’ food systems.

While nutrition and dietetics professionals are well positioned across food systems to support development of SFS, a return to a stronger socioecological systems curriculum in education and training will be necessary to make the most of these opportunities.

2.6. Critical Dietetics
Critical Dietetics is an emerging area of international dietetic practice and theory(86–88) that forwards a transdisciplinary approach to understanding food, health and people, and is committed to nutrition and dietetic research and practice that demonstrates reflexivity, explicit declaration of underpinning values, and social justice. Critical Dietetics theorists advocate for integration of these commitments in dietetic education and training(89,90) and as such, is a useful theoretical stance to examine the second research question in the context of a dietetic practice where individual health, the health of society (social system) and ecological systems are considered interdependent.
3. Methodology

This chapter presents the methodological choices, ontological and epistemological views and position of the present author, the research design and main methods used.

As an umbrella for the this research, Post Normal Science (PNS)\(^{91-94}\) provides a suitable methodological approach. It was born out of a need for answering scientific questions in the context of a high degree of uncertainty, urgency, and a plurality of legitimate perspectives, and where traditional methods of applied sciences fall short\(^{92}\). The goal is to "produce socially and technically robust information fit for sustainable decision making"\(^{92}\ p.13\) and as such, it is appropriate for the research questions addressed in this dissertation. PNS applies transdisciplinary methods with the goal to address complex socioecological sustainability problems. As with all methodological choices, the methods applied in Post Normal Science are informed by the research questions and the ontological position of the researcher.

3.1. Ontology

The methods applied in this dissertation are underpinned by my view that human social systems are nested within, and dependent on ecological systems. Ecological systems are usually examined by researchers adhering to an objective, or realist\(^{95}\) ontology. They are dynamic, complex and influenced by human society, but in my view, exist outside of socially constructed ideas. This is also true, to some extent, for social systems, where patterns at the system level can be observed from an objective lens; this has been done with the development of (objective) Social Sustainability Principles, as part of the FSSD\(^{62,66,96}\). Generally, in social systems, reality is constructed and experienced through social interactions and is therefore, to a significant extent, subjective.
3.2. Epistemology
Given the multiscalar, social and ecological nature of SFS research, it requires methods that recognise the legitimacies of multiple understandings of truth. In this research, both objective and subjective understandings of truth inform the methodology. As an epistemological approach, this leaves the research open to arguments based on multiple knowledge cultures engaging in dialogue about what is (facts) and what ought to be (values)(95).

Transdisciplinary understandings of truth production welcome methods that blend the traditions of many disciplines, and welcomes multiple forms of knowledge as legitimate. This includes academic knowledge alongside organizational, specialised, local community, and individual knowledge(95). The use of transdisciplinary methods is increasingly recognized as an important approach in food systems research(45,49). In practice, the process of including and valuing localized knowledge in research and decision making implies a decentralization of power in the system.

3.3. Position of the Researcher
I am a Registered Dietitian (RD) in Canada and have been a member of that community for nine years (six years preceding the case studies that focus on nutritionists and dietitians as a case community). As such, I am embedded in the socially constructed realities of this community. This influences my analysis and interpretations of the case study data; it may result in preconceived or biased analysis, and can also lend depth to the research through trust-based relationships, and a deep understanding of the cultural context of the data(97,98). See section 3.6 for a discussion on how to handle potential influences of my biases.

Further, given my position in the community, it is appropriate to acknowledge what I think “ought to be” or the values position that I hold.
I subscribe to an “ecological”\((43)\) or ‘biosensitive’\((49)\) paradigm, whereby decision making on all scales is guided by a move toward sufficiency, and that is sensitive to parametres that define sustainable conditions of socioecological systems. From this position, humans can be part of a sustainable future, and are one species on a planet with finite resources.

3.4. Research Design & Methods

In the context of PNS and the values position of the researcher, this research is normative—seeking to understand and influence reality. A combination of designs and methods have been used to answer the research questions. The methods used in each research phase are summarised here, and described in more detail in the following subsections. Using exploratory design, a combination of narrative literature review,\(^{(99)}\) the Five Level Model (5LM) and the Backcasting from Sustainability Principles procedure of the FSSD\(^{(40)}\) and Delphi Inquiry methods\(^{(100)}\) were used to understand the research landscape. Following this, applying descriptive design, the 5LM and Backcasting from Sustainability Principles, and a Delphi Inquiry method that included community workshops were used to understand and describe SFS concepts and action at a community level, while the Cultural Adaptation Template\(^{(49,101)}\) was used to select and communicate SFS indicators. To guide the analysis, the FSSD was used as a foundational concept for sustainability and sustainable development (as per section 2.3), Community Development theory was used to support methods and analysis (as per section 2.4), and Critical Dietetics theory was used to guide analysis (as per 2.6). The designs, methods and theories used are summarised in Table 1, alongside the resultant papers.

*Five Level Model*

Besides the SPs (introduced in Chapter 2), two other components of the FSSD are used in this dissertation research: the 5LM and the Backcasting from Sustainability Principles procedure\(^{(40)}\). The FLM is helpful in aiding
analysis and structuring of data and interrelationships between phenomena of different character. The 5LM thus aids categorization of data and interrelationships of importance to strategic sustainable development. The system level (i) includes essential aspects for a sustainable socioecological system and descriptions of interrelations, among these; the success level (ii) includes a vision of success framed by a principled definition of sustainability; the strategic guidelines level (iii) includes guidelines for prioritizing actions toward success; the actions level (iv) includes concrete actions prioritised into a strategic plan; the tools level (v) includes concepts, methods, tools and other forms of support for the decision making and work with the above levels. The FLM was used primarily in this research to help analyse and organise community level data (responses from the participants) in Phase 2 and Phase 3 (Table 1).

**Backcasting from Sustainability Principles**

In practice, FSSD theory is often implemented through the ABCD procedure, which is used to operationalise Backcasting planning and redesign toward an SP-framed vision; shortened to “Backcasting from SPs” in this dissertation. It facilitates iterative co-creation (between the community and the facilitation team; in this case, researchers) of strategic transitions toward sustainability through the following steps:

- **A Step:** Learn about the FSSD and create a vision of success framed by the principled definition of sustainability of the FSSD.
- **B Step:** Gather baseline information regarding the current reality of the system under question, and clarify strengths and challenges in relation to the vision.
- **C Step:** Generate creative solutions for making progress from the current reality to the vision of success.
- **D Step:** Identify strategic actions from the initial C Step list, that is, prioritise possible actions based on their ability to move the system toward the defined vision of success.
In this dissertation, the “ABCD procedure” and ‘Backcasting from SPs’ are used interchangeably.

Based on the outcomes of the descriptive phase of this research, an ABCD-informed procedure for capturing community determined visions, plans and indicators that can be—but does not have to be—facilitated using the Delphi Inquiry method was proposed. It was then applied in Phase 2 (case study) of the research.

Delphi Inquiry Method
The Delphi Inquiry method engages a panel of experts in a particular subject or field in an in depth and iterative dialogue between the panel and the research team. In the Delphi Inquiry method, the research team asks questions of the panel, collates and summarises the responses, which are shared back anonymously with the panel for reflection, before answering the questions again. This is repeated two to three times to generate a greater understanding of perspectives (both convergent and divergent) among the collective, and to move toward consensus. In this research, the Delphi Inquiry process was facilitated using online survey software to collect participant responses, as panel members were in disparate geographic locations and the software collated the data automatically. To send the anonymized, composite summary of responses from the research team to the participants, email was used. As proposed in Paper 2, the questions included in the Delphi Inquiry of the case studies were modeled on the procedure for Backcasting from SPs to: (a) create a vision of success framed by sustainability principles; (b) develop a common understanding of the current reality; (c) generate; and (d) prioritise strategic actions, in addition to identifying indicators appropriate for tracking local progress toward sustainable food systems. In this research, we held a fourth and final round which was a face-to-face workshop to provide an opportunity for clarity that is difficult to reach via electronic interfaces.
While other research teams have used the Delphi Inquiry method to facilitate indicator development for SFS\textsuperscript{(102)}, in this research it helped provide rich data for (i) answering the research questions, and (ii) providing the foundations for a roadmap useful to the case communities to facilitate SFS development.

\textit{Cultural Adaptation Template}

The Cultural Adaptation Template (CAT)\textsuperscript{(49)} has been developed to theorise the nature of relationships between factors that drive the capacity of a culture to adapt in such a way that is sustainable (i.e., their adaptive capacity to survive into the future). Using a causal loop diagram (CLD, Figure 2), the CAT illustrates the dynamic interrelationship between its central constructs: cultural paradigms, community, human health, wellbeing, and ecosystems.

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{figure2.png}
\caption{Cultural Adaptation Template}
\end{figure}

\textit{Figure 2. Cultural Adaptation Template}

Reproduced from Dyball and Newell \textsuperscript{(103)} with permission. The direction of the relationship between variables is shown by an arrow, but not the polarity (+/-) of the relationship.
The CAT was used in this dissertation as both a theoretical and methodological support to: (i) delimit and visually articulate the system of interest; (ii) illustrate whether and in what way community level action contributes to broader, global goals for SFS; and (iii) frame and work with indicators in a way that addressed key challenges with traditional indicator frameworks—namely, being nimble in the absence of (especially) community level data.
<table>
<thead>
<tr>
<th>Research Design</th>
<th>Methods and Analysis</th>
<th>Theoretical Framework</th>
<th>Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1:</td>
<td>Narrative Literature</td>
<td>None</td>
<td>Paper 1: <em>Conceptualizing and Assessing Sustainable Food Systems and Diets</em> …</td>
</tr>
<tr>
<td>Exploratory</td>
<td>Review</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phase 2:</td>
<td>Delphi Inquiry, 5LM* &amp; Backcasting from SPs†</td>
<td>FSSD Community Development</td>
<td>Paper 2: <em>Food System Sustainability across Scales</em> …</td>
</tr>
<tr>
<td>Exploratory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phase 3:</td>
<td>Delphi Inquiry, 5LM &amp; Backcasting from SPs</td>
<td>FSSD Community Development</td>
<td>Paper 3: <em>How can Dietitians Leverage Change for SFS in Canada?</em></td>
</tr>
<tr>
<td>Descriptive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phase 4:</td>
<td>CLD Delphi Inquiry, 5LM &amp; Backcasting from SPs</td>
<td>Cultural Adaptation Template FSSD</td>
<td>Paper 4: <em>Assessing Community Contributions</em> …</td>
</tr>
<tr>
<td>Prescriptive</td>
<td></td>
<td>Critical Dietetics</td>
<td>Paper 5: <em>Critical Dietetics and Sustainable Food Systems</em></td>
</tr>
</tbody>
</table>

* = Five Level Model of the FSSD; † = using the ABCD Procedure of the FSSD.
3.5. Establishing Transdisciplinarity
The Delphi Inquiry process, underpinned by FSSD theory and methods, supported the research methodology by inviting transdisciplinary data collection and analysis. The type of “expertise” needed in the Delphi Inquiry method is driven by the research question, and thus the panels in this research included various knowledge domains: academic experts from a wide array of food-related disciplines and sectors\(^{(104)}\), professional experts\(^{(31,105)}\), and community members (cases not included in this dissertation). This resulted in a mixture of qualitative and quantitative evidence from various disciplines and knowledge cultures\(^{(95)}\) including peer reviewed, professional and personal experience. The FSSD facilitates genuinely transdisciplinary research for sustainability. The SPs provide an objective frame for sustainability in socioecological systems. And while this implies a specific ontological position, the methodological supports of the FSSD invite synergism between different tools and methods across diverse disciplines\(^{(60)}\), as described in section 2.3.

3.6. Establishing the Quality of the Research
The established techniques for ensuring rigour and trustworthiness in research are set up to allow the users of the outcomes to evaluate whether they can trust the outcomes to be “true” based on validity, reliability, generalizability, or their interrelated qualitative terms: dependability, credibility, transferability and confirmability\(^{(106)}\). However, in PNS research, the goal is to seek research outcomes that are high quality, rather than true\(^{(92)}\)—that is to say, validity is determined by “fit for sustainable decision making”\(^{(92} \text{p.13})\). In this dissertation, the quality of the research is established through the interrelated concepts of robustness and trustworthiness. Robustness refers to results that are socially and technically strong (i.e., likely to work in the real world) despite constraints that might exist (e.g., political or physical landscape), and compatible with a plurality of stakeholders. In this dissertation it is built through inclusion of stakeholder communities and legitimacy of multiple knowledge cultures
and types of expertise, such as professional, local community, and organizational knowledge\(^{(92,95)}\). Trustworthiness, similar to its qualitative research evaluation, refers to the ability of end users to be able to trace, access and evaluate the research. In this dissertation, trustworthiness is built through transparency, reflexivity and (like robustness) inclusivity and legitimacy of diverse expertise. Table 2 describes how robustness and trustworthiness is established in this dissertation.
### Table 2: Establishing Robust and Trustworthy Research

<table>
<thead>
<tr>
<th>Quality of Research Concept</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1°</td>
<td></td>
</tr>
<tr>
<td>2°</td>
<td></td>
</tr>
<tr>
<td>3°</td>
<td></td>
</tr>
</tbody>
</table>

#### Robust

- **Inclusivity and legitimacy of diverse expertise.**
  - Literature review not limited by peer reviewed research or disciplinary boundaries.
  - Phase 2 Delphi Inquiry included multidisciplinary and sectoral participants\(^{(104)}\).

#### Transparency

- **Clear declaration on position of the researcher, values and assumptions included\(^{(e.g., 31)}\).**
- Reports between each round record concept evolution.
- Inclusion of a face-to-face workshop.
- Workshop for clarity seeking conversations and accessibility.

#### Reflexivity

- **Delphi Inquiry process explicitly encouraged debate and dissent.**
- Declaration of diverging views and values captured in the reports and papers\(^{(e.g., 31)}\).

#### High Quality

- **Trustworthy**
  - Inclusivity and legitimacy of diverse expertise.
  - As per above.
4. Summaries of Appended Papers

This chapter gives brief summaries of the appended papers, including outcomes and insights, clarifies how the papers contribute to the dissertation, and clarifies the contributions of the present author.

The way the papers build on one another is as follows. The first paper sets the scene for how SFS and diets are conceptualized and assessed, and what challenges remain for supporting community level contributions. Paper 2 proposes a process and framework to address challenges set out in Paper 1. In Paper 3, the proposed process is tested through a case study, and explores the role of the dietetics community in SFS. In Paper 4, the proposed framework is used to inform an assessment process for local-to-global engagement for SFS. In the final paper, the roles and challenges for dietitians in SFS work are explored, and suggested ways forward proposed.

4.1. Paper 1
Carlsson L (n.d.) Sustainable Food Systems and Diets: a review of concepts & measurement. Submitted for journal publication.

Relation to the Dissertation
This paper presents the main outcomes of Phase 1 of the research—the literature review. It summarizes the state of published knowledge and practice with respect to how SFS are conceptualized and assessed. The goal was to understand the potential of various existing frameworks, concepts, methods and tools to help guide action for SFS at the community level that is aligned with global goals for sustainability.

Contribution of the Present Author
I conducted the literature review, analyzed the results, and wrote the paper.
Outcomes
There are two main outcomes. The first is a comprehensive set of themes that provide a description of what types of issues, determinants, drivers, and outcomes are being considered in order to conceptualise, assess, and operationalise food systems and diet sustainability. These themes inform a transdisciplinary summary of SFS discourse, and corroborate the themes in the framework proposed in Paper 2. The themes can be grouped into five main categories: health, ecological, social, cultural, and economic. These tend to be themes that represent issues of importance to various interest groups. In addition, some themes represent attributes and considerations for the whole system.

The second main outcome is a summary of the various strengths and challenges of approaches being used to conceptualise and assess SFS. Some noteworthy elements of this summary include that visionary and multidimensional concepts (and associated measurement approaches), such as the definitions presented in Chapter 1, are broad and thus, inclusive of diverse worldviews; however, they lack specificity about what defines a sustainable state in the various concepts they include. Resilience-based concepts define sustainability clearly, but are challenged by high data needs and missing data. Approaches that delineate the “parametres” of the system provide clarity on defining sustainability in the system, while being nonprescriptive about how SFS manifests (thus inclusive of diverse worldviews). However, not all the parametres have clear measurement benchmarks, and thus, there is a need for tools that can accommodate those data/benchmark gaps.

Insights
With respect to SFS conceptualization, multidimensional approaches to defining SFS, or those that include categorized lists of themes important to a community or context, hold promise for inviting communities to determine their own priorities, and can be used to guide actions aligned
with global goals. With respect to SFS assessment, parameters-based approaches, such as the Planetary Boundaries framework and the FSSD can also be used to support alignment between action in communities and global goals, and hold promise for guiding action even when fine grained data at the community level is incomplete.

4.2. Paper 2

Relation to the Dissertation
The research captured in this paper initiated the empirical portion of the exploratory work. It describes the process used for gathering transdisciplinary perspectives on food systems sustainability from experts in the field in an effort to better understand how SFS can be conceptualised and assessed, in a way that is accessible and inclusive of community level work.

Contribution of the Present Author
In this research phase and paper, I co-developed the design, and contributed to data collection and analysis. I led the writing process.

Outcomes
The research informed the development of a framework that organises multidimensional (ecological, social, human health, and food system infrastructure) and multiscalar (local/community, national, and global) themes important to SFS, and distilled those common, or stable, to diverse global contexts, while being flexible at the local/community level. Another outcome of the research was to spark critical dialogue with participants about how to use the research outcomes to inform further action.
This led to the theoretical and methodological foundations for a local-to-global approach to community planning and assessment that was subsequently used and refined in the case studies to engage communities in learning and planning for SFS. It combined the Delphi Inquiry method with Backcasting from Sustainability Principles and the 5LM, to understand and describe SFS concepts and action at a community level.

**Insights**

Overall, the research team gained insight into the complexity, with respect to scope and scale, of both conceptualizing and assessing SFS. Regarding indicators important to measure progress toward a vision (or themes in the framework), there are multiple “stable” indicators that are appropriate to measure themes at the national and global levels. However, indicators at the local level must be more flexible. This local level flexibility is critical for meaningful engagement from communities. The FSSD was helpful to facilitate critical dialogue within objective parameters (the SPs) for what is possible, while allowing for local flexibility. The insights led to a two-pronged focus in Phase 3 of the research. One was to test the proposed local-to-global approach for working with communities to determine their own pathways forward, and another was to further develop the framework for assessment purposes.

**4.3. Paper 3**


*Relation to the Dissertation*

This paper describes one of several case studies that contribute to Phase 3 of the research, and applied the methods proposed in Paper 2. It is one of two case studies that focused on nutrition and dietetic professionals (the second is captured in Works Additional to the Dissertation). The paper
presents learning outcomes related to working with communities to determine their own pathways forward. It also presents outcomes that are concrete and specific to the case community in the form of a vision, identification of barriers to that vision, and high leverage actions to address those barriers.

**Contribution of the Present Author**
I led the recruitment and communications with the case study partners and the writing process. I co-led all other phases of the research.

**Outcomes**
The results capture how participating Canadian dietitians envision SFS, what barriers they perceive for moving toward the envisioned SFS, and what upstream actions they find plausible within the professional community to address those barriers. Combining a Delphi Inquiry method with the FSSD was successful in inviting considerable dialogue within the profession that led to shared learning, and a roadmap\(^\text{107}\) for how dietitians can contribute to SFS. This roadmap, shared as a full and summary report on the members only website, is being used now to guide professional action.

**Insights**
The case study confirmed the utility of the SPs, which are a central element of the FSSD, in framing discussion and analysis for articulating *if and in what ways* the barriers described undermine sustainability. Therefore, the SPs were also helpful in generating ideas for actions that can address those barriers, and in articulating how. The research process confirmed that it is difficult to engage with a truly diverse audience within the community. Some voices were missing, and methods will need to be adapted to ensure those are heard. Finally, the research process demonstrated that working with a community of practice (i.e., rather than a geographic community) provided access to *organizational and specialized* knowledge. While
academic expertise gained in earlier phases of the research is important, so too is professional expertise about ways that dietitians are able to (and do) help address unsustainable conditions. The nutrition and dietetics community has a strategic position in the development of SFS with its broad scope of practice, which includes diverse roles in various food system sectors.

4.4. Paper 4

Relation to the Dissertation
This paper develops the specifics of assessment needed to operationalise the framework proposed in Paper 2—for guiding “local-to-global” assessment of SFS, specifically considering the learning outcomes from Paper 1 regarding assessment, that is, nimble in the absence of comprehensive data, especially at the community level.

Contribution of the Present Author
I led the recruitment and communications with the case study partners and the writing process. I co-led all other phases of the research.

Outcomes
Combining the FSSD informed Delphi Inquiry method proposed in Paper 2, and used in Paper 3, with additional theory and methods from the Cultural Adaptation Template (CAT), this paper suggests a procedure to develop and assess community level indicators that focus on process, or on community level actions. These are responsive to the local context and can be mapped to the global context using the CAT.
Insights
This paper reinforces the outcomes published in Paper 3, namely that the Delphi Inquiry method, informed by theory and methodological supports from the FSSD, is a strong approach to balancing the well-recognised need to engage communities in developing relevant indicators, against the strategic need to develop assessment tools that create alignment between communities and across scales.

The CAT, illustrated using CLD, is helpful for building dynamic hypotheses about how actions relate to SFS themes. Such diagrams can help support assessment in the absence of some data points. Using the Sustainability Principles of the FSSD as objective parametres strengthens these dynamic hypotheses by anchoring the actions in objective sustainability. Actions are addressing identified SP violations.

The CAT also theorises the importance of cultural paradigms as a driving force of change. In this case study, facilitating SFS literacy within the nutrition and dietetics profession supports positive feedback loops that strengthen the SFS focus within the professional paradigm, which in turn can amplify adaptations for, and positive contributions to, broader SFS development.

4.5. Paper 5

Relation to the Dissertation
This paper challenges the dominance of biomedical knowledge in the field of nutrition and dietetic scholarship and practice. Readers are invited to consider a paradigm where individual health, the health of the social system, and ecosystem health are of equal importance, and inextricably
linked. This values position is explored for its importance to food systems sustainability, and to the field of nutrition and dietetics, now and into the future. It builds on Paper 3 through three examples from three different countries, examining how dietitians are currently integrating SFS into practice. These are not three cases that apply the process proposed in Paper 2, but rather, distills important leverage points from across the three examples and explores the barriers to action.

**Contribution of the Present Author**
I contributed to setting the objectives and frame of the paper. I led the writing process and I contributed with one of the case examples.

**Outcomes**
This paper is the first to position SFS within Critical Dietetics, which previously concerned itself primarily with a socially just dietetic discourse and practice. The paper also documents and consolidates an SFS thread in the historical dietetics discourse. The chosen case studies support previous research findings (e.g., those in Paper 3) that articulate some of the strategic roles that can be filled by nutrition and dietetics professionals, while adding a new contribution by describing sociopolitical, professional, and institutional barriers.

**Insights**
The historical introduction to the SFS discourse in dietetic scholarship and practice highlights that a socioecological perspective to food and nutrition is likely part of the disciplinary foundations, but that this has been put to the side in an effort to legitimise the field as a rigorous science through an increasingly biomedical focus. A critical first step to strengthening an SFS ready profession is to *integrate* SFS into training programs. This echoes one of the key suggestions from Paper 3, and adds that a critical and systematic approach to education would integrate a sustainability *lens* through which to develop nutrition and dietetic education, practice and
scholarship, rather than incorporate it as a separate topic. Such a lens would require learning and practice across all curricular and practice areas that is knowledgeable and attentive to the needs, limitations and interdependencies of the economic, social and environmental systems. While Paper 3 stressed that SFS work in dietetics should be reflexive and collaborative, this paper adds and stresses the importance of systems thinking to understand the terms, concepts and current issues. This way of thinking (as opposed to reductionist models) advances the need for extending the remit of what is considered rigorous and relevant evidence to guide dietetic practice standards. It also helps to make visible, the need for collaboration with other disciplines and sectors.
5. Main Results and Discussion

This chapter presents and discusses the synthesized results of the dissertation. In responding to the main research questions, this dissertation contributes to: (i) theory and procedural supports for engaging and guiding communities in the development of globally SFS; and (ii) practice, through concrete, contextual results relevant to the case community.

Consistent with the systems theory underpinning this research, it is important to consider that all the insights are interrelated. However, for practical purposes, they are organised in response to the main research questions—which can be negotiated as theoretical, and practical in nature, respectively.

5.1. Response to Research Question 1

*How can SFS be conceptualised and assessed in a way that invites community level participation in the development of globally SFS?*

There are three overarching characteristics that can be distilled from the research addressing this question. These general characteristics are presented first. Following that, a prescriptive procedure is given that combines methods and tools that have proved useful for engaging with community to contribute to globally SFS, and assess their contributions in such a way that is attentive to the characteristics. Both general characteristics and the procedure are presented in recognition that there is never just one way to achieve a goal. The general characteristics represent the insight that emerged from this particular research, and are of course, shaped by the ontological and epistemological stance of the researcher(s). The more prescriptive summary is offered for the audience that is interested in evaluating, adapting, and replicating the approaches that were used in this research.
Using Participatory, Multidimensional Approaches
There is a diverse set of interrelated, multidimensional themes that capture the global discourse on sustainable food systems. The scope of the concept can be overwhelming. Therefore, engaging communities directly in determining the relevance and meaning of sustainability to their own context, using their own language and priorities, is important to avoid complexity paralysis (“the problem is too big and complicated for me to act”). This is confirmed in the case study with Canadian dietitians (Paper 3), where participants clearly articulated themes important to the dietetics community that contribute to broader national and global goals, while recognizing that many themes (e.g., energy use and climate stability) were not within the remit of nutrition and dietetics professionals, at least not alone. This highlighted the need for collaborative approaches (see section 5.2).

Using Concrete Parametres
Multi-dimensional approaches (as defined in Paper 1) to conceptualizing and assessing SFS have utility in simplifying the concept, often providing a list of important themes (as in Paper 2). However, these lists of themes fail to provide concrete understandings about what defines sustainability. This exacerbates the potential for complexity paralysis. From an SSD perspective, this is also problematic because without necessary and sufficient principles (a form of parametres) defining sustainability, well intended actions (e.g., food banks) for broadly agreed upon themes (e.g., food security) can lead to contradictory outcomes or simply moving the problem elsewhere in the system. The Sustainability Principles of the FSSD allow for freedom to identify actions to address barriers to SFS, while also helping to avoid moving the problem or creating other sustainability problems. In this way, assessment at the community level need not be stymied by inadequate locally relevant data.
Using Systems Thinking & Tools

Systems thinking and tools, such as CLD, help to illustrate and understand complex interrelationships between many, multidimensional themes that capture SFS. As many have highlighted, one major dilemma in assessing SFS is how comprehensive of a model or process to build\(^{33,49,108}\). On the one hand, including many variables results in a broad and high resolution description. On the other hand, having few variables allows for specific depth, but lacks comprehensive breadth of the interrelated issues. It is useful to be able to zoom in and out along this spectrum of broad to narrow, and CLDs such as the CAT, provide a helpful tool for this purpose.

Summary of Proposed Methods & Tools

Throughout this research summary, and in the attached papers, the methods used to engage and guide community in the development of globally SFS have been described. Paper 4 also suggests a concrete procedure for developing and assessing indicators that address some of the key challenges related to global alignment and absence of data. This is based on the testing and experiences taken together over the whole period of doctoral studies. In consideration of the above described important general characteristics, Table 3 summarizes a procedural outline to put these into practice, and some advantages and limitations for consideration. The methods and tools outlined draw from established methods and tools, brought together in a novel way. Each method or tool can be cross referenced from Chapter 3, and the papers for a more detailed description for implementation.
Table 3: Procedure for Inviting and Guiding Community Level Participation in the Development and Assessment of Globally Sustainable Food Systems

1. Engage community in participatory, multidimensional approaches to conceptualizing their role in SFS.

<table>
<thead>
<tr>
<th>Step</th>
<th>Method/Tools</th>
<th>Brief Description</th>
<th>Advantages and Limitations (Further details, justification and discussion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Delphi Inquiry; FSSD Backcasting from SPs</td>
<td>Invite diverse members of the community to participate in panel to discuss: (A) a vision of SFS, (B) the barriers and supports in today’s reality for the community, (C) possible actions for moving toward the vision, and (D), which actions are strategic to prioritise. Include a question about relevant indicators to measure progress toward the vision.</td>
<td>Online survey software can ensure anonymous responses and encourage honesty. Technology access might be a barrier in some contexts, and other formats for the dialogue are possible (e.g., meetings, interviews). The panel make-up should strive to include diverse disciplines, sectors, or knowledge domains. Maximize engagement, realizing that traditionally marginalized groups might take targeted efforts to engage. Indicators may not be available or of high quality, but this procedure can inform the development of relevant indicators. (Section 3.4; Papers 2, 3, 4)</td>
</tr>
<tr>
<td>1.2</td>
<td>Delphi Inquiry; Qualitative analysis with FSSD (5LM; SP)</td>
<td>Questions asked iteratively in two-three consecutive rounds. After each round, analyse and organise data from each round using 5LM to separate, e.g., possible actions from visionary concepts. Concurrently analyse and organise data using SPs to evaluate comprehensiveness of the responses with respect to sustainability.</td>
<td>Iterative nature supports member checking, increases learning between all participants, including the research team (or any team facilitating the procedure, increases ownership and buy-in. Helps organise and structure input from diverse knowledge domains, so that it is comparable. a priori theming will help important ideas emerge that may have been recorded under another question.</td>
</tr>
<tr>
<td>Step</td>
<td>Method/Tools</td>
<td>Brief Description</td>
<td>Advantages and Limitations (Further details, justification and discussion)</td>
</tr>
<tr>
<td>------</td>
<td>--------------</td>
<td>-------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1.3</td>
<td>Delphi Inquiry</td>
<td>Use analysis to provide a composite summary between each round for consideration by panel prior to answering questions again.</td>
<td>SP analysis: supports facilitating dialogue about comprehensive sustainability. (Optionally) introduce SPs to participants, depending on context, time and appropriateness to audience (time is required to learn and work with SPs). Best to use it as part of the analysis here, but optional, as it can be done as part of 1.6 and 1.7. (Section 3.4, Papers 2, 3)</td>
</tr>
<tr>
<td>1.4</td>
<td>Delphi Inquiry</td>
<td>In second and third rounds, explicitly ask for panel to amplify, disagree, or ask for clarification re: composite summary.</td>
<td>Helps build trustworthiness in results, learning across knowledge domains, and highlight potential areas of tension that require addressing (Section 3.4, Papers 2, 3)</td>
</tr>
<tr>
<td>1.5</td>
<td>Delphi Inquiry; FSSD Backcasting from SPs</td>
<td>End Delphi Inquiry process with face-to-face workshop to finalise data, discuss outstanding issues. Finalise D-Step: facilitate conversations around which of the actions are “upstream” or high-leverage.</td>
<td>Helps build clarity and relationships Breaks anonymity May result in participant voices being “silenced” somewhat by group dynamics or ability to attend (Section 3.4, Paper 2)</td>
</tr>
</tbody>
</table>
**1.6-1.7 can be done in advance of the concluding workshop, and then, further refined, or can be completed after the workshop**

<table>
<thead>
<tr>
<th>Step</th>
<th>Method/Tools</th>
<th>Brief Description</th>
<th>Advantages and Limitations (Further details, justification and discussion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.6a</td>
<td>Qualitative coding</td>
<td>Finalise list of multidimensional themes relevant to the community level that capture the vision of success (A) within SPs.</td>
<td>List of themes used to frame (outcome) indicators. Concrete definition of sustainability defines what is and is not sustainable within vision themes, and provides parameters to align visions and action across different communities and scales. <em>(Paper 2)</em></td>
</tr>
<tr>
<td>1.6b</td>
<td>Local-to-global assessment framework</td>
<td>Populate community layer of framework for local-to-global SFS indicators.</td>
<td>Optional Helps conceptualise relevant themes as related to themes established by global expert panel. Can add layer of complexity, may not be necessary. <em>(Papers 2, 4)</em></td>
</tr>
<tr>
<td>1.7</td>
<td>Qualitative analysis with FSSD (SPs)</td>
<td>Organise such that themes are related to key barriers to that theme, barriers are aligned articulated as SPs violations, and high-leverage actions are aligned with barriers.</td>
<td>Concrete definition of sustainability (parameters) that define what is and is not sustainable. Barriers articulated as SPs violations helps isolate how communities can, through barrier-specific actions, drive progress in a theme toward a more sustainable state, even across different communities and scales. <em>(Paper 3)</em></td>
</tr>
<tr>
<td>1.8</td>
<td>Delphi Inquiry</td>
<td>After the workshop, provide final summary report. If possible, include steps 1.6-1.8.</td>
<td>Final summary report can be used as a strategic roadmap, or a foundation for similar strategic work <em>(105,107)</em>. <em>(Papers 2, 3)</em></td>
</tr>
<tr>
<td></td>
<td>Outcomes</td>
<td>As a result of Phase 1, the community will have defined: 1. A vision statement and list of themes which capture the important concepts in the vision. 2. Barriers to the vision, articulated as drivers of unsustainable conditions.</td>
<td></td>
</tr>
</tbody>
</table>

38
### 3. High leverage actions that address the barriers, and a list of potential and relevant indicators for both actions and the vision.

### 2. Apply systems thinking and tools to guide assessment and evaluation

<table>
<thead>
<tr>
<th>Step</th>
<th>Method/Tools</th>
<th>Brief Description</th>
<th>Advantages and Limitations (Further details, justification and discussion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>CAT; Causal Diagrams</td>
<td>Use CAT to delimit a system of interest (can be one focus theme and several related themes). Refer to community identified barriers, actions related to that theme (step 1.7). Use CLDs to visualise the system of interest, guided by CAT.</td>
<td>Helps to avoid complexity paralysis, highlight how finer grained (community level) subsystems are linked to broader goals. Can involve the community in this phase (in face-to-face workshop), but it can also be developed parallel or afterwards, depending on appropriateness and resource capacity. CLDs informed by the CAT not exclusive of the role of other sectors and disciplines to contribute positive change. Multiple systems of interest possible. (Section 3.4; Paper 4)</td>
</tr>
<tr>
<td>2.2</td>
<td>Delphi Inquiry; CAT</td>
<td>Use community identified indicators that capture process (actions, D) and outcomes (vision themes, A) related to the system of interest.</td>
<td>Using community identified barriers and indicators allows other forms of knowledge (other than academic) to be used to develop indicators. Process indicators help elucidate the “role” of the community in driving change. (Paper 4)</td>
</tr>
<tr>
<td>Step</td>
<td>Method/Tools</td>
<td>Brief Description</td>
<td>Advantages and Limitations (Further details, justification and discussion)</td>
</tr>
<tr>
<td>------</td>
<td>-----------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2.3</td>
<td>Local-to-global assessment</td>
<td>Screen indicators for: high-quality, practical, sufficient, necessary. Identify and collect suitable alternatives if needed.</td>
<td>Community identified may not meet screening criteria. Strive to develop or adjust indicators that meet criteria, while being true to the intention of community indicators. <em>(Paper 4)</em></td>
</tr>
<tr>
<td>2.4</td>
<td>Delphi Inquiry; CAT</td>
<td>Outcomes indicators become “stocks” in the CAT informed CLD, while process indicators govern the ‘flow’ or actions that are responsible for the dynamic relationships. Evaluate increasing/decreasing state of outcome or process to understand whether actions drive toward or away from sustainable state, and where potential points of leverage (community level actions) may lie.</td>
<td>Data may still be missing. Process indicators help inform dynamic hypotheses about indicator interrelationships, including across scales, in the absence of data. CAT theory helps develop inferences about the influence of sociocultural norms, and opportunities to shape SFS-sensitive cultural paradigms. Requires familiarity with using and reading CLDs. CLDs of various subsystems can be combined to examine the overall behavior of a larger system with respect to sustainability.</td>
</tr>
<tr>
<td>2.1-4</td>
<td>Outcomes</td>
<td>As a result of Phase 2, the team and community will have defined: 1. A subsystem of interest (or multiple). 2. A revised list of relevant indicators that measure both actions (process indicators) and vision themes (outcomes indicators). 3. A “map/diagram” that conceptualises how actions at the community level contribute to the vision, and broader global SFS development, such that assessments can be made.</td>
<td>Food systems are part of dynamic socioecological systems. As such, this procedure is meant to be used iteratively, as time and resources allow. Iterative use will allow for continued follow-up between all stakeholders, as-needed revision of the strategic plan that it informs, and even perhaps the original vision.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step</th>
<th>Method/Tools</th>
<th>Brief Description</th>
<th>Advantages and Limitations (Further details, justification and discussion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3</td>
<td>Local-to-global assessment</td>
<td>Screen indicators for: high-quality, practical, sufficient, necessary. Identify and collect suitable alternatives if needed.</td>
<td>Community identified may not meet screening criteria. Strive to develop or adjust indicators that meet criteria, while being true to the intention of community indicators. <em>(Paper 4)</em></td>
</tr>
<tr>
<td>2.4</td>
<td>Delphi Inquiry; CAT</td>
<td>Outcomes indicators become “stocks” in the CAT informed CLD, while process indicators govern the ‘flow’ or actions that are responsible for the dynamic relationships. Evaluate increasing/decreasing state of outcome or process to understand whether actions drive toward or away from sustainable state, and where potential points of leverage (community level actions) may lie.</td>
<td>Data may still be missing. Process indicators help inform dynamic hypotheses about indicator interrelationships, including across scales, in the absence of data. CAT theory helps develop inferences about the influence of sociocultural norms, and opportunities to shape SFS-sensitive cultural paradigms. Requires familiarity with using and reading CLDs. CLDs of various subsystems can be combined to examine the overall behavior of a larger system with respect to sustainability.</td>
</tr>
<tr>
<td>2.1-4</td>
<td>Outcomes</td>
<td>As a result of Phase 2, the team and community will have defined: 1. A subsystem of interest (or multiple). 2. A revised list of relevant indicators that measure both actions (process indicators) and vision themes (outcomes indicators). 3. A “map/diagram” that conceptualises how actions at the community level contribute to the vision, and broader global SFS development, such that assessments can be made.</td>
<td>Food systems are part of dynamic socioecological systems. As such, this procedure is meant to be used iteratively, as time and resources allow. Iterative use will allow for continued follow-up between all stakeholders, as-needed revision of the strategic plan that it informs, and even perhaps the original vision.</td>
</tr>
</tbody>
</table>

40
5.2. Response to Research Question 2

How can the nutrition and dietetics community contribute to the development of globally SFS?

In addition to insights into theory and procedural supports, this dissertation contributes to concrete, contextual results for nutrition and dietetic practice. While they are written as generalised insights for the nutrition and dietetics community in response to the research question, their relevance may extend beyond this community to other professional, geographic, or cultural communities.

Integrate Sustainable Food Systems into Existing Practice

While recognizing that nutritionists and dietitians alone do not own this problem space, they are well positioned to contribute in many ways. Nutritionists and dietitians are trained to think across scales, and existing roles reflect that. They work with individuals, organizations, communities, and even broader public policy. They also work across sectors including private agriculture and food industry, private and public health/nutrition care, research, public policy, and civil society organizations (not for profit). Because of this, there are many entry points to influence the system, and ones in which nutritionists and dietitians are already skilled in making positive change for health outcomes. These include roles that leverage change at the local level (e.g., nutrition care with individuals), as well as national (e.g., influencing national food guidance policy\(^{(109)}\)) and international level\(^{(105)}\). The detailed roles are captured comprehensively in Paper 3, as well as in related reports from the research team\(^{(105,107)}\).

To Focus on the Approach

A critical first step stressed by participating dietitians was ensuring a common language, which is critical for professional competence with various roles for the nutrition and dietetics community. The broader research also suggests that systems tools help guide users to think broadly
about the many relevant factors in the socioecological systems, and this helps ensure that the common language and competence is based in transdisciplinary evidence. This is important at a time when the SFS discourse is easily misconstrued by competing voices, often with vested, conflicts of interest\(^{(46)}\).

The importance of collaborative approaches is threaded throughout this discussion, and strongly related to the inherent multidimensionality of SFS. Collaboration with other health professions (e.g., physicians), disciplinary fields (e.g., agriculture, environment, etc.), and sectors (e.g., industry, civil society organizations, etc.) is critical. A collaborative approach could be seen as a divvying up of the various themes between disciplinary or sectoral areas of practice, for a common goal. Systems thinking advances the notion that the various themes are interconnected, and therefore, working together using shared, transdisciplinary techniques is likely most effective.

There are many types of knowledge and expertise, and it will be necessary to combine these to achieve comprehensive success. Just as the organizational and specialized expertise within this professional community (Papers 3 and 5) was valuable in supporting the theoretical expertise among academics (Papers 1 and 2), so too can this insight be extended to further knowledge cultures such as the local community and individual\(^{(95)}\) knowledge cultures.

There is no SFS template to guide SFS action, but a need to open the political space for critical dialogue to address emergent conditions\(^{(48)}\). A reflexive approach to continued dialogue is an important approach highlighted in this research. For example, one barrier to SFS in dietetic practice identified in Paper 5, was that dietetics has adapted uncritically to the dominant individualized discourse of neoliberal politics and biomedical paradigms. Without adequately problematizing these
structures vis-à-vis the goal (generally human health), the field has struggled to make genuine progress on health related issues with socioecological origins. Continued and reflexive dialogue, informed by systems thinking, is needed. Further, parameters defining sustainability are helpful in creating objective boundaries to guide such reflexive discourse in a way that is globally aligned. Continued reflection on underlying assumptions about the parameters themselves should also be part of the dialogue\(^{(40)}\). The question then becomes, as an organization and/or a community, how to create such a space? The procedure summarized in Table 3 provides an example of how to do so.

If, from a community development perspective\(^{(76)}\), nutritionists and dietitians have an obligation to foster community ownership over the knowledge and skills necessary to perpetuate SFS, theoretically\(^{(49,56)}\) this encourages positive feedback loops in the system that support adaptation toward a sustainability-focused cultural paradigm. The state of the cultural paradigm, in turn, is an important factor in this self-perpetuating cycle, as our cultural paradigms influence the structures in our communities. Using the above procedure and insights is supportive of this approach, however, more research on a “practice-for-paradigm-shift” is needed.

5.3. Limitations and Future Research Directions

Given the overall dominance of data from North America, Europe and Australia informing the findings from this research, the conclusions and recommendations for practice are most robust and trustworthy in, and therefore transferrable to, communities in those regions. In the context of dietetic practice, this can be extended to regions where professional practice and culture have roots in these regions, (e.g., through colonial history, or the fact that nutrition and dietetics professionals are trained in accredited programs abroad). To make the research outcomes more robust in a global context, future research opportunities include expanding the knowledge domains, cultural scope and geographical scope included.
However, such knowledge diversity needs to be balanced against a recognition that knowledge related to SFS challenges, solutions and measurement will always be dynamic, partial and plural, and not possible to entirely understand\(^{(110)}\).

Complex problems rarely have simple solutions, and this research is no different. While aiming to explore how to align local-to-global progress for SFS, this research proposes a procedure for inviting and guiding communities to contribute in self determined ways to SFS. However, the procedure and related concepts and theories require time and training, and are not easily “picked up” by communities. Future research opportunities include exploring and refining the procedure and included methods and tools, and supporting them with software or other types of training toolkits.

Future research is also needed to explore barriers to engagement in SFS. While some research is beginning to shed light on the challenges to dietetic engagement with SFS\(^{(111-113)}\), questions remain. One that is particularly relevant to the outcomes of this research, is how to effectively integrate collaboration, reflexivity and systems thinking into education, training and professional development.
References


Paper 1. Conceptualizing and Assessing Sustainable Food Systems and Diets: A Review

Liesel Carlsson

Paper 1 is submitted for publication as:
Conceptualizing and Assessing Sustainable Food Systems and Diets: A Review

Abstract

Objective: To synthesize research conceptualizing and measuring sustainable food systems (SFS) and diets and discusses the results from the perspective of supporting community level participation in global SFS. Design: Researchers conducted a narrative review of the literature, structured results into emergent categories and themes, and analyzed against known challenges to community level measurement. Results: Concepts defining SFS fall into the following broad approaches: visionary, multidimensional, resilience and parametres. Within these, common categories and emergent themes are reported. Assessment of SFS and diets can be grouped into three general approaches: multidimensional progress reporting, composite scores, and vulnerability assessments. Assessment is challenged by data gaps, especially at the community level, making community engagement in broader global goals elusive. Conclusions: Results contribute to SFS theory by suggesting a need to further develop existing parametres concepts, which set out system limits and principled approaches to governing those systems and show promise for assessment in the absence of adequate data. Future research directions might explore parametres approaches for supporting community level contributions to SFS in a way that demonstrates local-to-global alignment. These will be relevant to practitioners in nutrition, public health and community development, who are well-positioned to facilitate such work.

Keywords: Sustainable Food Systems; Sustainable Diets; Concepts; Assessment
1. Introduction

Food systems provide for human food and nutrition security. They contribute to and are affected by pressing sustainability challenges\(^{(1-3)}\), and this has a direct effect on population health\(^{(1,4)}\). Practitioners and scholars engaged in food, nutrition, and sustainability work at the community level are challenged by the fact that most concepts and assessment tools are national or global in scope. Assessment tools are ill-equipped to support evaluation of community level contributions to sustainable food systems (SFS) in a way that demonstrates alignment with global goals for SFS. While current approaches to assessing SFS and diets present impressive advancements on various fronts, gaps remain in how to do so in a way that facilitates alignment between communities and with broader global concepts.

Measuring\(^1\) food system sustainability is important because what gets measured is often what gets done. Assessment tools allow decision makers to evaluate progress toward a goal and mobilise resources to “move” indicators in the ‘right’ direction. However, numerous worldviews underpin how SFS are defined, leading to a multiplicity of concepts and assessment tools. In the context of the predicted urgency of the food sustainability challenge\(^{(5-7)}\), alignment in concepts and assessment is important to concerted action.

Alignment is challenged by the multiscalar and complex nature of food systems in two ways. First, the physical and conceptual distance hinders communities from seeing clearly, their role in SFS. Food systems are globalised, connecting localities and nations across the world in myriad

---

\(^1\) In this paper, *measurement* refers to an objective quantification of one or more elements of SFS; *assessment* uses measurements to objectively assess the state of SFS (although some overlap exists in how these terms are used between papers); and *evaluation* is the process by which judgment is passed, based on the evaluation.
producer-to-consumer relationships\textsuperscript{(8,9)}. Actions at the community level are impacting, and are impacted by, interactions with the broader systems. Yet, conceptual work defining SFS and diets resides largely at the global level\textsuperscript{(10–14)}, and assessment at the national level or broader\textsuperscript{(15–19)}. National level data allow for a coarse-grained analysis and comparison between countries, but have less sensitivity to local context. Second, publicly available data to measure comprehensive SFS is incomplete\textsuperscript{(20)}, and at the community level data is inconsistent or ill-fit to capture the problem evoking a “need-for-more-data” trap that can paralyse important evaluation phases in community level efforts for food and nutrition sustainability.

The purpose of this paper is to: (i) synthesize the state of the research on conceptualizing and measuring SFS and diets, (ii) organise the findings into a typology of concepts and assessment tools, and (iii) discuss the findings for their utility in supporting community level contributions to SFS in a way that demonstrates local-to-global alignment.

2. Methods

Traditional narrative literature review methods\textsuperscript{(21)} were used to examine SFS concepts and assessment approaches. Using all combinations of the key terms: “Sustainable food systems” or ‘sustainable diets,’ and ‘indicators’ or ‘metrics,’ or ‘assessment,’ and ‘community,’ or ‘community level,’ researchers first used the Discovery Layers Primo and Summon to systematically search the university library holdings, electronic resources and theses. This included, but was not limited to the Elsevier, Scopus, EBSCO and Web of Science, Springer, Taylor and Francis, JSTOR, Wiley, Cambridge and Oxford databases. Google Scholar was also used. The search was stopped when no new articles relevant to community level sustainable food system assessment were found. The
search was conducted between October 2016 and February 2017. The search was not delimited by publication date.

The articles were filtered using the following inclusion and exclusion criteria—peer reviewed articles and conference proceedings, grey literature reports, and books which conceptualise SFS and diets, present or propose comprehensive or multidimensional assessment processes, and/or examine measurement at the community level. References pertaining to value-chain assessment were also included where they used comprehensive approaches applicable to community level assessment. Excluded were assessments specific to a project, program or institution.

Comprehensive assessments are those which attempt to measure multidimensional SFS, rather than one or a few indicators (e.g., greenhouse gas emissions only). Many were multiscalar or can accommodate the interactions between local, national, regional and global scales in food systems. An indicator category represents broad sustainability dimensions such as ecological, social, cultural economic, or human health dimensions, and used to organise specific themes and indicators. A theme represents a key concept to SFS (e.g., biodiversity) and includes one or more indicators which contribute to its measurement (e.g., agricultural diversity and dietary diversity). The term community includes communities unified by geographic space (e.g., a town), and communities of common interest (e.g., a professional community).

A general typology of concepts and assessment approaches emerged based on how concepts were structured, and in some cases, their epistemological roots. Not all concepts and assessments fell cleanly into distinct approaches, and for simplicity in this article they are categorised under the typology that best fit and is most helpful to the purpose of the review—to support community level participation in globally aligned SFS goals. With a different focus, one might reassign the category. To organise the SFS
concepts, broad categories that emerged from the data were developed. Finer-grained themes were tabulated verbatim, where possible, under the most appropriate category and closest to the meaning conveyed by the original authors. A list of common themes was developed by coding each of the verbatim themes.

3. Results

3.1. Conceptualizing Sustainable Food Systems and Diets
Concepts defining SFS fell into the following general typology: visionary, multidimensional, resilience and parameters approaches. Visionary definitions read as conceptual ideals across some combination of or categories—most often, ecological, social, cultural and economic. These describe, with succinct, compelling language, a future reality for food systems and diets.

The need for more specific detail within each category led to multidimensional ways of defining food system sustainability, some of which build on previously established visionary definitions. Multidimensional approaches offer a list of specific themes to guide assessment (and action).

The need to understand, against what standard these themes are evaluated, sparked the development of two more approaches to conceptualizing food system sustainability—those based on what factors make the system more resilient or more vulnerable to shocks, and those based on parameters, or system boundaries, which define the needs of the system. The following sub-sections summarise the literature accordingly.

Visionary Concepts
Among visionary approaches to defining SFS and diets, there is significant conceptual overlap. Most agree that there is a human-ecosystem
interaction that needs to be balanced, where the human element includes human health, society and economy, and that the purpose of food systems is to serve human food and nutrition needs. In addition, all but one definition (Sumner) explicitly include a temporal element that highlights futurity, or long-term consideration of future generations. Table 1 summarises visionary definitions of SFS and diets, some of which are also the conceptual anchor for approaches presented in subsequent sections.
Table 1. Visionary Approaches to Defining Sustainable Food Systems and Diets

<table>
<thead>
<tr>
<th>Article</th>
<th>Concept</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>HLPE (2017) Nutrition and Food Systems. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security (HLPE Report Series No. 12) Rome.</td>
<td>Sustainable Food Systems</td>
<td>Those that “...[deliver] food and nutrition security for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised.”</td>
</tr>
<tr>
<td>Story M, Hamm MW &amp; Wallinga D (2009) Food Systems and Public Health: Linkages to Achieve Healthier Diets and Healthier Communities. Journal of Hunger &amp; Environmental Nutrition 4, 219–224.</td>
<td>Sustainable Food Systems</td>
<td>“Sustainable food system[s]... provide healthy food to meet current food needs while maintaining healthy ecosystems that can also provide food for generations to come, with minimal negative impact to the environment; encourage local production and distribution infrastructures; make nutritious food available, accessible, and affordable to all; are humane and just – protecting farmers and other workers, consumers, and communities.”</td>
</tr>
<tr>
<td>Article</td>
<td>Concept</td>
<td>Definition</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>--------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Sumner J (2011) Serving Social Justice: The Role of the Commons in Sustainable Food Systems. <em>Studies in Social Justice</em>, 5.</td>
<td>Sustainable Food Systems</td>
<td>“A sustainable food system involves an interdependent web of activities generated by a set of structures and processes that build the civil commons with respect to the production, processing, distribution, wholesaling, retailing, consumption and disposal of food…” (Civil commons is both our natural commons (biosphere) and human social organization and structures set up to provide us access to the natural commons).</td>
</tr>
<tr>
<td>Burlingame B &amp; Dernini S (2012) Sustainable Diets and Biodiversity: Directions and Solutions for Policy, Research and Action. Rome, Italy: Nutrition and Consumer Protection Division, Food and Agriculture Organization.</td>
<td>Sustainable Diets</td>
<td>“Sustainable diets are those diets with low environmental impacts, which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources.”</td>
</tr>
<tr>
<td>Meybeck A &amp; Gitz V (2017) Sustainable diets within sustainable food systems. <em>Proceedings of the Nutrition Society</em>, 76.</td>
<td>Sustainable Diets</td>
<td>“A diet that contributes to the good nutritional status, and long term good health of the individual/community, and that contributes to and is enabled by, sustainable food systems, thus contributing to long term food security and nutrition.”</td>
</tr>
</tbody>
</table>
Likely the most widely used definition of SFS is the one used by the Food and Agriculture Organization (FAO) of the United Nations, who define SFS as those that “… [deliver] food and nutrition security for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised.”

Anchored in the Brundtland concept of sustainable development, there is a clear focus on securing intergenerational equity in human food and nutritional security, while protecting resources across three broad categories: economic, social and environmental. The details of what specific economic, social and environmental bases to generate food security … are not [to be] compromised, or what level of minimal negative impact on the environment is needed to protect future generations, is not clear. This conceptualization is reflected strongly by others, such as Agovino, Cerciello, and Gatto\(^{(22)}\), as well as Story, Hamm and Wallinga\(^{(23)}\). The latter authors expand the definition to include more thematic detail, and as such, are also included in the next section.

Sumner\(^{(24)}\) describes food system sustainability in relation to the *civil commons*, which is our natural commons—our biosphere—as well as our human social organization and structures set up to provide us access to the natural commons. In this way, Sumner envisions SFS as public domain, designed to provide and protect universal access to food. The private sphere is by definition excluded from food system involvement. Sumner builds on a body of earlier scholarly work that expanded the sustainability dialogue beyond environment to include social justice aspects\(^{(25–28)}\).

Sustainable Diets\(^{(12)}\) has emerged as a concept that highlights consumer demand, choice and responsibility in influencing food system sustainability. This is particularly salient in industrialised countries where foods with high environmental impact and low nutritional quality are prevalent\(^{(29)}\), and high consumer agency is experienced. Meybeck and Gitz argue that sustainable diets are inseparable from SFS, capture the consumption-driven contribution to food system sustainability in addition
to meeting human nutrition needs, and are drivers of both individual and system level change for SFS\textsuperscript{(11)}.

These visionary definitions delineate the desired future reality of food systems and diets into broad categories (e.g. ecological, social, cultural, human health and economic). They are compelling descriptions that provide rallying points for a desired future, but inadequate to guide assessment or action for their sake.

*Multidimensional Concepts*

Multidimensional concepts attempt to define what important themes make SFS and diets more practical to measure and act upon through more detailed themes in the definition text (Table 2), or through themes articulated in the original source. Themes capture issues, determinants, drivers, and/or outcomes, under the general categories: ecological, social, cultural, human health, economic and “other” dimensions. Due to space constraints, each of the original themes are not included for the multidimensional concepts in Table 2, but rather, integrated into Figure 1.
<table>
<thead>
<tr>
<th>Article</th>
<th>Concept</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Story M, Hamm MW &amp; Wallinga D (2009) Food Systems and Public Health:</td>
<td>Sustainable Food Systems</td>
<td>As per Table 1</td>
</tr>
<tr>
<td>Linkages to Achieve Healthier Diets and Healthier Communities. Journal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sumner J (2011) Serving Social Justice: The Role of the Commons in</td>
<td>Sustainable Food Systems</td>
<td>As per Table 1</td>
</tr>
<tr>
<td>Diets: A Descriptive Analysis of the Determinants and Processes That</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Influence Diets and Their Impact on Health, Food Security, and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tara Garnett (2014) What is a Sustainable Healthy Diet: A discussion</td>
<td>Sustainable Diets</td>
<td>Definition not included; focuses on issues of concern.</td>
</tr>
<tr>
<td>paper. Food Climate Research Network.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mason P &amp; Lang T (2017) Sustainable Diets: How Ecological Nutrition</td>
<td>Sustainable Diets</td>
<td>“health-enhancing, has low environmental impact, is culturally appropriate</td>
</tr>
<tr>
<td>Can Transform Consumption and the Food System. London ; New York:</td>
<td></td>
<td>and economically viable,”</td>
</tr>
<tr>
<td>Earthscan, from Routledge.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Most multidimensional approaches to conceptualizing SFS and diets begin with a visionary definition (see Table 1) and use various methods to further define more specific themes. For example, Story, et al. expand on the FAO’s definition with six more fine grained themes built into the definition statement. Similarly, Johnson et al.\(^{(30)}\) and Jones et al.\(^{(31)}\) built on Burlingame and Dernini’s definition to identify an additional 28 and 24 themes respectively. While not proposing an assessment approach per se, they are suggesting there is a need for multidimensional concepts of sustainable diets to guide comprehensive assessment and action. Mason and Lang\(^{(20)}\) also begin with their own succinct definition of sustainable diets, which recalls the common categories of environment, social/culture and economy, before suggesting a set of 40 themes (“omni-standards”) as an *ecological nutrition* approach to guide policy and action.

Sumner’s concept, as described previously, is anchored in social justice and the human right to our civil commons. In addition to themes, Sumner also describes *attributes* (“pillars”) of the social structures necessary to achieve SFS and Garnett\(^{(32)}\) describes ‘issues to consider’ as a way to conceptualise sustainable diets, and guide discussion and analyses.

There is a degree of theme saturation, which is captured in an emerging list of common themes within these categories (Figure 1). These represent common ideas where different wording was used between articles. For themes and categories, all attempts were made to preserve the authors’ original meaning. Themes were placed in only one category and could be debated or moved. Some overlap between themes does exist. Some themes were articulated as overarching considerations and/or attributes of the system as a whole (not a component of a category). Figure 1 includes common themes from all conceptual and assessment approaches reviewed.
Figure 1. List of Common Themes Used Across all Conceptual and Assessment Approaches

Social and cultural categories are combined to simplify the visual. Themes listed within the outer ring denote attributes and considerations for the whole system, positioned around and within the categorical themes.

These themes provide a description of what types of issues, determinants, drivers and outcomes are being considered in order to conceptualise, assess, and operationalise food systems and diet sustainability. However, use of any combination of these themes for assessment and evaluation purposes (e.g., sustainable water use) requires an understanding of what constitutes a sustainable state within each theme (e.g., how much water can
be used sustainably, and what is the capacity of the ecosystem to regenerate clean water?)

Resilience Concepts
The need to understand what needs to be sustained, and against what standard these themes should be evaluated has pushed the development of resilience and parametres approaches.

Ericksen and Ingram\(^{(33,34)}\) have provided instrumental additions to how food systems are conceptualized. Their Food Systems Framework presents food systems as socioecological systems (rather than, e.g., a linear value chain), and maps the human and ecological factors central to food systems, food security, and their complex interactions. This work has informed important modeling and assessment work led by Prosperi, Allen and colleagues\(^{(15,16)}\) who discuss sustainability as “a property of a system, rather than an approach to agriculture ...” This resilience approach implies that food system sustainability is dependent on the capacity to respond to and overcome change (such as climate change or social instability) while still serving the food system purpose. Prosperi and Allen use themes (or variables) to assess the vulnerability of the system\(^{(15,16,35)}\).

Eakin et al.\(^{(36)}\) assert that themes (as currently used) are outcomes that various knowledge domains (e.g., agriculture, ecology, nutrition) prioritise as to what needs to be sustained, and that variance in prioritised themes is normal in a heterogeneous, dynamic system (as is our society). However, rather than focus on thematic outcomes, Eakin proposes that sustainability in the system is determined by attributes of the system, namely: modularity, diversity, innovation, congruence, and transparency.

This resilience approach to food systems sustainability highlights three important concepts: (1) that it is attributes of the socioecological systems that make it sustainable; (2) that many themes are important to the realities
of a time and place, but may not make the system more sustainable; and (3) to that end, the goal is a dynamic state. This approach is scalable, and if used for assessment, is dependent on rich data at the scale it is being used.

**Parametres Concepts**

The term *parametres* has many field-specific definitions. In this article, the term captures the concepts of defining system limits, constants in an equation, and what defines the rules of operation in a system.

The Sustainable Development Commission of the UK defined sustainable diets through a series of dietary recommendations, such as reducing consumption of meat and dairy products\(^{(37)}\). These recommendations are considered “parametres” in that they provide general guidelines, sometimes called principles, for making food choices that are both healthy and sustainable. They are somewhat prescriptive because they are based on the existing conditions in the food system and therefore, salient to issues of a time and place. This work also included a set of policy recommendations, and has helped inform the multidimensional approach to sustainable diets described by Mason and Lang in the previous section.

Marsden and Morley\(^{(38)}\) present SFS parametres that are less prescriptive (e.g., the need for integration of environment and economy, maximizing equity in decision making, etc.). They argue that rather than a template of prescriptive actions, parametres create space to guide critical and reflexive dialogue, and inform governance of emergent conditions\(^{(38)}\). This contribution highlights the potential for temporal and spatial diversity in how SFS manifest at the community level. For example, there is a current focus on the need to reduce meat and dairy consumption in industrialised and high-income nations to reduce environmental impacts\(^{(39)}\); however as animal-based food producers adapt to methods that have lower environmental impacts, this focus may shift to other, more salient issues.
Identifying parameters to frame reflexive decision making is likely a sound approach to sustainable food system development given the ever-changing conditions in the system.

Carlsson, Callaghan, Morley and Broman\textsuperscript{(40)} also proposed an approach to conceptualizing food systems sustainability using the Framework for Strategic Sustainable Development’s eight Sustainability Principles as theoretical “boundary conditions,” which define sustainability within a list of multidimensional, and multiscalar themes. In this way, it builds on multidimensional approaches, compares to Marsden and Morley’s non-prescriptive, principled-approach\textsuperscript{(41,42)} as well as to the resilience approaches, which are concerned with sustainability of the system, rather than particular thematic outcomes.

Table 3 summarises the work using resilience and parameters approaches to conceptualizing SFS and diets. The literature in Tables 2 and 4 together, captures the conceptual underpinnings of current approaches to conceptualizing SFS.
<table>
<thead>
<tr>
<th>Article</th>
<th>Definitions</th>
<th>Typology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable Development Commission (2009) Setting the Table: Advice to Government on Priority Elements of Sustainable Diets. UK. Marsden T, Morley A (2014) Sustainable Food Systems: Building a New Paradigm. Routledge, New York</td>
<td>&quot;The approach taken for this study presumed that the definition of a sustainable diet can be expressed through a series of recommendations as to how the current UK diet should be modified.&quot; No explicit definition. Uses parametres to guide critical and reflexive governance of emergent conditions: These parameters for defining sustainable systems are captured in the themes for measurement.</td>
<td>Parametres</td>
</tr>
<tr>
<td>Allen T &amp; Prosperi P (2016) Modeling Sustainable Food Systems. Environmental Management 57, 956–975.</td>
<td>Refer to Story Hamm and Wallinga for a general definition of SFS. Then they describe sustainability as &quot;a property of a system, rather than an approach to agriculture towards sustainability.&quot; (p 3). Sustainability is ‘‘the ability of a system to maintain productivity in spite of a major disturbance, such as caused by intensive stress or a large perturbation’’ (Conway 1985), and a system’s ability to continue over time (Hansen, 1996).</td>
<td>Resilience</td>
</tr>
<tr>
<td>Carlsson L, Callaghan E, Morley A, Broman G (2017) Food System Sustainability across Scales: A4A Proposed Local-To-Global Approach to Community Planning and Assessment. Sustainability 9:1061.</td>
<td>A vision, compiled by global food system sustainability experts: Sustainable food systems nourish communities in culturally appropriate ways. To achieve this, water, nutrient and energy cycles sustain and enhance ecosystems, people and communities. Sustainable and secure food systems are compatible with the productive capacity of the ecosystems upon which they depend. Good governance of this system is a responsibility shared by all, and there is respect for diverse ways of knowing and achieving this vision.</td>
<td>Parametres</td>
</tr>
</tbody>
</table>
3.2. Measuring Sustainable Food Systems and Diets

After a brief introduction of general characteristics of existing assessment approaches, they are reviewed by: multidimensional progress reporting, composite scores, and vulnerability assessments. In the following, community level measurements are highlighted.

*General Characteristics of Assessment Approaches*

Comprehensive measurement of SFS and diets depends on identifying appropriate indicators for each of the identified themes. They tend to rely on publicly available, internationally comparable data from sources such as the World Bank, FAO, WHO, Euromonitor or other data sets. The data is mainly supranational, national and regional (e.g., European Union or Mediterranean) in scope. This facilitates comparison between countries^\textsuperscript{43}, which might also have different food system types^\textsuperscript{44}. Indicators typically measure social, ecological, and economic drivers or outcomes data, or a mix of both^\textsuperscript{18,45,46}. Others measure societal responses (e.g., policy responses to a driver)^\textsuperscript{22,47}.

Some proposed assessment approaches included in Table 4 specify indicators, but not the approach to analysis^\textsuperscript{45,46}. These add to the conceptual landscape of themes and potential indicators, and as such, they are categorised as “indicator sets” in Table 4.

*Progress Reporting*

Levkoe, Lefebrve and Blay-Palmer propose a Pan-Canadian Sustainable Food Systems Report Card, which is framed by the principles of food sovereignty, and so, focus on measures important to the human right to food, and the right to define food and agricultural systems. Point-in-time, multidimensional data are compared to historical data on the same indicators, signifying the direction, if not magnitude, of change (e.g., “getting worse, mixed, getting better”). As a report card, this is helpful in overviewing the state of the system; however, the indicators are not
compared to a baseline for sustainability. For example, food waste will be compared to historical trends, rather than a level of and type of waste that the socioecological system can sustainably handle. Feenstra, et al., Gamboa, et al, and Nugent, Levin, and Grafton, et al. appear to be using variations on this type of data representation and comparison.

**Composite Scores**
Composite indices give meaning to the data by simplifying the score; metrics behind each indicator within a theme or category are weighted and combined, and transformed onto a scale with a standard range (typically 1-100, but not always), usually with higher values equating to a better score. The score is based on a calculation that compares the score of one unit (usually a nation) against the mean. This composite can be a single, aggregate index or score, ranking countries using a red/poor, amber/moderate or green/good code based on their relative score. These types of indices can also be subdivided to include multiple aggregate scores for themes (within which there are multiple indicators). Composite scores provide the end users (e.g., decision makers) with a simplified synthesis of what the combined indicators reveal for various priority areas (e.g., related to regional policy goals or sustainability categories). One way to present the results of this latter approach is using spider web diagrams, or radar charts which visualise the relative strength or weakness of a particular theme/category.

**Vulnerability Assessments**
Allen and Prosperi also propose composite scoring, but anchored in a resilience concept of sustainability that analyses indicators according to their contribution to vulnerability (to food insecurity due to global environmental change). The authors propose a comprehensive set of (multidimensional) indicators, and highlight that static indicator sets are not appropriate and because complex systems have dynamic qualities, there is a need for flexible indicators. This is particularly true at the
community scale\textsuperscript{(49)}. This proposed approach can accommodate complex system interactions and is theoretically appropriate to use at a finer grained scale such as a community, where data exist.

Assessment at the Community Level

In one of the first attempts at comprehensive SFS assessment, Feenstra et al.\textsuperscript{(50)} suggest a comprehensive set of subnational indicators which frames California as the community of interest. Like the Pan-Canadian Sustainable Food Systems Report Card\textsuperscript{(51)}, the indicators are comparisons to historical data and thus, show change over time on various themes. This work involved community stakeholders to identify indicators relevant to the spatially specific complexities of the community.

Two value chain assessment examples offer insight into community level, comprehensive SFS assessment—the FAO’s Sustainability Assessment of Food and Agriculture systems (SAFA)\textsuperscript{(52)} and the Sustainable Agri-food Evaluation Methodology (SAEMETH Framework)\textsuperscript{(53)}. The SAFA Framework has been adapted for use at the city level\textsuperscript{(47)} where researchers used a composite scoring approach to inform urban policy. The SAEMETH Framework assesses a single-product supply chain (such as lentils or capers) against Slow Food Foundation for Biodiversity’s criteria (Peano, 2015). Like SAFA, the SAEMETH Framework is adaptable to the community level, especially where communities are heavily invested in the production of a particular food product. However, supply chains generally span geographic scales and thus, these two frameworks also offer insight into multiscalar assessment challenges, such as the limited reach of localised food policy\textsuperscript{(47)} and how divergent worldviews influence assessment outcomes across scales\textsuperscript{(54)}. Tools to facilitate comparisons between communities (the way national level assessments do) as well as across scales is still elusive, yet important in highly connected food systems\textsuperscript{(20,55)}. 

78
<table>
<thead>
<tr>
<th>Article</th>
<th>Definitions</th>
<th>Typology of Concept</th>
<th>Typology of Assessment</th>
<th>Indicator Scale</th>
<th>Cross-scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feenstra G, Jaramillo C, McGrath S, Grunnell AN (2005) Proposed</td>
<td>Used a goal-based approach (i.e., the &quot;goals of a sustainable food system&quot;</td>
<td>MD</td>
<td>MD</td>
<td>Local</td>
<td>(State-Level)</td>
</tr>
<tr>
<td>Indicators for Sustainable Food Systems. Ecotrust</td>
<td>frame the indicators). See Indicator themes for goals.</td>
<td></td>
<td>Progress Reporting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fanzo J, Cogill B, Mattei F (2012) Identifying Appropriate Metrics of</td>
<td>Uses Burlingame &amp; Dernini FAO Bioversity definition</td>
<td>MD</td>
<td>Composite</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sustainable Diets and Food Systems. Bioversity International</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workshop Report. Bioversity International &amp; CIHEAM-IAMM, Montpellier,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>France</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Berry, E., Dernini, S., Burlingame, B., Meybeck, A., &amp; Conforti, P (2014)</td>
<td>&quot;... in more general terms, sustainability is the endurance of systems and</td>
<td>MD</td>
<td>Indicator Set (TBD,</td>
<td>National</td>
<td></td>
</tr>
<tr>
<td>Food Security and Sustainability: can one exist without the other? Public</td>
<td>processes. The organizing principle for sustainability is sustainable</td>
<td></td>
<td>considering composite</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health Nutrition 18, 2293–2302.</td>
<td>development, which includes four interconnected domains: ecology, economics,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>politics and culture.&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sustainability in Complex Agri-Food Systems: The SAEMETH Framework.</td>
<td>no definition referenced.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sustainability 7, 6721–6741.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

79
<table>
<thead>
<tr>
<th>Article</th>
<th>Definitions</th>
<th>Typology of Concept</th>
<th>Typology of Assessment</th>
<th>Indicator Scale</th>
<th>Cross-scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allen T &amp; Prosperi P (2016) Modeling Sustainable Food Systems. Environmental Management 57, 956–975.</td>
<td>Refer to Story Hamm and Wallinga for a general definition of SFS. Then they describe sustainability as &quot;a property of a system, rather than an approach to agriculture towards sustainability.&quot; (p 3). Sustainability is &quot;the ability of a system to maintain productivity in spite of a major disturbance, such as caused by intensive stress or a large perturbation&quot; (Conway 1985), and a system’s ability to continue over time (Hansen, 1996).</td>
<td>Resilience</td>
<td>Vulnerability Composite</td>
<td>National</td>
<td>Mediterranean Region</td>
</tr>
<tr>
<td>Article</td>
<td>Definitions</td>
<td>Typology of Concept</td>
<td>Typology of Assessment</td>
<td>Indicator Scale</td>
<td>Cross-scale</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
<td>---------------------</td>
<td>------------------------</td>
<td>-----------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Gamboa, G., Kovacic, Z., Di Masso, M., Mingorría, S., Gomiero, T., Rivera-Ferré, M., &amp; Giampietro, M. (2016). The Complexity of Food Systems: Defining Relevant Attributes and Indicators for the Evaluation of Food Supply Chains in Spain. Sustainability 8, 515.</td>
<td><em>The food system links three different aspects of life: (1) biological, i.e., the living processes used to produce food and their ecological sustainability; (2) economic and cultural traditions which affect people’s use of food [1].political, i.e., the power and control which different groups exert over the different parts of the system; and (3) social, i.e., the personal relations, community values, and cultural traditions which affect people’s use of food.</em></td>
<td>MD</td>
<td>MD Progress Reporting</td>
<td>Global</td>
<td>Food value chain</td>
</tr>
<tr>
<td>Carlsson L, Callaghan E, Morley A, Broman G (2017) Food System Sustainability across Scales: A Proposed Local-To-Global Approach to Community Planning and Assessment. Sustainability 9:1061. doi:10.3390/su9061061</td>
<td>A vision, compiled by global food system sustainability experts: <em>Sustainable food systems nourish communities in culturally appropriate ways. To achieve this, water, nutrient and energy cycles sustain and enhance ecosystems, people and communities. Sustainable and secure food systems are compatible with the productive capacity of the ecosystems upon which they depend. Good governance of this system is a responsibility shared by all, and there is respect for diverse ways of knowing and achieving this vision.</em></td>
<td>Parametres</td>
<td>TBD (considering parameters)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Article</td>
<td>Definitions</td>
<td>Typology of Concept</td>
<td>Typology of Assessment</td>
<td>Indicator Scale</td>
<td>Cross-scale</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>------------------------</td>
<td>-----------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Levkoe, C. Z., Lefebvre, R., &amp; Blay-Palmer, A. (2017). Food Counts: A Pan-Canadian Sustainable Food Systems Report Card (Fledge). Retrieved from <a href="https://fledgeresearch.ca/resources-results/foodcounts/">https://fledgeresearch.ca/resources-results/foodcounts/</a></td>
<td><em>Food sovereignty prioritizes &quot;the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems&quot;.</em></td>
<td>MD</td>
<td>MD</td>
<td>Progress Reporting</td>
<td>National</td>
</tr>
</tbody>
</table>

Table 4 Footnote: MD, multidimensional
4. Discussion

There is no one correct definition of SFS or sustainable diets, nor one perfect tool for assessment\(^{(56)}\). There are, however, a number of key points that emerge from this review that are important to consider. As laid out in the introduction, in this section the findings are discussed in the context of facilitating coordinated local-to-global progress on SFS and diets.

4.1. Involve the Community

Alrøe and colleagues\(^{(56)}\) argue that assessment must be contextually relevant and transparent about which underlying worldview or values shape them. Worldviews that shape our understanding of SFS and diets vary across time, place and priorities\(^{(54)}\). This review reveals that, while dominated by North American and European research, there is a wide array of worldviews (especially as they relate to what sustainability means). This influences approaches, categories, themes and indicators, and ultimately makes assessment a complex and contentious task.

Depending on how SFS are conceptualised, and therefore the themes and indicators selected, two different evaluations can easily produce different results\(^{(54)}\). This is challenging, as it is dependent on the values underlying the assessment approach. It also underscores the need for involvement of the end users of the assessment data, a point emphasised by others\(^{(31,49,53)}\), and not new to the community-based practitioners in the field\(^{(57,58)}\). Community involvement in the development of concepts or definitions, as well as the selection of important themes and indicators is important because it allows for flexibility to accommodate local priorities and diverse knowledge domains. This process can facilitate mutual learning\(^{(56)}\) and engagement with SFS\(^{(40,59)}\). Involving community in deliberative, reflexive decision making for SFS also supports pluralism and distributed power, or an “... opening up ... the local-to-global public spaces to debate and enact politics of sustainability”\(^{(60)}\). This has been argued as a strength in
sustainable development work\textsuperscript{(60,61)}, not least, because it may increase the likelihood of acceptance and uptake\textsuperscript{(62)}.

4.2. The Need for Concerted Action

One risk to community involvement is a splintered approach, or divergence between communities. Clear connection to globally unified objectives about what needs to be sustained is important to facilitate alignment between communities and for broader progress. Multidimensional concepts and indicator sets can facilitate concerted action through common themes. Figure 1 offers an emerging list. Having multiple, adaptable indicators within each theme such that users can choose or create relevant measures is one approach to accommodating community involvement\textsuperscript{(40)}. Resilience and parametres approaches also provide clear definitions of either what needs to be sustained, or what boundaries guide action. This can also create flexible platforms and alignment in the overall trajectory of the efforts.

4.3. Issues of Scale

Currently, the diet-impact relationship is often so distal and complex that “we immediately get lost in scope, scales and data”\textsuperscript{(11)}. For example, if driver indicators such as diet composition data are compared to known outcome indicators, such as greenhouse gas emissions related to diet composition, it is difficult to assign a location/nation to the outcome. This is because imported food will have emission outcomes attributed to the source country, not the country where the food is consumed. Data for tracking health and sustainability across scales is daunting “... [u]nless there is total traceability of all products consumed, with for each of them total information on the specific impacts of their production, transformation, transport and conservation ...”\textsuperscript{(11)}. These issues of scale undermine even well-intended policy. To align community assessment with broader progress, indicators are needed that are useful at several scales\textsuperscript{(20,35)} or those that can show driver-impact across scales. Resilience
concepts and assessment approaches show promise to accommodate the multi-directional relationships of influence between drivers and outcomes across scales, where data exists.

4.4. The Dearth of Local Data
Assessment approaches rely on the availability of consistent, high quantity and quality data across scales and themes. Assessing food systems sustainability in such a way that invites community level participation in global progress requires local data. Marsden and Morley point to the dearth of consistent data that allows for more fine grained analysis. This is prohibitive to communities wanting to act in an evidence informed way because national “... statistics mask complexities, many of which are bound up in place. Perhaps more importantly, they can obfuscate spatial and scalar inequalities in the production, trade, and consumption of food ... Regional and local perspectives must be taken into account ...”(63).

One solution is to support massive data collection, which will, at best, work in resource rich regions with this priority. However, resilience and systems approaches would also recognise that SFS are dynamic, and so too, the data needs(49). Given the abovementioned challenges related to values-based choices in data, divergent goals and scalar complexity, whether more data is the right solution, is questionable.

4.5. Nimble in the Absence of Data
In the absence of adequate data, a parametres approach to conceptualizing SFS could be helpful. For example, those that guide dietary choices toward known ecological and health co-benefits(20,37), or guide governance decisions around similar co-benefits(63) can facilitate evaluation and decision making in the absence of complete data.

Table 5 summarises the strengths and challenges of the different approaches to SFS conceptualization and assessment in the context of their
utility inviting and supporting community level participation. Strengths and challenges pertaining to conceptual approaches include those that might arise if used as a foundation for assessment.
Table 5. Summary of the Strengths and Challenges of Approaches

<table>
<thead>
<tr>
<th>Conceptual Approach</th>
<th>Strength (including if used to guide measurement)</th>
<th>Challenge (including if used to guide measurement)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visionary Concepts</td>
<td>Can be educational and motivational</td>
<td>Not specific enough to guide action</td>
</tr>
<tr>
<td></td>
<td>Can accommodate community involvement</td>
<td>Often unclear specifics on what needs to be sustained</td>
</tr>
<tr>
<td></td>
<td>Can accommodate diverse worldviews</td>
<td>Often unclear specifics what standard defines sustainable state of vision</td>
</tr>
<tr>
<td></td>
<td>Can result in splintered approach (accommodating local, diverse visions)</td>
<td>May result in splintered approach (accommodating local, diverse visions)</td>
</tr>
<tr>
<td>Multidimensional</td>
<td>Can accommodate community involvement</td>
<td>Often unclear specifics what standard defines sustainable state of vision</td>
</tr>
<tr>
<td>Concepts</td>
<td>Can be educational</td>
<td>May result in splintered approach (accommodating local, diverse visions)</td>
</tr>
<tr>
<td></td>
<td>Can accommodate diverse worldviews</td>
<td>High data needs</td>
</tr>
<tr>
<td></td>
<td>Can facilitate concerted action through common themes</td>
<td>Dearth of local data</td>
</tr>
<tr>
<td></td>
<td>Can accommodate dynamic nature of food systems</td>
<td></td>
</tr>
<tr>
<td>Resilience Concepts</td>
<td>Can accommodate issues of scale and complex data interactions</td>
<td>High data needs</td>
</tr>
<tr>
<td></td>
<td>Can accommodate dynamic nature of food systems</td>
<td>Data needs are constantly changing, especially at the local level</td>
</tr>
<tr>
<td></td>
<td>Clear and concrete definition of what needs to be sustained</td>
<td></td>
</tr>
<tr>
<td>Parametres Approaches</td>
<td>Non-prescriptive about how SFS manifests (day-to-day actions/reality)</td>
<td>Less/not flexible to community involvement and input on parametres</td>
</tr>
<tr>
<td></td>
<td>Clear and concrete understanding of what needs to be sustained</td>
<td></td>
</tr>
</tbody>
</table>
Can support concerted action through boundaries (parametres)
Can accommodate issues of scale

<table>
<thead>
<tr>
<th>Measurement Approach</th>
<th>Strength</th>
<th>Challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multidimensional Indicator</td>
<td>Highly detailed analysis</td>
<td>Need for highly literate end-users</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Often anchored in annual progress, not concrete sustainability benchmark</td>
</tr>
<tr>
<td>Progress Reporting</td>
<td></td>
<td>Often limited to national-level (or broader) data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Does not accommodate complex driver-outcome, and scale interactions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>May oversimplify and mask true cause-and-effect relationships</td>
</tr>
<tr>
<td>Composite Scores</td>
<td>Provide simplified analysis and highlight broader challenge areas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>May motivate political change through competition between nations</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parametres Approaches</td>
<td>Measurement anchored in a concrete sustainability benchmark</td>
<td>Often conflates national rankings with concrete sustainability benchmark</td>
</tr>
<tr>
<td></td>
<td>Some can accommodate guidance in absence of complete data</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Can accommodate issues of scale</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

88
4.6 Translating Assessment Data to Invite Communities into Coordinated Action

Multidimensional indicator progress reporting provides end users with detailed analysis of multiple criteria, but need highly literate decision makers to translate the results into action. They are likely most useful for national (or other scale) monitoring, rather than engaging communities, due to the dearth of local data.

Composite scores and indices can communicate simplified SFS priorities and, as such, are convenient policy tools. However, simplifying to one or a few scores oversimplifies the existing complexity, masks true cause and effect relationships, hides assumptions and values influencing the aggregations, and could lead to well-intentioned but ill-placed policy and behaviour change. The masked complexities may just lie at the root of a local food or nutrition challenge that programs or policy are attempting to address.

Furthermore, depending on the assumptions made in the computations, an index often compares between nations (or other geographic boundaries) rather than against a benchmark necessary to achieve sustainability. While national rankings can be used to motivate political change, this might encourage complacency in countries “doing well,” even though a ‘green’ light might be highly unsustainable. Also, national rankings do nothing to highlight the role of communities.

Theoretically, a parametres approach might encourage progress anchored in a known benchmark, i.e., how far each country is from the “boundaries” of a sustainable society, while leaving ample room in the political space for dialogue about how to address and govern emerging conditions. Yet, there are not known benchmarks for all the themes important to food system sustainability, leaving data gaps in our benchmarks. However, the character of parametres differs, and some can act as “boundaries” even in
the absence of data, combined with current indicators where data exists. As such, parameters offer a promising avenue in the context of community involvement in global SFS.

The parameters concepts in this review are conceptual tools not measurement tools; however, some useful examples exist outside of the SFS literature that use parameters to define and measure against system limits. These provide models that can possibly be adapted, and become useful in the food system context.

One example is the Planetary Boundaries framework\(^{(5)}\) (PB), an approach to environmental assessment that measures the global status of various themes (e.g., climate change) against estimated critical tipping points (a form of parameters that define environmental sustainability) for that theme. After the period of data collection for this literature review, the PB has been used to prescribe healthy and environmentally sustainable eating patterns, based on extensive data in today’s current conditions\(^{(65)}\). Limitations to this approach are that social dimensions of sustainability are not included in the parameters, and that they are all planetary in scale. The Framework for Strategic Sustainable Development (FSSD) is another approach, which includes a principled definition of integrated socio-ecological sustainability\(^{(66)}\) articulated by way of Sustainability Principles (a form of parameters). According to FSSD, violations of these Sustainability Principles are the reasons for unsustainable conditions (e.g., Planetary Boundaries being approached and surpassed). As such, the FSSD sets causal parameters, and the PB sets outcomes parameters. From the perspective of supporting community level participation in global SFS, the FSSD also includes procedural tools to support co-creation of strategic plans across knowledge domains and scales—akin to visionary and multidimensional approaches previously discussed. Therefore, it seems promising for inviting community participation and coordinating local-to-global progress for SFS\(^{(40)}\) without risking a splintered approach.
Limitations of the FSSD are that mastery of the concepts and procedural tools takes time, making it challenging to use at the community level without adequate training, and existing Sustainability Principles represent the current state of knowledge, and may evolve over time, along with research\(^{66}\).

4.7. Limitations

_Apropos_ the observation that worldview affects assessment choice, the background and understandings of the author influences the analysis and synthesis of the research materials, despite the intention to provide a balanced review driven by the idea of facilitating transitions toward SFS. Another author may have generated a different typology or arrangement of the data. Furthermore, research emerges daily which might shift the analysis. Less research emerges from countries outside of Europe and North America. This review is limited by a lack of more global perspectives, which exacerbates inequities and our collective capacity to complex challenges such as SFS\(^{67}\).

5. Conclusions

In conclusion, significant progress has been made in developing concepts and tools to support the work of practitioners, policy makers and scholars working with food, nutrition and sustainability issues. However, none of the research reviewed has adequately addressed the need for tools that invite and support community level participation in concerted global progress toward SFS. Such tools would also accommodate the challenge of avoiding a splintered approach in multiscalar systems, while being nimble in the absence of adequate data. This literature review contributes to the discourse by identifying the strengths of several approaches in filling these gaps.
For the purpose of inviting communities in defining SFS and diets relevant to their socioecological context, co-development of visionary and multidimensional concepts can be valuable. Further, this approach can foster mutual learning in the process. Practitioners and scholars in nutrition, public health, and community development are trusted professionals at the broad food-health interface, and as such are well placed to facilitate this type of public engagement and learning. Approaches have been proposed for this purpose\textsuperscript{(40)}.

To maximise alignment between community efforts, and with broader global goals, use of globally-aligned themes in multidimensional concepts can avoid splintered effects. Resilience concepts that set concrete definitions about what is to be sustained, and parametres concepts that define the boundaries of such diversity, are also useful in this respect. All assessment approaches proposed thus far are challenged by immense and shifting data needs at various scales, much of which may not exist at the community level.

This literature review contributes to practice by suggesting a way forward. While recognizing the value that highly specialised indices are contributing to progress for SFS at a global scale, further adaptation and development of parametres approaches is worthwhile, and an important future research direction. Parametres concepts of sustainability that set out system limits, and principled approaches to governing those systems show promise in that they can guide action in the absence of data. Examples in the sustainability literature can be adapted for use to support community level practitioners. These can also be combined with other approaches, such as visionary or multidimensional approaches to accommodate the advantages of community involvement.

In complex systems, it is inherent that no silver bullet will address a challenge. However, parametres approaches have the potential to support
diverse communities to contribute meaningfully, and in self-defined ways, to common SFS goals.
References


Paper 2. Food System Sustainability across Scales: A Proposed Local-To-Global Approach to Community Planning and Assessment

Liesel Carlsson, Edith Callaghan, Adrian Morley, Göran Broman

Paper 2 is published as:
Food System Sustainability across Scales: A Proposed Local-To-Global Approach to Community Planning and Assessment

Abstract

Interest in food systems sustainability is growing, but progress toward them is slow. This research focuses on three interrelated challenges that hinder progress. First, prevailing visions lack a concrete definition of sustainability. Second, global level conceptions fail to guide responses at the local level. Third, these deficiencies may lead to conflicting initiatives for addressing sustainable food systems at the community level that slow collective progress. The purpose of this article is to (1) describe the development of a framework for assessing food system sustainability which accommodates local level measurement in the context of broader national and global scale measures; and (2) to propose a process that supports community determinacy over localised progress toward sustainable food systems. Using a modified Delphi Inquiry process, we engaged a diverse, global panel of experts in describing “success” with respect to sustainable food systems, today’s reality, and identifying key indicators for tracking progress towards success. They were asked to consider scale during the process in order to explore locally relevant themes. Data were analyzed using the Framework for Strategic Sustainable Development (FSSD) to facilitate a comprehensive and systematic exploration of key themes and indicators. Key results include a framework of indicator themes that are anchored in a concrete definition of sustainability, stable at national and global scales while remaining flexible at the local scale to accommodate contextual needs. We also propose a process for facilitating community level planning for food system sustainability that utilises this indicator framework. The proposed process is based on insights from the research results, as well as from previous research and experience applying the FSSD at a community level; it bears
promise for future work to support communities to determine their own pathways, while contributing to a more coordinated whole.

**Keywords:** sustainable food systems; community development; indicators; sustainable development; backcasting

### 1. Introduction

Our global food system is dominated by processes that undermine the ecological and social systems, while also failing to adequately meet human nutritional needs [1–8]. In response, significant strides have been made in conceptualizing and defining sustainable food systems and identifying specific drivers that lead toward and/or away from full system sustainability [9–12]. Efforts have also been made in designing comprehensive indices that could measure our collective progress toward sustainable food systems [13]. This previous work has laid solid ground for further strengthening sustainable food systems conceptualizations and enhancing their usefulness for mapping pathways to success; however, the work can be strengthened in three ways. First, while several thoughtful definitions and visions of sustainable food systems exist, they lack a clear articulation of the boundaries that divide what is and is not sustainable. Without this clarity, the definitions end up as a “laundry list” of challenges to address, but do not help guide long-term strategic thinking, or even day-to-day decision-making. Second, global level conceptualizations of sustainable food systems are insufficiently fine grained to guide decision-making in communities responding to food system challenges. This may inhibit communities from seeing their role in a larger context, and to engage in evidence based planning and action that supports both sustainable community development, and a global sustainable food system. Third, the disconnect leads to a diversity of initiatives addressing sustainable food systems at the community level. While diversity in the
approaches to addressing food system sustainability is a strength, the likelihood that individual initiatives are guided by visions, or definitions, of success that lead in divergent or fundamentally opposing directions, impedes coordinated global progress. Coordinated, or more efficient progress towards an evidence-informed sustainable direction is important given strong links between our food system and, for example, climate [3,6], and predictions of the urgency linked to climate change in this century [1,14].

In this article, we present results from a global Delphi Inquiry process completed in 2015 with a panel of experts in food system sustainability, set out a tool for tracking progress toward sustainable food systems that aims to balance the need for community determinacy and global cohesion. We also describe a proposed process for using this indicator framework in community level visioning and planning grounded in an operational definition of global sustainability. This article describes in detail the methods and rationale behind the indicator framework, setting the stage for ongoing research which aims to better understand how to assess food system sustainability, and to test this framework and process set out in this article in community level contexts.

1.1. Food System Sustainability: Concepts and Measurement Challenges

One of the most often cited definitions of sustainable food systems is that of the United Nations High Level Panel of Experts on Food Security and Nutrition, who define sustainable food systems as those that “[deliver] food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised” [15]. The strength of this high level, aspirational definition of sustainable food systems is its broad and inclusive nature. Any food system stakeholders could find a way to identify with this definition. As such, it is more appropriate as a vision of
sustainable food systems. However, as with most visions, it fails to help decision-makers navigate the complexities of sustainable development [16,17] because it is aspirational not operational. How does one know whether future generations are being compromised? What economic, social, and environmental parameters cannot be crossed in order for future generations to have food and nutrition security? Further, it sets stakeholders up for a ‘triple bottom line’ approach (balancing economy, society, and environment), which provides no parameters for how to sustain each dimension for future generations, and runs the risk of ill-informed compromise between them. This, in practice, often gives precedence to short-term economic gains.

Moving from broad visionary concepts to more specific constructs, Johnson [9] and Jones [11] identify more operational constructs important to sustainable diets useful to our research, categorised into social, health, ecological, as well as the global political, economic, and ecological context (see Jones et al. for a detailed list). Eriksen [18] and Ingram [19] provide further operational clarity through describing food systems as a set of activities (such as food production, provision, governance, etc.) and outcomes of those activities, (such as food availability, population health, environmental integrity, etc.). Ingram’s food systems model aims to support understanding of the complex interactions and feedback loops between activities and outcomes, and how the food system is continually impacted by various social and environmental drivers of change. The model clearly links sustainability challenges, through food systems, to human food security outcomes. Allen and Prosperi build on Ingram’s work, to model and measure food system sustainability [20], making significant progress in the effort to define clearly what is more, or less, sustainable, by positioning vulnerability/resilience indicators between drivers of change and food system outcomes as the predictor of full system (of interest) sustainability. This focus on vulnerability and resilience
indicators adds a critical understanding of how drivers relate to resiliency outcomes (and, thus, to sustainability).

A second way by which our conceptualization of the food system can be enhanced is by addressing scale transferability. A growing body of research seeks to measure sustainable food systems with publicly available data [13,20–23]. These lend strength to much needed cross-sectoral, national, and global policy prioritization. However, there are well-recognised trade-offs between comprehensiveness (or breadth) and ability to use such data for more fine grained analysis at a local level [12,24].

There isdisconnect between the design and operationalization of global, regional, or national level measurement and analysis, and requirements of local level stakeholders attempting to respond to these challenges on a daily basis. This disconnect inhibits communities’ ability to see their role in a larger national or global system of food and sustainability, and to engage in strategic action that supports both sustainable community development, and a global sustainable food system. For example, global initiatives such as the Food Sustainability Index [25], informed by an abundance of national and supranational level data that dominates the data landscape, provide policy-makers with data to inform food system decisions. These data shape our understanding of the problem and approach to solutions. They are important but often misaligned with local level specificity, as even within nations, different localities may experience significantly different cause-and-effect relationships between the ecological and social variables unique to each context.

Finally, a myriad of grassroots initiatives are also responding to the need for sustainable food systems at the local level, alongside more contextually-relevant measures (e.g., Slow Food Presidia [26] or urban food production [27]). However, to track the contributions of various local initiatives to food system sustainability over time would then be like
“comparing apples and oranges”. Without assessment techniques that can accommodate this diversity, important contributions are not well-recognised for their contributions to the broader context.

A method for measurement that accommodates the complexity of multiscalar interactions is needed to create measurement tools that are useful for more fine grained analysis, without building on reductionism [28]. That is to say, tools that focus on measurements that accommodate local-scale measurement without disregarding national- and global-scale context. In this next section we describe existing sustainability theory that underpins our methodology, chosen for its potential to fill the gaps just described—in particular a definition of sustainability that has clear boundary conditions to delimit what is and is not sustainable, regardless of geographic scale.

1.2. Foundations for Sustainability

The Framework for Strategic Sustainable Development (FSSD) is a well-tested sustainability framework used by scholars and practitioners to frame complex, multiscalar, and “real-world” challenges, and to enhance understanding and operationalization of sustainability [29]. As such, this framework was particularly valuable for framing our research and data analysis. The components of the FSSD used in this research are described here; how they were used in the analysis are described under section 2.

A key feature of the FSSD is the five level model (5LM). When attempting to make change in any system, such as an organization or a community, it is important to understand where opportunities to leverage change exist. The 5LM allows for categorization of five dimensions important to strategic sustainable development. The system level (1) includes essential aspects for a sustainable socio-ecological system and descriptions of inter-relations among these, the success level (2) includes a vision of success framed by a principled definition of sustainability, the strategic guidelines
level (3) includes guidelines for prioritizing actions toward success, the actions level (4) includes concrete actions prioritised into a strategic plan, and the tools level (5) includes concepts, methods, tools, and other forms of support for the decision-making and work with the above levels. These five levels help facilitate clarity of thinking and planning for change. When combined with Sustainability Principles (see Box 1), the 5LM is useful for planning sustainable outcomes. The eight Sustainability Principles of the FSSD, have been developed over time, and refined according to five selection criteria (necessary, sufficient, general, concrete and non-overlapping [29]), to theorise a principled definition of sustainability useful for Backcasting planning and redesign for sustainability.

**Box 1. FSSD sustainability principles**

*In a sustainable society, nature is not subject to systematically increasing*

1. concentrations of substances extracted from the Earth’s crust (e.g., fossil carbon and metals);
2. concentrations of substances produced by society (e.g., CFCs and NOx); and
3. degradation by physical means (e.g., over-harvesting of forests and over-fishing).

*and people are not subject to structural obstacles to . . .*

4. health (e.g., by dangerous working conditions or insufficient rest from work
5. influence (e.g., by suppression of free speech or neglect of opinions);
6. competence (e.g., by obstacles to education or insufficient possibilities for personal development);
7. impartiality (e.g., by discrimination or unfair selection to job positions); and
8. meaning-making (e.g., by suppression of cultural expression or obstacles to co-creation of purposeful conditions).

The definition includes three basic principles for ecological sustainability and five basic principles for social sustainability. These principles allow
for a deeper understanding and operationalization of sustainability by clarifying the underlying causes of unsustainability. As these principles are articulated as negations of basic mechanisms by which the ecological and social systems can be degraded. It is also implicit that countless opportunities for sustainable futures exist, provided the principles are not violated. While specific sustainability issues are mentioned as examples in Box 1, the principles cover the basic causes of unsustainability. This allows for a strong and inclusive conceptualization of sustainability that guides problem solving and innovation without the need to explicitly state or understand every detailed consequence of violating these principles. Economic principles are not part of the definition, since the economy is not seen as a primary goal in itself; it is a human construct and part of our social system, designed to facilitate a means to an end. As such, economy plays an important role in human activities and decision making and is an integral part of the FSSD. Strategic sustainable development implies transitions via economically viable steps towards ecological and social sustainability, and then to keep society within that frame during its further evolution. This strategic work is in particular supported by the so-called ABCD procedure of the FSSD, as briefly described below.

FSSD theory, including the sustainability principles, are often applied in practice through the ABCD procedure, a procedure for strategic planning in complexity. The ABCD procedure facilitates iterative work with visioning, information gathering, sharing knowledge, and planning for action, referred to as “Backcasting from success”. Through this collaborative procedure, participants are encouraged to move through four stages.

A. Create a vision of success framed by the above principled definition of sustainability.

B. Gather baseline information regarding the current reality of the system under question and clarify strengths and challenges.
C. Generate creative solutions for making progress from the current reality toward the vision of success.
D. Identify strategic actions from the initial C-list; that is to say, prioritise possible actions based on their ability to move the system, using economically viable platforms, toward the defined vision of success.

The FSSD has been used in many contexts to actively work with organizations, often through action research, to address complex sustainability challenges (e.g., [30–32]). In this research we have applied the framework to our design and analysis (described in section 2). In doing so, we have adapted the approach to help meet the knowledge gaps outlined in the introduction, maintain a grounding in established sustainability science, and set ourselves up to apply our outcomes in communities in a manner that aligns well with how the FSSD is traditionally applied.

2. Materials and Methods

This research brought together a diverse group of global experts to inform the development of a method for tracking progress toward sustainable food systems, and to support community level planning that is grounded in an operational definition of global sustainability. To collect thoughtful, well-considered responses that weighed various possible perspectives and silenced none, a modified Delphi Inquiry process offered a mechanism for conducting an iterative, anonymous conversation with multiple experts [33,34]. The modified Delphi consisted of three rounds conducted via an online survey, and a final round in a three-day workshop.

To assemble an expert panel, researchers applied mixed purposive sampling methods [35], drawing names through personal contacts, publications, and affiliations with organizations active in the field (e.g.,
NGO’s), and expanding the invitee list by inviting suggestions for other key voices to include. To ensure diversity, the final list of experts was stratified according to geographic region, gender, sector, and field. Of the 83 experts who were invited, 31 experts agreed to participate on the panel. Collectively, panel members represented five continents, three sectors (private, public and not-for-profit), and numerous fields of work including nutrition, human ecology, food security, sustainability science, sustainable development and business. The panel was, however, homogeneous with respect to education; each of the 31 experts had at least post-secondary education. Approval for the project was obtained from Acadia University’s Research Ethics Board prior to contacting participants, and contingent on full and informed consent to participate.

The online survey consisted of three questions: (1) What is your vision of sustainable, secure food systems? (2) How would you describe our current reality? (3) What indicators would you track to measure progress toward the vision you described? The vision of success is an intended target, ideally an inspirational one. It sets up the end-goal vis-à-vis a concrete definition of sustainability and the current reality, to guide what indicators can track progress. That is to say, what to measure is dependent on the end goal, and from where we are starting.

In between survey rounds, researchers created one collated file of the anonymous responses and one composite summary. Both of these files were sent to the expert panel for consideration prior to the subsequent round, as per Delphi protocols, to apprise all members of the collective responses prior to considering the same questions again in consecutive rounds. In the third round of online survey the questions were modified to request that the participants focus on the local, or community context from which they came. Of the 31 people who agreed to participate on the expert panel, 21 responded to the first and second online Delphi round, and 17 responded to the third round. Drop-off in responses was expected, due to
respondent fatigue and inability to meet the rapid Delphi schedule (responses were requested within two weeks of the survey being sent). The online survey system encoded responses separately from contact information to protect anonymity.

Between each round, the researchers analyzed questions one and two. Responses were coded using a priori categories that combined the 5LM, with the eight sustainability principles in a matrix. This process allowed us to: (1) isolate constructs related to the vision of success as distinguished from suggested actions or tools for achieving that success (e.g., waste management, or Life Cycle Analysis, respectively); and (2) examine the extent to which the constructs proposed for the collective vision of success reflected a future that could exist without violating the sustainability principles, and thus were comprehensive from a sustainability perspective. During the iterative process, researchers structured the composite summary according to concepts proposed across the principles. Where possible, participant language was used to capture the data such that participants would see their own ideas reflected. Indicators from each round were also included in each composite summary. Duplicates were removed, and the entire list was circulated for consideration.

The face-to-face workshop brought together 14 participants. An external facilitator and graphic harvester led the workshop over three days. The purpose of the workshop was also to build and solidify relationships with an interdisciplinary team of practitioners and researchers. Thus, participants were invited to consider the workshop as a transition from research participant to participating researchers with equal voice in the shaping of the results and next steps. To facilitate this transition, develop relationships and maximise idea-sharing, the workshop included interactive, small and large group facilitation.
To provide context, researchers introduced the expert panel to the FSSD as a framing concept guiding our research, and gave opportunity to discuss it. However, to maximise genuine participation, participants were not required to apply it during the workshop. Rather, the FSSD continued to provide a mental model for researchers for in situ and post-workshop data analysis.

During the workshop, participants focused on four primary activities. First, the group was tasked with assessing the vision of success for sustainable food systems that emerged from the online Delphi process and developing a final version that they could all agree on. Second, participants reviewed the indicator list from round three alongside other indicators from the literature (included in the workshop by the research team so that potentially important indicators were not overlooked), and categorised indicators into three categories: unanimous agreement, mixed agreement, and discard. The goal of this exercise was to compile a final, comprehensive list of indicators that are important to encompass the full breadth of sustainability. Third, participants reviewed possible designs for framing the indicators. Finally, participants discussed possible methods and criteria for the validation process and future use of the indicators and indicator framework. Full methods of the face-to-face workshop are captured in more detail in the workshop report [36]. The following section captures the broader results of the research.

3. Results

There were four distinct outcomes from this project, summarised here and then expanded in the following sub-sections. First, a vision of success for sustainable food systems and a description of the current reality. This provides context for understanding the extent and nature of the gap between where we are now and where we aim to be. Second, the work resulted in indicator themes organised in a framework with two axes (see
Figure 1) that categorise the indicators according to thematic categories, and geographic focus. Third, the research process, in particular the interactive nature of the workshop, facilitated rich conversations within a community of researchers and practitioners with remarkable breadth and depth of knowledge, due to their diverse geographic and vocational backgrounds, as well as research and lived experience. This allowed for critical conversations about definitions and measurement that added a fourth research question: “What process would facilitate cross sectoral discussions for development of community level visions, plans, and indicators to track the progress?” A suggested process was the fourth outcome of this study, and described after presentation of the first three outcomes.

Figure 1. Indicator Themes for Measuring Sustainable Food Systems
The global and national level indicator themes are relatively stable, while the local level ones are flexible; indicators within themes will vary
according to context, the themes and indicators at a community level should be determined by the community.

3.1. Vision of Success

In an effort to produce a simple, clear vision that is memorable, workshop participants condensed the vision from the third round of online surveys. The final wording is captured in Box 2. It was the intention of the expert panel to use the term “nourish” in its broadest sense, including nutritional nourishment as well as social and spiritual nourishment. These statements capture the values espoused by the expert panel that are integral to sustainable food systems. They are articulated in the active, present voice, to emphasise that this vision represents a desired reality.

Box 2. A vision for sustainable food systems

| Sustainable food systems nourish communities in culturally appropriate ways. |
| To achieve this, water, nutrient and energy cycles sustain and enhance ecosystems, people and communities. Sustainable and secure food systems are compatible with the productive capacity of the ecosystems upon which they depend. Good governance of this system is a responsibility shared by all, and there is respect for diverse ways of knowing and achieving this vision. |

As described in the methods section, the vision is the result of collective work and provides an aspirational goal. It is not a definition, which should provide more operational guidance. The sustainability principles were used during the development phase (research analysis) to avoid conceptual gaps in the vision. One important result of the first research question is that the outcomes of the visioning process elicited responses that reflected a future where all eight sustainability principles are not violated. For example, one participant suggested that “sustainable food system would be orientated toward enhancing the capacity of those who engaged in it to live well.” This was categorised as support of sustainability principle number six; meaning that “people are not systematically hindered from learning and
developing competence individually and together, e.g., by obstacles for education or insufficient possibilities for personal development”. Thus, while the final wording of the vision is significantly condensed to be compelling and memorable, its development was informed by sustainability theory of the FSSD.

3.2. Current Reality
The collective summary of the current state of affairs generally depicts a system of imbalance and inequity, vulnerable to the projected changes in climate, population, and politics. The consensus was that competition, rather than collaboration, dominates our food system, and that a high level of concentration of power and influence has evolved. Such concentration of power and influence risks perpetuating inequality and systematic ecological and socioeconomic challenges. Analysis uncovered specific examples of violations to all eight sustainability principles, underscoring the unsustainability of the system.

Throughout the process there also were several reminders of progressive action within the food system. The consensus highlighted that the food system is dynamic, responding, and adapting as temporal, social, political, and climactic factors fluctuate. Feedback loops inform actors within our system, therefore, providing opportunity for positive, innovative progress (e.g., increasing climate disruptions stimulating productive adaptation strategies in the food sector). Promising practices, structures, and knowledge are being used globally that can support redirection toward the vision of a sustainable food system.

Participants suggested that this juxtaposition between discrete promising practices amidst the unsustainable whole creates public ambiguity in the perceived state of the system. This ambiguity has the potential to splinter public opinion about a sense of urgency, and create grounds for divergent and potentially conflicting pathways forward.
3.3. Indicator Themes and Indicator Framework

The workshop discussion and analysis of indicators garnered little unanimous agreement. In fact, from 90 indicators the group examined, only two were unanimously eliminated, and thirteen were unanimously agreed upon. The remaining indicators had varying levels of agreement. However, thematic analysis of the suggested indicators revealed clear themes in what experts agreed were important constructs to measure. Using these constructs, indicator themes were created that captured more stable sustainability constructs that are central to food system sustainability. Each theme contains one, or more, high-quality indicators that can be chosen for measurement purposes; these indicators will be discussed in a separate paper with a stronger focus on metrics.

Figure 1 presents the indicator themes within the indicator framework. The following sections describe and provide a rationale for the layout of the framework followed by the content, before describing the process for which it is now being tested, and further developed, to guide community level action.

The layout of Figure 1 is informed by two things. The workshop group felt that categorizing indicators according to the eight sustainability principles was unnecessarily fine grained and unwieldy, and would likely stymie efforts to communicate a set of globally and regionally appropriate indicators. We, therefore, created four thematic categories (horizontal axis) that more broadly capture relevant measures for food systems: ecosystem integrity, social system integrity, human health, and food system infrastructure. These reflect the indicators suggested by the expert panel, are informed by sustainability principles, and also acknowledge previous work [9,19,22,23,37,38]. As per our discussion of the role of the economy in FSSD sustainability theory in section 1.2, economic indicators that are useful in tracking food system sustainability are embedded within indicator themes (e.g., inequality, food security, pay equity, food prices). As such,
economic outcomes in this model are indicative means to an end rather than primary outcome goals.

The layout is also designed to facilitate an understanding of indicator interrelationships across thematic categories (horizontal axis) and geospatial scales (vertical axis): global, regional/national, and local levels. This is reflective of a natural separation of the suggested indicators through the data collection process. Further, scale-based categories that acknowledge multiscale influence and impacts will help to capture the complex global-to-local dynamics of the food system. Scale-appropriate indicators are necessary for accurate and appropriate measurement, and to avoid inappropriate decisions being made based on data from an inappropriate scale [24,39]. For example, if a university modifies its procurement strategy to include a certain percentage locally-produced food, then it should be informed by data regarding the availability of adequate local capacity.

The content of Figure 1 is informed by the vision, and the theming of suggested indicators. In the Delphi rounds, experts were asked to describe their vision of a sustainable food system, and name indicators that would be necessary to track progress toward such a vision. As such, the indicator themes that populate the framework developed in alignment with the vision of globally-sustainable food systems (see Box 2). For example, the vision highlighted “water, nutrient and energy cycles [that] sustain and enhance ecosystems” as important, and corresponding indicator themes for ocean integrity, nutrient cycles, and climate change are included (see global level, ecosystem indicators).

For national and global indicators within each theme there was mixed agreement on which specific indicators were most appropriate, but general agreement on the important constructs of sustainable food systems that need to be measured (which is captured by indicator themes in Figure 1).
Indicator themes at the local level are visibly absent. Results from the workshop (also supported in the literature) were unequivocal that global or national aggregate data, even when framed in such an interdisciplinary and comprehensive way, does not capture the intricate, place-based realities that people experience. In considering local level measurement challenges, the dearth of local level indicators available, and disagreement over appropriate indicators, led to consideration as to whether one set of indicators could be applied at local levels given that local contexts vary significantly. More importantly, local community members’ perceptions of the particular context of their community are specific to the community members who live in that space. Therefore, tracking change and development within each community will be more productive if the indicators are perceived as important to them. Local level indicators would need to be created in situ, in collaboration with local food actors, in order to adequately reflect local realities and priorities.

Based on this outcome, participants contributed to developing a process for capturing community-determined visions, plans and indicators to adequately answer research question four. This is well aligned with the ABCD procedure of the FSSD. It is first when there is a (preliminary) vision (A) agreed upon by the actors (e.g., at a local level) that indicators measuring such a vision can be meaningfully discussed and determined. Furthermore, it is first when the current situation is assessed (B), possible actions are explored (C) and a transition plan of prioritised actions for closing the gap (D) is established that indicators matching intermediate (preliminary) goals can be meaningfully discussed and determined. Using a predefined rigid set of indicators is not recommended [32]. For now, the local level indicator themes remain flexible to the locality. However, the above does not exclude utility in a more stable (but not rigid) set of global and national indicator themes (with suggested indicators). We, therefore, developed and screened a set of indicators that actors can choose from so that: (1) various groups of actors do not need to invent all
indicators from scratch each time; (2) the risk of missing indicators that are likely useful and important is reduced; (3) the need for considering interrelations between levels is made clear; and (4) comparison between local communities regarding some indicators is facilitated. Indicator themes are also helpful for informing the development of additional indicators.

3.4. Process
The Delphi Inquiry process used in this research project resulted in open engagement, participation, reflection, positive relationship-building, and generated clear outcomes to the research questions. Furthermore, the online portion of the process supported dialogue where meeting face-to-face was limited by geographic distances, expensive travel, and time constraints. Based on these insights from the method used, along with previous experience with successful application of the FSSD at the community level [32], we propose a second phase of research. Integrating the Delphi Inquiry process into FSSD strategic planning (described in more detail in section 1.2), and using the proposed indicator framework to gather community-specific measures of progress, the purpose of this second phase of research is to validate and refine the indicator framework developed in this research, and refine an approach for community planning and assessment for food system sustainability across scales.

With a focus on geographic communities and “communities of influence” (e.g., professional communities), the next phase of research has, at the time of writing, two case studies underway. In each, a broad array of local food system actors are invited to participate in an iterative conversation through three consecutive rounds of inquiry (using online surveys), where they are anonymous to one another, followed by face-to-face dialogue. Facilitated by the anonymous nature of the first three rounds, participants may honestly express priorities and dissent more so than if the work is done only face-to-face. This process facilitates community members in an
ABCD informed process to (A) create a vision of success framed by sustainability principles, (B) develop a common understanding of the current reality, and in particular describe the barriers and facilitators as they relate to violations of the sustainability principles, (C) create and articulate possible solutions, and (D) prioritise strategic actions, as well as identifying indicators appropriate for tracking local progress toward sustainable food system. Locally-appropriate themes for measurement will be developed in the manner described in section 2, and populate the framework. The more stable national and global level indicator themes will be adjusted if necessary.

Prior to the final face-to-face workshops, researchers will collect data for local level indicators that community members identified as important in previous rounds, and present them according to Figure 1 with corresponding national and global level data. This will be used to stimulate and ground workshop discussions in a way that is reflective of communities’ concerns, informed by data reflecting the current community baseline, and is informed by the broad and strategic perspective on sustainability provided by the FSSD. The intended research outcomes of this second phase of the research will be to identify patterns in the more flexible themes recognised as important to local level visions (and, therefore, indicators), further validate the more stable indicator themes for national and global level assessment, and explore how to best work with communities to determine their own pathways toward sustainable food systems while contributing to national and global food system sustainability.
4. Discussion

With respect to the development of the indicator framework, it is important to reiterate that there was mixed agreement on indicators at all geographic scales. This was a strong indication that, like the challenges and trade-offs to modelling food systems discussed by Prosperi and Allen [20], there is no perfect set of predefined indicators; in particular at the local level. They will need to be developed, refined, and adapted in such a way that they are helpful in managing decision making in complex and changing environments. As in all strategic work, it is essential for actors to preliminarily agree upon what they want to achieve and a plan for how to achieve it via intermediate goals. This provides a foundation for selecting, developing, and combining appropriate tools and other forms of support for the transition work, including indicators.

However, there is utility, given the interconnected nature of food systems, in providing enough structure that measurement at the local level is comparable between localities. Categories of measurement indicators (e.g., ecological integrity, social integrity, human health, food system infrastructure), informed by sustainability science, facilitate development of indicator themes that allow such comparison. There is also utility anchoring, or linking, local realities in common national and global level data. Given that food systems interconnect on multiple scales, from global to local, it is useful to be able to examine or monitor outcomes across scales. For example, it may be useful to compare local malnutrition indicators to their national counterparts to provide broader context and elucidate localised barriers or facilitators to nutrition. It may also be useful to situate a localised challenge (like a drought affecting food availability) in a larger scale so as to examine the capacity of the local food system to adapt or respond, through leveraging regional or national networks [24]. Providing more stable national and global indicator themes (and suggested indicators) could also save time for local actors when they discuss and
establish indicators, and help them avoid the risk of missing indicators that are likely useful and important.

Finally, the suggested process is intended to support communities in speaking for themselves while also supporting them with resources for dialogue and understanding of the broad nature of sustainability. This approach is consistent with the literature on community change and development. Travers [40] suggested that change rooted in power imbalances (such as in sustainable food challenges) requires a participatory perspective. This approach is echoed by community development practitioners [41,42] and by FSSD practitioners [29] who also call for community participation in defining the problem, goal and strategy, leveraging contextually-relevant knowledge and developing ownership over the solution. For example, the vision of success, shaped by the global panel of experts, is a description of a reality that captures important sustainability concepts on a global scale; however it is likely, and desirable, that the vision would be worded differently had other participants been involved. The process of engaging in the visioning process should, according to theory, build ownership of and accountability over a self-defined issue, leverage local knowledge, and help address the difficulty of agreeing on locally-relevant indicators. However, in order to build coordinated, evidence-informed action, results suggest that using the existing principle-based theory of sustainability of the FSSD to define sustainability in the development of a community vision will be helpful. Case study of the suggested process is ongoing and we hope will lead to a more nuanced understanding of how communities can lead change for sustainable food systems that is grounded in a concrete definition of sustainability, and thus helps to coordinate across geographic scales.

4.1. Limitations
The research process that is described here brought together a panel of experts that had diverse geographic, disciplinary, sector, and gender
representation. Still, participants represented predominantly Western nations and a higher socioeconomic status, given the English language, Internet access, and travel requirements for participation in the project. The results and future research plan described in the results and discussion sections might therefore have limitations regarding transferability to other cultural and socioeconomic contexts (e.g., not all community cultures value consensus building). Within future community work, researchers will need to adapt protocols to accommodate diverse realities. In applying the proposed process within communities, vested interests remain. There are many reasons why somebody might not be able to participate in a community-led process (choice, not invited, inadequate time, etc.) and, thus, there remains a question of whose voice is not being heard. The process applied requires skills and resources to facilitate. At present it demands a research team, trained facilitator, and money to bring people together for a face-to-face workshop. As such, application of the process will be uneven. Finally, case studies in diverse contexts are necessary to test, develop and validate this promising approach for maximal effectiveness and efficiency in diverse community contexts.

5. Conclusions

In conclusion, we acknowledge the significant work being done to conceptualise, define and measure sustainable food systems, and build on it by contributing to addressing three central challenges: the need for an operational sustainability definition, tools to translate global level conceptualizations into action at the community level, and the need to accommodate diversity and community determinacy at the same time as concerted progress.

The challenge is to accommodate the diverse needs and priorities of communities in such a way that still builds toward a sustainable global system. The process of coming to agreement across worldviews, cultures,
and fields of expertise is riddled with dissenting views. This diversity can result in entrenched disagreements that inhibit progress, or be leveraged to ensure breadth of representation and to enhance understanding. Strategic leadership that can accommodate the challenges of local diversity, and tap into its strengths, is necessary while guiding us toward a sustainable food future.

Using a modified Delphi Inquiry process in combination with the FSSD, this research resulted in a proposed set of stable indicator themes and indicators at the national and global level, and a suggested process for addressing the need for a flexible set of local level indicator themes and indicators. This method bears promise for future work to address these central challenges. The sustainability principles of the FSSD help define the conditions for sustainability, while allowing room for contextually-relevant visions of successful sustainable food systems that guide localities in contributing to a sustainable whole. The authors propose engaging communities to work with this combined approach and to test the utility of the proposed framework of indicator themes, in diverse local contexts. We suggest that, conducted across many communities, this process has the potential to support community determinacy over food system sustainability, while also supporting national and global system sustainability.

Acknowledgments: This work was supported by the Social Sciences and Humanities Research Council of Canada under Grant (number 761662). Financial support from VINNOVA (Swedish Governmental Agency for Innovation Systems) is also gratefully acknowledged. The authors are grateful to Anne Stieger who was invaluable in preparing indicators, and in helping to design and manage the face to face workshop.

Author Contributions: E.C. and L.C. conceived and designed the research project, carried out data collection and analysis, and led the
writing process; A.M. contributed as one of the participating experts, to
data analysis and writing; and G.B. contributed as an advisor to L.C. in the
research process, and to writing the article.

**Conflicts of Interest**: The authors declare no conflict of interest.
References


10. Burlingame, B.; Dernini, S. Sustainable Diets and Biodiversity: Directions and Solutions for Policy, Research and Action; Nutrition


Paper 3. How Can Dietitians Leverage Change for Sustainable Food Systems in Canada?

Liesel Carlsson, Edith Callaghan, Göran Broman

Paper 3 is published as:
How Can Dietitians Leverage Change for Sustainable Food Systems in Canada?

Abstract
Purpose: In this paper, we begin to set out language defining sustainable food systems (SFS) in Canada, through the voices of dietitians, and identify leverage points where dietitians can affect change. Methods: Dietitians of Canada members were invited to a Delphi Inquiry process; questions explored a vision of SFS in Canada, barriers to that vision, and actions. Results were independently analysed by 2 members of the research team who used the Framework for Strategic Sustainable Development to structure the data. Results: Fifty-eight members participated. The resultant vision describes a future food system in 15 thematic areas of the social and ecological systems. Barriers are described according to how they undermine sustainability. High-leverage actions areas included: (i) facilitating knowledge development within the profession and public, (ii) influencing organizational policy to support SFS, and (iii) and influencing public policy. Approaches to such action included: (i) facilitating cross-sectoral collaboration and (ii) applying reflexive approaches. Conclusions: This research suggests a multidimensional understanding of food systems sustainability among dietitians. The vision provides some language to describe what dietitians mean by SFS and can be used as a compass point to orient action. Action areas and approaches have the potential to drive systemic change while avoiding unintended consequences.
1. Introduction

Contemporary food systems are unsustainable and have avoidable, negative effects on public health [1]. Often referred to as “Wicked Problems” [2, 3], food system challenges resist clear resolution because of inherent socioecological complexity; they require interdisciplinary approaches to problem solving [3, 4]. The dietetic profession has long recognised its role in supporting food system sustainability [5] and is well situated to contribute, given dietitians’ expertise in interdisciplinary and intersectoral settings. Diverse examples of how dietitians translate research and policy into guidance for sustainability exist [6–9]; however, a more concerted and strategic professional contribution is warranted [5–7, 10]. At the time of writing, unpublished strategic work is beginning at the International Association of Dietetics Associations around the role of dietitians in sustainable food systems (SFS). Dietitians of Canada (DC) has begun work to identify a strategic role for the profession and to set an organizational priority of ensuring that Canadian dietitians are prepared to be “key partner[s] in intersectoral dialogue on innovations that support sustainable food systems and promote healthy diets” [11]. To move forward, a clear understanding of SFS and opportunities for action were identified as organizational needs [11]. The specific objectives of this research were to engage Canadian dietitians to:

1. Spark dialogue about SFS to develop a collective vision of success.
2. Identify perceived barriers to SFS in the current Canadian context.
3. Identify and prioritise actions that will facilitate progress toward the vision of success.
4. Identify a process to measure progress toward the vision.

In this paper, we begin to set out common language defining SFS in Canada through the voices of dietitians and identify places in the systems to most effectively intervene. Results related to the fourth objective,
measuring progress, will not be reported in this paper, but will be the subject of a future publication.

The importance of a clear and shared understanding of SFS cannot be understated. While progress has been made toward conceptualizing the multidimensional nature of food system sustainability [4, 12–17], there are no agreed-upon criteria and the emerging picture rests on abstract definitions of sustainability. This undermines concrete action. Therefore, in our data analysis we used the sustainability principles (SPs) of the Framework for Strategic Sustainable Development (FSSD) [18] as an operational definition of ecological and social sustainability. We also used the Five Level Model (FLM) of the FSSD, which aids in structuring data of different character and understanding of their relationships. The FLM can be used to separate, for example, information about what is sustainable from what programs and policies could help us move toward a more sustainable system.

Table 1. A Principled Definition of Sustainability, Articulated as Eight Sustainability Principles (SP) (18)

<table>
<thead>
<tr>
<th>SP</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP1</td>
<td>Concentrations of substances extracted from the Earth’s crust (e.g., fossil carbon)</td>
</tr>
<tr>
<td>SP2</td>
<td>Concentrations of substances produced by society (e.g., pesticides)</td>
</tr>
<tr>
<td>SP3</td>
<td>Degradation by physical means (e.g., over-harvesting fish)</td>
</tr>
<tr>
<td>SP4</td>
<td>Health (e.g., by dangerous working conditions)</td>
</tr>
<tr>
<td>SP5</td>
<td>Influence (e.g., by suppression of free speech)</td>
</tr>
<tr>
<td>SP6</td>
<td>Competence (e.g., by obstacles to education)</td>
</tr>
<tr>
<td>SP7</td>
<td>Impartiality (e.g., by discrimination)</td>
</tr>
<tr>
<td>SP8</td>
<td>Meaning-making (e.g., by suppression of cultural expression)</td>
</tr>
</tbody>
</table>
2. Methods

2.1. Design and data collection
Grounded in qualitative research methods developed for community planning and assessment for SFS [19], this project engaged dietitians in a Delphi Inquiry process [20, 21]. This method invites participation as an expert (in this case a professional expert) in an iterative dialogue that strives to generate a greater understanding of perspectives (both convergent and divergent) among the collective and to move toward consensus. Purposive and snowball sampling methods were used to recruit DC members who are Registered Dietitians via the organization’s newsletter, internal network communication channels, and direct email invitations to personal networks. A total of 4885 dietitians received the invite to participate, some via multiple routes. No respondents were excluded. One author (LC) is a member of DC and the Sustainable Food Systems Leadership Team, and this research was done in part to support the purpose of this team [22]. Ethics approval for this research was granted by Acadia University Research Ethics Board.

The Delphi process, facilitated by online survey software, Lime Surveys, included 3 iterative rounds of questions: 1. Please describe your vision of a sustainable food system in Canada. 2. What current barriers exist for your vision of a sustainable food system in Canada? 3. What actions would be most effective in achieving this vision?

Between each round, a composite summary of responses was returned to participants via email. This represented the research team’s interpretation of the collective responses. In the second and third rounds, participants were asked to reflect on the composite prior to reconsidering the same questions, adding new ideas, reinforcing ideas they felt were important, and expressing dissent. Each round also contained an open comment and question field. Anonymous and confidential handling of all data was
intended to encourage honest contributions to the dialogue. A fourth round was held face-to-face, using a mixture of facilitated plenary and small group discussions as well as idea gathering via carousel-style harvesting. These techniques were used to maximise participation. In such a way, participants could work through challenging issues in free-flowing conversation, solidify the vision of SFS, and prioritise actions for change. Participation in the workshop could not be anonymous, and participants were encouraged to consider this prior to disclosing previous contributions and choosing information to share at the workshop.

2.2. Data Analysis
Responses to all questions were analysed independently by 2 members of the research team using the FLM and the SPs of the FSSD [18] to guide a priori coding. The FLM aids in structuring data of different character and includes the levels: system, success, strategic guidelines, actions, and tools. The SPs belong to the success level and are used to frame visions, to ensure they are sustainable (Table 1).

Responses to question 1 (vision of SFS in Canada) were analysed against both the FLM and the SPs as per previously justified methods [19]. The FLM allowed us to isolate vision responses (success level) from responses representing possible routes or supports (actions or tools levels). For example, school gardening is one possible action in a food system contributing to the vision of a food secure community [23, 24]. The SPs were used to examine the emerging themes in the vision statement against a concrete definition of sustainability, allowing us to determine vision scope. From the responses, a composite vision was created. Where possible, participant language was used. All ideas, including outliers, were incorporated in the composite.

Responses regarding question 2 (barriers) were analysed against the SPs to understand how the identified barriers to the vision obstruct progress.
toward SFS. Suggested actions were prioritised according to where participants felt the profession has “upstream” leverage, the theoretical depth of leverage [25, 26], and whether they were oriented toward individual- or organizational level (such as DC) actions.

3. Results

Participants Round 1 included 58 participants that self-selected for their interest and knowledge in their field, of which 40 participated in round 2, and 28 in round 3. Ten participants of the Delphi attended the face-to-face workshop. Some bursary support was available, but the associated time and cost limited travel to the workshop by participants spread over the nation. This participation rate across rounds reflects that of previous experience with this method [19]. These 10 participants were joined by an additional 5 members of the DC Sustainable Food Systems Leadership Team. Participants represented each of the Canadian Provinces; however, no invitees from the Yukon, Northwest Territories, or Nunavut chose to participate.

3.1. Vision of Sustainable Food Systems in Canada
Participants defined a purpose statement in which to anchor the vision: the purpose of (human) food systems is to provide nutritious, safe, and high-quality food and water that supports human health and welfare. The vision, presented in Table 2, represents participating dietitians’ collective vision of SFS in Canada. This vision is not a definition per se, it describes a future food system state where current (key) barriers to SFS have been replaced by structures supporting sustainable conditions and provides a compelling vision to guide action. From this vision, themes were distilled and are listed in Figure 1. These themes represent an expression of a multidimensional understanding of what influences food system sustainability. There was dissent about the degree to which “locally sourced” foods were desirable, but the overall dialogue leaned toward sovereignty, or adequate power on
the part of Canadians (especially producers) to influence their food system, as well as a sense of security that we can meet our food needs from Canadian production (even if we do trade). They are here bounded by the SPs to indicate that activities within all themes must together comply with the SPs for the vision(s) to be sustainable.

Table 2. A Vision of Sustainable Food Systems Described by Canadian Dietitians

<table>
<thead>
<tr>
<th>Sustainable food systems (SFS) in Canada steward and enhance ecosystems, and respect the needs of other species in those ecosystems. They prioritize biodiversity, fertile soils, clean water, and clean air by using resources at a rate they can sustain, within and outside national borders, and through responsible use of materials and energy along the entire the supply chain. They strive to be “closed loop” in terms of materials and energy flows.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFSs are sovereign and self-sufficient while supporting other countries’ food sovereignty. A collaborative network of food system actors (producers, processors, retailers, consumers, etc.) share decision-making power, resources, and returns equitably. These networks support viable, intergenerational livelihoods, and genuine consumer choice.</td>
</tr>
<tr>
<td>They support food literacy. The systems are transparent (e.g., food labelling, industry activities, etc.), traceable and trustworthy. Canadians have the capacity to produce, access, and prepare food, reflect and act on the socioecological implications of their food choices.</td>
</tr>
<tr>
<td>They support equitable and just access to food for all Canadians in a manner that is empowering, inclusive, dignifying and respectful. Healthful foods are affordable and available for all Canadians, including marginalized and remote communities, in particular Indigenous and Northern communities.</td>
</tr>
<tr>
<td>They support a healthy relationship with food, such that Canadians value food, its origin and quality, and express identity and culture through foods. All of these core values are reflected in institutional settings (schools, workplaces) and Canadian food policy. The governance of sustainable Canadian food systems involves multiple stakeholders in a reflexive process that honours traditional and expert knowledge, to continually support dynamic change in our system. Governance applies a precautionary principle to decision making at all levels, in order to achieve the above vision.</td>
</tr>
<tr>
<td>Responsibility in the system, including the ecosystems on which it depends, is also shared by stakeholders, and this responsibility is enforced. All of the above is captured in a comprehensive Canadian Food Policy, and Canadian dietitians take an active leadership role in food system advocacy, education and governance, guided by current evidence on food in a sustainable society.</td>
</tr>
</tbody>
</table>
3.2. Barriers to the Vision
Respondents identified perceived barriers or obstacles to their identified vision of success; these are described below according to how they undermine sustainability (see also Table 3).

Participants presented strong concern over harmful effects of food systems on ecosystems. Examples of key upstream barriers to protecting ecosystems from harm include: a lack of policy and legal frameworks that are based in a precautionary approach with respect to natural resource management (SP3), high-volume use of chemicals foreign to nature (SP2), infrastructure reliant on non-renewable energy sources (SP1), and cultural expectations with respect to the variety and availability of products in the supply chain that drive extensive use of fossil fuels (SP1).
Further, there was concern among participants about the ways that current food systems in Canada challenge social sustainability. Examples of social structures that systematically obstruct health (SP4) include a lack of mechanisms regulating the healthfulness of food environments, the varied and sometimes body weight based, ideological use of the term “health”, and related de-prioritization of food.

Results illustrated a perceived imbalance of power in food systems (SP5) that affects whose voice is heard, how information flows, which food products dominate the food environment, and available food choices. For example, participants felt that industry has significantly more influence over policy makers and consumers than do health or environmental organizations.

There was also a perceived proliferation of competing health and “eco” messaging that create noise and confusion but lack evidence. This is exacerbated by insufficiently transparent food labelling laws, which do not require SFS-relevant information (e.g., ingredient traceability and regulating terms such as “free range”). Food literacy is a critical aspect of SFS, dependent on eaters who can navigate complex, daily decision-making with competence. Examples of key obstacles to such competence (SP6) include insufficient education to allow for effective navigation of the food system (e.g., reading food labels).

Structures that systematically fuel inequalities are barriers to a sustainable society as they result in partial treatment of individuals and groups (SP7). From the results, examples of this included weak governance structures that inequitably distribute wealth and influence, such as an inadequate minimum income, and economic structures favouring increasingly intensified food production.
Food is a source of individual and collective meaning making through expression of identity and culture. Examples of key upstream barriers to meaning making (SP8) included regulations requiring federally inspected meat in schools, which impacts communities’ ability to purchase local or traditional foods that have meaning.

3.3. Actions Leading Toward the Vision
This section is organised by types of activities dietitians might do, and how. Action areas fell into 3 categories: knowledge development, organizational change, and public policy and 2 action approaches: collaborative and reflexive approaches.

Participants highlighted a need for strengthening SFS literacy through dietetic education and professional development opportunities. Ensuring professional competence underlies successful implementation of all other actions. It is also critical to developing tools for effective public education. Many Canadian dietitians work in and with organizations that can affect infrastructure change (e.g., through local food purchasing and renewable energy policies). Engaging in institutional level policy revisions using a SFS lens is one high leverage opportunity. Furthermore, dietitians can, and do, advocate for shaping and regulating the food environment. Results stressed the importance that health, social, economic, and ecological outcomes carry equal weight in advocacy messages and, ultimately, in the way our food system is regulated.

To address these action areas, 2 central qualities emerged. First, creating strong partnerships and networks across sectors, disciplines, and departments was identified as critical to this interdisciplinary challenge. The second was applying reflexivity. For example, examining preconceptions, views, and values about what is meant by topics such as health and seeking to understand the views of colleagues, both within and beyond the dietetic profession, who are resistant to changes. The values
position reflected in this research are captured well by the assertion that “…health, social, economic and ecological outcomes carry equal weight…” (Action list, Table 3). In summary, dietitians identified a number of potential action areas for upstream leverage points to SFS as well as barriers that block actions.
<table>
<thead>
<tr>
<th>Barriers</th>
<th>Sustainability Violations</th>
<th>Actions</th>
<th>Collective or Individual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action Area: Facilitating SFS knowledge development</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competing food-health-sustainability messages that lack evidence</td>
<td>SP5</td>
<td>Develop common language and shared understanding of SFS within the profession</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Identify and dispel common myths about SFS</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Develop a “case” for sustainability using both dietetic and publicly accessible language</td>
<td></td>
</tr>
<tr>
<td>Inadequate opportunities for developing understanding of the interactions between food, people and the environment</td>
<td>SP6</td>
<td>Educate for SFS literacy in public schools &amp; community</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Advocate for curricular integration of SFS</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Include SFS literacy in dietetic education</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Advocate for curricular integration</td>
<td></td>
</tr>
<tr>
<td>Cultural expectations of, and stable access to, a variety of imported foods year-round</td>
<td>SP1</td>
<td>Educate about satisfying food and nutritional needs in a way that is less reliant on energy and transport intensive practices</td>
<td></td>
</tr>
<tr>
<td>Cultural de-prioritization of food</td>
<td>SP4</td>
<td>Advocate and educate for prioritizing cultural food (e.g., creating time for meals in homes and institutional settings)</td>
<td></td>
</tr>
<tr>
<td>Action Area: Influencing organizational policy to support SFS infrastructure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food system infrastructure powered by non-renewable energy</td>
<td>SP1</td>
<td>Develop sustainable standards policies for use within the workplace (organization)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Advocate for structures which also support small to medium scale players in the food system</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Support smaller scale food initiatives and structures (e.g., CSAs, farmer’s markets, food policy councils etc.)</td>
<td></td>
</tr>
<tr>
<td>Economic structures that favour intensified food production systems</td>
<td>SP7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barriers</td>
<td>Sustainability Violations</td>
<td>Actions</td>
<td>Collective or Individual</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>---------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Increasing urban sprawl on fertile land</td>
<td>SP3</td>
<td>Coordinate with other sectors on access to and preservation of arable land</td>
<td></td>
</tr>
<tr>
<td>Action Area: Influencing public policy and legislation for SFS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absence of comprehensive national food policy that sets a course for SFS</td>
<td>All SPs</td>
<td>Advocate for Canadian food policy where health, social, ecological, and economic outcomes carry equal weight</td>
<td></td>
</tr>
<tr>
<td>Absence of legal mechanisms that protect SFS</td>
<td>All SPs</td>
<td>Advocate for legal mechanisms bound to a precautionary approach</td>
<td></td>
</tr>
<tr>
<td>Inadequate regulation of “healthfulness” in food environment</td>
<td>SP4</td>
<td>Advocate for monitoring and reporting systems for a healthy food environment (e.g., as done for food safety)</td>
<td></td>
</tr>
<tr>
<td>Inadequate regulation on food marketing</td>
<td>SP5</td>
<td>Advocate for the prohibition on marketing unhealthy foods, especially to children, via all media</td>
<td></td>
</tr>
<tr>
<td>Inadequately transparent food labelling laws</td>
<td>SP6</td>
<td>Advocate for the inclusion of sustainability information on food labels (e.g., expanding and using protected terms such as “free range”)</td>
<td></td>
</tr>
<tr>
<td>Lack of adequate minimum income for all</td>
<td>SP7</td>
<td>Advocate for policies which systematically dismantle income inequalities</td>
<td></td>
</tr>
<tr>
<td>Regulations that impact communities’ ability to procure meaningful foods</td>
<td>SP8</td>
<td>Advocate for reconsideration of the requirement for federally inspected meat in institutions, like schools</td>
<td></td>
</tr>
<tr>
<td>Action Approach: Facilitating cross-sectoral partnerships and collaboration for SFS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barriers</td>
<td>Sustainability Violations$^{(18)}$</td>
<td>Actions</td>
<td>Collective or Individual</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Absence of comprehensive national food policy that sets a course for SFS</td>
<td>All SPs</td>
<td>Advocate for and participate in cross-sector collaboration in the development of Canadian Food Policy</td>
<td>♕ ♕</td>
</tr>
<tr>
<td>Competing food-health-sustainability messages that lack evidence</td>
<td>SP5</td>
<td>Share tools, resources and research with colleagues</td>
<td>♕</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contribute nutrition expertise to research on SFS</td>
<td>♕</td>
</tr>
</tbody>
</table>

Action Approach: Applying reflexive approaches

| “Healthism” | SP4 | Reflect on own, and other sectors’ assumptions about what health means | ♕ |
| Regulations that impact communities’ ability to procure meaningful foods | SP8 | Seek to understand diverse worldviews | ♕ |

Note: Actions (column 3) are grouped according to action area or approach, which barriers they address (column 1), and to which SP(s) the barriers primarily relate (column 2). It is common that each action contributes to addressing more than one barrier and relates to more than one SP. One primary barrier and SP are indicated for brevity. The content includes a mixture of verbatim and paraphrased data (where several similar ideas were collapsed). Column 4 (far right) identifies whether actions are strategic to the individual (e.g., a dietitian) or the organization (e.g., DC), although some overlap might occur given the diverse roles dietitians play. SFS, sustainable food systems; SP, sustainability principle; CSA, Community Supported Agriculture.
4. Discussion

Among participating dietitians, there is a collectively rich and multidimensional understanding of the factors influencing SFS and potential solutions (see Figure 1 and Table 3). A multidimensional approach, which is defined by a set of relevant themes [4, 12] is emerging as a useful way to provide more specific guidance for action than what can be derived from broad definitions such as the widely accepted definition of SFS used by the Food and Agriculture Organization (FAO): “A sustainable food system is a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised” [27]. Multidimensional approaches support decision-makers to unpack broad concepts such as “social sustainability” into requisite components for action (e.g., health, food sovereignty, food justice, etc.). By engaging the end-user community in defining their vision, it is possible to unpack the relevant components for action. Utilizing the operational definition of sustainability provided by the FSSD [18] promotes visions that are sustainable and guide innovation of actions (see Figure 1).

We discuss the proposed action areas and approaches to better understand their potential strength, as the efficacy of some proposed actions have greater evidential support than others. The indications for individual and collective action (Table 3) highlight ways individual dietitians can support SFS. While we are not proposing that responsibility for SFS rests with the individual, individual action can make a significant contribution to sustainability outcomes [28] as they are often more immediately implementable than collective actions.

Facilitating public SFS competence through multidimensional food literacy [29] efforts is one promising leverage point [30, 31] (Table 3,
Facilitating SFS knowledge development). Knowledge alone is rarely sufficient to illicit behavioural change, but it is one important component. Adequate professional development and training opportunities for dietitians is a logical first step, and new research is exploring the opportunities and challenges to practical training for sustainable food systems in Canada [32, 33]. The development of a common language around SFS is also an important early step that this research begins to address.

Related to professional development, the need to be clear and reflective about underlying values and assumptions also surfaced in the results; it is captured well in the contrasting views on “healthful” and “healthism” (Table 3, Applying reflexive approaches). While some participants indicated that obstacles to health (e.g., “Inadequate regulation of ‘healthfulness’ in food environment”) obstructed progress toward the vision by systematically undermining genuine consumer choice for healthful foods, others cautioned that ideological standpoints on health can themselves be systematically damaging to society (e.g., extensive literature on negative health and social outcomes caused by weight-based discrimination [34]). Consideration of underlying values and assumptions within reflective and critical dialogue is a critical step in negotiating action for SFS. The need for ongoing reflexivity about which values underpin such SFS-related learning, discourse, and action is consistent with other research [35–37], and reflexive approaches may support learning and organizational change (e.g., DC) on a deeper level [38].

There is some evidence to support the efficacy of suggested actions related to organizational policy (Table 3, Influencing organizational policy to support SFS infrastructure). At public institutions, like schools and hospitals, it has been suggested that the economic scale is adequate to drive shifts in a sustainable direction [39]. Suggested actions related to institutional procurement show promise to drive social food norms [30]
and meaningful change toward more equitable inclusion of small-to-medium scale food businesses. Dietitians have been actively supporting [40], and are well situated to, initiate meaningful organizational change [41].

Further, public policies and governance structures related to food that are based on multidimensional understandings of SFS are advocated for [4]; however, little uptake at the national governance level limits empirical evidence. Two public policy areas are emerging: dietary guidelines (e.g., Canada’s Food Guide to Healthy Eating) that combine recommendations on sustainable and healthy eating patterns show promise [30, 42], whereas for food labelling (e.g., front-of-package) the evidence is unclear [30, 31]. Again, consumer knowledge alone is rarely enough to illicit behavioural change, but policies, such as those proposed in Table 3 (Influencing public policy and legislation for SFS) have potential to create a supportive food environment from which (food literate) consumers can make sustainable choices. The government of Canada opened up several food policy related consultations (e.g., dietary guidance) in 2016 for public and multisectoral association input; DC [43] and many individual dietitians participated in this process.

Given the “Wicked” nature of food system sustainability challenges that span geographic scales and food system sectors, an interdisciplinary and intersectoral collaborative approach has logic for action at an institutional and public policy level (Table 3, Facilitating cross-sectoral partnerships and collaboration for SFS). In part because such an approach would help foresee unintended consequences of changes to dietary patterns, such as simultaneously lowering greenhouse gas emissions and nutritional quality of the diet through for example, inappropriate substitution of animal-based proteins with plant-based foods that do not provide adequate nutrients [30] such as protein, iron, zinc, etc. Such unintended consequences are certain and partly responsible for the wicked nature of the problem. Many
dietitians work in interdisciplinary teams, and this presents an opportunity to invite colleagues to work together on food system sustainability through knowledge and tool sharing and collaborative advocacy efforts on issues of common concern.

The conclusions drawn are limited by reach: the lack of voice from Canadian dietitians who are not members of DC and/or are from the Yukon, Northwest Territories, and Nunavut limits the transferability of the research to a full Canadian context. Furthermore, the principles of Truth and Reconciliation would support a more specific inclusion of Aboriginal knowledge systems [44] into our efforts to understand and act on Canadian food system sustainability challenges, which have unique and significant relevance to cultural food security [45]. Further, demographic data were not collected, and this limits the ability of the researchers to assess the degree to which the results and conclusions are likely to reflect the perspectives and experiences of the broader population.

5. Relevance to Practice

In conclusion, the dialogue in this research captures a rich and multidimensional understanding of the issue of food system sustainability. Articulated as a vision, this provides language to describe what dietitians mean by SFS and can be used as a compass point to which dietitians can orient action. The results also identify leverage points where dietitians, as individuals and as a profession, can leverage system change for sustainability by: (i) facilitating knowledge development, (ii) influencing organizational policy to support SFS infrastructure, and (iii) influencing public policy and legislation. The research findings have the potential to drive deeply systemic change that address unsustainable food systems while avoiding unintended consequences. Leadership in this area of practice will require continual reflection on underlying values and assumptions, overarching goals, as well as actions that shape the route
taken. The findings are directly relevant to the DC Sustainable Food Systems Leadership Team, contributing a membership voice to what matters and how to approach integrating food system sustainability into professional practice.

Important next steps in this research include following up on measurement tools to track progress towards this vision, understanding northern- and Aboriginal-specific approaches not explicitly captured in this research, conducting studies across international borders on parallel strategic work, understanding how practicing dietitians utilise this current work to guide action, and mapping what tools and resources are needed to support dietitians to carry out this work.

**Sources of financial support:** The authors gratefully acknowledge financial support from VINNOVA (Swedish Governmental Agency for Innovation Systems) and the Acadia University Research Fund.

**Conflict of interest:** The authors declare that they have no competing interests.
References


26. Meadows D. Leverage points: places to intervene in a system. The Sustainability Institute, Burlington, VT; 1999.


28. Wynes S, Nicholas KA. The climate mitigation gap: education and government recommendations miss the most effective individual


36. Garnett T. Three perspectives on sustainable food security: efficiency, demand restraint, food system transformation. What role for life cycle


Paper 4. Assessing Community Contributions to Sustainable Food Systems

Liesel Carlsson, Edith Callaghan, Göran Broman

Paper 4 is submitted for publication as:
Assessing Community Contributions to Sustainable Food Systems

Abstract

**Background**: Evidence suggests that adjustments in food systems and human diets can make positive contributions to globally sustainable food systems (SFS). Assessing such contributions, especially at the community level, has two central challenges: 1) a lack of methods and tools that support alignment between communities and across scales, balanced against the need to involve the community in developing relevant indicators; and 2) the absence of adequate, fine grained data relevant to the community. **Purpose**: Addressing these two challenges, this paper builds on a local-to-global approach to engaging communities in SFS development, previously published, and illustrates using a community case study with Canadian dietitians. **Methods**: Researchers used the Delphi Inquiry method, guided by the Framework for Strategic Sustainable Development, to address the first challenge, together with causal loop diagrams informed by the Cultural Adaptation Template to address the second. **Results**: Process and outcome indicators were developed for dietitian-identified contributions to SFS. Modeling their interactions showed how some actions are already reinforcing a supportive paradigm in the profession, and priority areas for action and measurement. **Conclusions**: The methods used were a good fit for addressing the two central challenges guiding this work. As such, a procedural guideline is proposed. Further, results highlighted that dietitians have a strategic role in SFS development. Cultural paradigms are a driving force of change. Facilitating SFS literacy within the RD profession is a strategic first move as it generates positive feedback loops that can amplify adaptations for, and positive contributions to, broader SFS development.

**Keywords**: Sustainable Food Systems; Sustainable Diets; Dietitians; Indicators; Assessment; Community;
1. Introduction

Food systems are major contributors to unsustainable conditions in our ecological (1–4) and social (5) systems. Progress has been made in developing comprehensive sustainable food systems (SFS) assessment tools that can guide action and track progress at global and national levels (6–10). However, at a community level, progress in this regard has been much slower.

Being able to assess how community level actions and policies contribute to SFS development is important for community level engagement in SFS development (11). A community can be defined by its geographic scope (e.g., a city), as well as by sociological orientation such as cultural identity, common purpose or experience, etc. Examples of assessment tools (12) that have been used to inform policy related SFS measurement in city regions (13,14), and sustainability performance of food value chains (15,16), provide insight that informs potential indicators for use at the community level. However, community level assessment faces two central challenges.

The first is a lack of tools or methods that support synergistic progress among communities, and across scales with broader global goals. Synergetic progress is complicated by a well-recognised need for community involvement in the process of indicator development. Community involvement enhances the likelihood that assessment methods and tools will foster engagement, reflection and learning among participants, and thus encourage continual adjustment within the dynamic system (11,17,18,18,19).

The second is the relative lack of consistent, high quality, and reliable data at the community level—a phenomenon not unique to food systems assessment (19). The data needs are high, given the multidimensional and
multiscale nature of food systems and sustainability. Previous work (20) by this author team proposed a framework to organise indicators that help address the first challenge; however, in practice, the process of identifying relevant indicators created enormous and shifting demands for data that were often not available at the community level. Data collection requires expensive and time consuming methods, and is often not feasible for communities to engage with, or continue over time (19).

To address these challenges, the purpose of this paper is to build on a previously published local-to-global approach to engaging communities in SFS development by adding further methodological support, describing a concrete procedure for the application of the combined methods, and illustrating the procedure by a community case study with Canadian registered dietitians (RDs).

The community of RDs was deliberately chosen given their diverse roles throughout food systems. A promising body of evidence points to the potential for shifts in dietary choices (1,3,21–23) and food policies (24–26) to contribute to solutions for a sustainable food future (4,24,25). Some shifts, such as a move toward plant-based diets, are gaining attention for their co-benefits to human health and ecosystem sustainability (27,28). Further, the choices people make around what foods to eat are influenced strongly by social and cultural factors (29), and cultural and social norms shift over time in relation to local and global contexts. As part of this developing evidence, RDs are exploring ways to use their expertise to facilitate diet-related behaviour change, as well as the development of social and cultural norms that support sustainable dietary choices and food systems.
2. Methods

To address the challenges identified in the introduction, researchers used the Delphi Inquiry method (30), guided by theoretical and methodological supports from the Framework for Strategic Sustainable Development (FSSD) (31). This method has been used to support community involvement in determining relevant indicators for SFS (20), to define sustainability using objective parametres (31) that facilitate alignment between communities and across scales, and in articulating in what way communities contribute to sustainability (32). Causal loop diagrams (CLDs) informed by the theoretical and methodological supports from the Cultural Adaptation Template (CAT) (33) were chosen as a promising additional method to make inferences without access to all desired data (34), to hypothesise the dynamic relationships between variables (35) (expressed as indicators), and to highlight the important role of sociocultural norms (paradigms) (33) in community level SFS development.

The methods and theoretical frameworks that guide this research are summarized in Table 1 as they relate to their role in addressing the research challenges. The specific sequence of steps, or procedure used to apply the methods and tools, is detailed in Appendix A.
Table 1. Summary of Methods Used to Address the Assessment Challenges

<table>
<thead>
<tr>
<th>Assessment Challenge addressed in this article</th>
<th>Method/Tool Used</th>
<th>Theoretical Framework</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing methods and tools that support synergistic SFS progress between communities and across scales, while involving community in developing indicators relevant to the community.</td>
<td>Delphi Inquiry Method</td>
<td>Framework for Strategic Sustainable Development</td>
<td>Increased community involvement in indicator development. Providing objective parameters of sustainability to guide alignment between communities and across scales. Articulating in what way communities contribute to sustainability.</td>
</tr>
<tr>
<td>Accommodating the absence of (especially) community level data.</td>
<td>Causal Loop Diagrams</td>
<td>Framework for Strategic Sustainable Development Cultural Adaptation Template</td>
<td>Avoiding unknown (lack of data) problems by upstream definition of sustainability. Hypothesize dynamic indicator relationships between and across scales. Make inferences without access to all desired data. Make inferences about the influence of sociocultural norms.</td>
</tr>
</tbody>
</table>

2.1. Delphi Inquiry Method
Researchers engaged Canadian dietitians in a Delphi Inquiry process (32,36) in three iterative, online rounds of questions that asked participants to describe: (1) their vision of a sustainable food system in Canada, (2) current barriers to the vision, (3) what actions would be most effective in achieving the vision, and (4) what indicators are necessary to assess progress toward the vision. These questions were informed by a procedure for Backcasting from Sustainability Principles (SPs) (31). The details of
the theoretical and methodological supports from the FSSD are described in the next section.

Using *a priori* coding informed by the Five Level Model (5LM) and the Sustainability Principles (SPs) of the FSSD, the research team analysed and organised the data into a composite summary of responses for participants to consider in advance of answering the same questions again in subsequent rounds. The 5LM was used to separate and structure different data types (e.g., possible actions vs. visionary concepts). The SPs were used concurrently to organise and evaluate comprehensiveness of the emerging vision with respect to sustainability. In the second and third rounds, participants were invited to amplify ideas, express any disagreements, or ask for clarifications regarding information in the summary. This process was iterative, with cycles of data collection and analysis. Using qualitative, open coding and theming, the research team analysed the results of all three rounds of question one to create a multidimensional list of themes capturing their vision of SFS. A fourth and concluding round of the Delphi Inquiry process, a face-to-face workshop, allowed participants to finalise discussions from the online results.

Following the workshop, the research team produced a final report to the community which was formatted for use as a roadmap (36) and to inform other strategic work (37–39). The research team also published an article (32), in a journal targeted to this community audience, which examined and related the vision themes against the results from questions two and three. Responses to question two uncovered existing structures in the socioecological system, encountered by professional RDs that are barriers to the vision themes. The SPs were used to understand and articulate whether, and in what way, barriers drive SPs violations and thus contribute to unsustainable conditions (for further detail on this analysis, see (32)). Responses to question three highlighted actions for addressing each barrier. In the Results section, an example of the relationships between
vision theme, barriers, SPs, and actions is shown in Table 3. The methods and results of questions one through three previously published (32) will be included in this paper in only enough detail to provide context for the assessment procedure. This paper builds on a subset of the results mentioned above, as well as unpublished data from question four.

2.2. Framework for Strategic Sustainable Development
The FSSD provides a definition of sustainability, comprising eight SPs (Table 2). To be sustainable, food systems must not contribute to violations of the SPs. Therefore, all of the themes capturing the vision of success were bounded by the condition that they cannot contribute to violations of the SPs, e.g., cannot be underpinned by systematically degrading nature by physical means (SP3) or systematically exposing people to partial treatment (SP7).

Table 2. A Principled Definition of Sustainability, Articulated as Eight Sustainability Principles (SPs)

| SP1 | In a sustainable society, nature is not subject to systematically increasing ... concentrations of substances extracted from the Earth’s crust (e.g., fossil carbon); |
| SP2 | concentrations of substances produced by society (e.g., pesticides); and |
| SP3 | degradation by physical means (e.g., over harvesting fish). |
| SP4 | And people are not subject to structural obstacles to ... health (e.g., by dangerous working conditions); |
| SP5 | influence (e.g., by suppression of free speech); |
| SP6 | competence (e.g., by obstacles to education); |
| SP7 | impartiality (e.g., by discrimination); and |
| SP8 | meaning making (e.g., by suppression of cultural expression). |

Within boundary constraints set by the SPs there are myriad possibilities for sustainable futures (40). Thus, the SPs provide objective parametres for sustainability that, if applied between communities and across scales, can help guide concerted action, while respecting community determinacy over their own specific visions, actions, and indicators for SFS.
Two additional components of the FSSD were used in this research. The first is the 5LM, which as implied, comprises five levels (38).

1. The system level includes essential aspects for a sustainable socioecological system and descriptions of interrelations, among these.
2. The success level includes a vision of success framed by a principled definition of sustainability.
3. The strategic guidelines level provides guidelines for prioritizing actions toward the vision of success.
4. The actions level includes concrete actions organised in a strategic plan.
5. The tools level includes concepts, methods, tools and other forms of support for decision making and working with the above levels.

The second is the ABCD procedure, which is used to operationalize Backcasting planning and redesign toward an SP-framed vision; shortened to “Backcasting from SPs” in this article (38). It facilitates iterative co-creation (between the community and the facilitation team, in this case, researchers) of strategic transitions toward sustainability through the following steps:

A. Create a vision of success framed by the above principled definition of sustainability.
B. Gather baseline information regarding the current reality, assess the system under question in relation to the vision of success (gap analysis), and clarify current strengths and challenges.
C. Generate creative solutions for making progress from the current reality to the vision of success.
D. Prioritise among the generated actions.
2.3. Causal Loop Diagrams
Causal loop diagrams (CLD) are tools used in systems sciences to help illustrate variables and relationships within a system. In public health it has been used, for example, to set realistic benchmarks for illustrating hypothesised public health indicator relationships where it would otherwise be challenging to measure variables in isolation (41). As such, CLD can be helpful in the absence of adequate, or directly comparable data because the state of one variable can be inferred from relationship to, and the state of related indicators.

After completion of the Delphi Inquiry process and using the Cultural Adaptation Template (CAT, described below) as a theoretical framework, researchers developed CLD to help delimit and visualise the relationships between the proposed indicators in the system of interest. In this paper, the system of interest was the Canadian dietetics community’s engagement with the RDs identified action area related to SFS knowledge development.

The indicator list that resulted from question four in the Delphi Rounds served as a member informed list of potential indicators that could help track progress toward, and achievement of, the desired vision. Actions that were considered to have deep leverage (42,43) were used to inform community level indicator development to assess how, if at all, community actions (i.e., those of the dietetics community) affect broader food systems sustainability outcomes (articulated as themes, see Table 4). The iterative nature of the Delphi is a form of member checking, and contributed to trustworthiness (44,45) in the development of indicators relevant to the community.

Literature and publicly available, free, databanks (e.g., Food and Agriculture Organization) were reviewed for possible data sources or alternative, practical facsimiles which captured participant ideas. The research team then screened the potential indicators using a previously
developed screening tool with the following criteria: necessary, sufficient, practical and high quality.

2.4. Cultural Adaptation Template
The CAT has been developed to theorise the nature of relationships between factors that drive the capacity of a culture to adapt in a way that is sustainable (i.e., their adaptive capacity to survive into the future) (33). These factors are: cultural paradigms, community, human health and wellbeing, and ecosystems, and they have been articulated using causal loop diagrams as in Figure 1 (33).

![Cultural Adaptation Template](image)

**Figure 1. Cultural Adaptation Template**
Footnote to Figure 1: Reproduced from Dyball and Newell (33) with permission. The direction of the relationship between variables is shown by an arrow, but not the polarity (+/-) of the relationship. The numbered arrows help orient the reader to a relationship in question.

The CAT theorises how the state of cultural paradigms in the system of interest influence, and in turn are influenced by, the state of the community (CLD links 1 and 2 respectively), ecological factors (link 6), and human
health factors (link 4). These influences can create either reinforcing or balancing feedback loops. This model can indicate relationships across scales and help illustrate how the state of a community (and a specific factor within that community) has influence over health (link 3) and ecological (link 5) outcomes. The CAT separates the state of cultural paradigms as a unique subsystem because of the influential role of cultural paradigms (mental models, belief systems, underlying assumptions) in influencing social and cultural norms (such as dietary choices) at the community level, and therefore the ability of a culture to adapt (survive) in changing environmental conditions.

3. Results

3.1. The Community Defines Their Vision
A vision was established to guide actions and assessment processes. Results indicated that RDs have a multidimensional understanding of the complex and interrelated ecological and social concepts of SFS (36). These themes represent what is important to the community at the particular time they were surveyed. Different themes may arise in other communities and/or at another time where different contexts and cultural paradigms dominate. All themes are bounded by the condition that their state does not violate any SPs.

Among many other dimensions (32,36), RDs envisioned that “…Canadians have the capacity to produce, access, and prepare food, reflect and act on the socioecological implications of their food choices. … They support a healthy relationship with food, such that Canadians value food, its origin and quality, and express identity and culture through foods…” (32 p.3). In this article, the vision theme “food literacy” represents the concepts in this portion of the RD vision, and is the focus of the following sections. Narrowing to one theme simplifies the example to a
conceptually manageable size for this article. Using food literacy as an example is strategic as there are currently no commonly accepted indicators.

According to Cullen et al., food literacy is inseparable from the concept of SFS; food literacy “… is the ability of an individual to understand food in a way that they develop a positive relationship with it, including food skills and practices across the lifespan in order to navigate, engage, and participate within a complex food system. It’s the ability to make decisions to support the achievement of personal health and a sustainable food system considering environmental, social, economic, cultural, and political components”(46 p. 143). As such, food literacy requires foundational knowledge (or literacy) in SFS.

3.2. The Community Defines Barriers to the Vision and High Leverage Actions

The Canadian RD community identified ‘facilitating knowledge development’ as one of three action areas for dietetic contributions to global SFS (32). Facilitating knowledge development for SFS literacy further contributes to food literacy more broadly, as per the above definition. Under the knowledge development action area, RDs identified specific actions intended to lead to a higher level of SFS literacy among RDs, and also the public.

Within this action area, Canadian RDs distilled central barriers and actions that would help address these barriers, thus supporting movement toward the vision. Table 3 summarises the barriers, identifies the primary way in which they violate SPs, and highlights upstream actions dietitians perceived to be their greatest leverage points. Presented this way, barriers and actions are components of driving forces which influence and indicate whether food literacy is moving toward or away from being supportive of sustainability.
Table 3. Barriers Facilitating Sustainable Food Systems Knowledge Development, Sustainability Violations, and Upstream Actions

<table>
<thead>
<tr>
<th>Barriers</th>
<th>SPs Violation (31)</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competing food-health sustainability messages that lack scientific evidence.</td>
<td>SP5</td>
<td>Develop common language and shared understanding of SFS within the profession. Identify and dispel common myths about SFS. Develop a “case” for sustainability using both dietetic and publicly accessible language.</td>
</tr>
<tr>
<td>Inadequate opportunities for developing understanding of the interactions between food, people and the environment</td>
<td>SP6</td>
<td>Educate for SFS literacy† in public schools &amp; community Advocate for integration of SFS in provincial education curricula Include SFS literacy in dietetic education Advocate for integration of SFS in national dietetics curricula</td>
</tr>
<tr>
<td>Cultural expectations of, and stable access to, a variety of imported foods year round Cultural de-prioritization of food</td>
<td>SP1 SP4</td>
<td>Educate about satisfying food and nutritional needs in a way that is less reliant on energy and transport intensive practices Advocate and educate for prioritizing cultural food (e.g., creating time for meals in homes and institutional settings)</td>
</tr>
</tbody>
</table>

* Reproduced with permission (32). † The actions described by dietitians use the language “SFS literacy.” In this paper SFS literacy is part of and contributes to food literacy.

### 3.2 The Community Identifies Relevant Outcome and Process Indicators

The proposed indicators measure one of two things: *outcomes* and *process*. Outcome indicators were based on the themes captured in the vision—how do we know we have achieved one of our “end goals,” while process indicators capture action—how are we contributing to a sustainable food system? Table 4 is organised by outcome and process indicators relevant to the issue of food literacy. Each theme/action is described, a method of measurement is proposed, data sources are identified, and a summary of the strengths and limitations of that indicator are provided.
Table 4. Indicators Capturing Dietitians Community Level Contributions to Public Food Literacy as part of SFS

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Description</th>
<th>Methods/Metric</th>
<th>Status Δ 2016-19*</th>
<th>Data Source</th>
<th>Strengths &amp; Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Food Literacy</td>
<td>Currently unavailable.</td>
<td></td>
<td></td>
<td>PEN†</td>
<td>Helpful but inadequate on its own. <strong>Necessary:</strong> Yes, quantitative measure on level of demand and access to the tools/resources for use. <strong>Sufficient:</strong> No, may not translate to increased food literacy. <strong>Practical:</strong> Yes, should be easy and inexpensive to measure. <strong>High Quality:</strong> Yes, can be measured accurately. However, will need revision for relevance as the level of literacy becomes high, because the number of downloads will then become static or decrease without downregulating the level of SFS literacy.</td>
</tr>
<tr>
<td>SFS Literacy among Dietitians</td>
<td>RD Level of confidence and/or competence specific to the SFS related aspects of food literacy.</td>
<td>The number of downloads of sustainability knowledge-based resource available on website (i.e., aimed at understanding the concept and issues.)</td>
<td>Increasing DC LoD† PEN†</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indicator</td>
<td>Description</td>
<td>Methods/Metric</td>
<td>Status Å 2016-19</td>
<td>Data Source</td>
<td>Strengths &amp; Limitations</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>------------------</td>
<td>------------</td>
<td>-----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Process Indicators (related to actions)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common Language</td>
<td>Competing SFS discourses creating confusion. Helps dietitians to communicate competently and confidently.</td>
<td>DC has definition for SFS, vision statement that reflects the values and ethics of the profession, position statement or paper</td>
<td>Increasing</td>
<td>DC website</td>
<td>Necessary: Yes, participants stressed importance to clear and coherent messaging. Sufficient: Yes, clearly establishes concepts and terms that align with DC values. Practical: Yes, easy to determine whether there is one or not. High Quality: Yes.</td>
</tr>
<tr>
<td>(Level of Standardization of SFS Language)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level of Curricular Integration in Dietetic Training</td>
<td>Dietetic education guided by ICDEP¹ Foundational Knowledge Statement #15, a-g, or updated equivalent.</td>
<td>Increase in Cognitive Complexity from current 1 (1 = Demonstrate broad knowledge; 2 = Demonstrate comprehension; 3 = Analyse, interpret and apply knowledge)</td>
<td>Static/ decreasing</td>
<td>PDEP¹</td>
<td>Necessary: Yes. Participants identified this as necessary for systemic change. Sufficient: Yes, it will clearly show progress towards more depth in coverage and curricular integration of SFS. Practical: Easy and inexpensive to measure. High Quality: Yes, it clearly indicates reliable progress.</td>
</tr>
<tr>
<td>Number (level) of Opportunities for SFS Education</td>
<td>For dietitians already in practice, DC SFS professional development resources.</td>
<td>Number of available resources.</td>
<td>Increasing</td>
<td>DC LoD, website and PEN.</td>
<td>Necessary: Yes, direct measure of “inadequate opportunities for developing [SFS] understanding …” Sufficient: Yes. Practical: Yes, easy and inexpensive. High Quality: Yes.</td>
</tr>
<tr>
<td>Indicator</td>
<td>Description</td>
<td>Methods/Metric</td>
<td>Status A 2016-19*</td>
<td>Data Source</td>
<td>Strengths &amp; Limitations</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>-------------------</td>
<td>-------------</td>
<td>----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Level of RD Engagement in Public Education**</td>
<td>Used as a general indicator for outreach and education efforts described in Table 2.</td>
<td>Number of downloads within DC resources that support public engagement processes (i.e., applied tools).</td>
<td>Static</td>
<td>DC website</td>
<td>Helpful, but inadequate on its own. Necessary: Yes, supports RDs to educate engage with the public. Sufficient: No, does not ensure or measure public engagement. Practical: Yes, easy and inexpensive. High Quality: Yes.</td>
</tr>
</tbody>
</table>

* Over time, the relational influence of some metrics may change in relation to the dynamism in the system.
† Dietitians of Canada (DC) is the Canadian professional association for RDs; Learning on Demand (LoD) is a website based portal for professional development webinars and courses.
‡ Practice-based Evidence in Nutrition.
‖ Integrated Competencies for Dietetic Education and Practice.
** Includes items from Table 3: identify and dispel common myths about SFS; develop a case for sustainability using publicly accessible language; educate for SFS literacy in public schools & community, and advocate for curricular integration; educate about satisfying food and nutritional needs in a way that is less reliant on energy/resource intensive practices; and, advocate and educate for prioritizing cultural foods.
3.3. Assessing How Actions at the Community Level Contribute to Global SFS Development

Without an existing measure of food literacy, measuring actions (process indicators, see Table 4) provides a way for this community to assess their contributions to food literacy. These process indicators are informed by practice-based expertise. As actions that address SP violations, in theory, they should help drive action toward a sustainable state.

Using the CAT as a model, Figure 2 shows the subsystem of interest, food literacy, as part of sustainable food systems. Figure 2 illustrates the nature of the relationships between the state of cultural paradigms within the profession (the level of focus on SFS in Canadian dietetic practice), the state of the community (the level of RD SFS literacy), the state of ecosystems (e.g., climate) and the state of human health and wellbeing (e.g., public food literacy). The state of the community is not simply about the level of knowledge that RDs hold, but rather the formal and informal structures that influence collective behavior among individual practicing dietitians (formal positions that guide policy, education and practice, as well as informal normative standards that influence practice). This differs from the state of the cultural paradigms within the profession, which represent the collective knowledge, beliefs and values that govern the communities’ judgments. An example of an SFS focused paradigm would be one which reflects the values position that was described in this case study, one in which “health, social, economic and ecological outcomes carry equal weight …” (32 p.6) in guiding professional practice.

The relationship between variables is indicated with either a positive (+) relationship, meaning when one increases, the other does as well, or a negative (-) relationship, where when one increases, the other decreases. In some relationships, there is a time delay (l). The theme food literacy is a variable which RDs want to increase (+), and exists at all scales. Climate stability, which is global in scale (Figure 2) is included to illustrate the
multiscalar capabilities of the proposed procedure, but not part of the example indicators outlined in this paper.

Figure 2. System of Interest: Food Literacy as Part of Sustainable Food Systems

Currently, there are two process indicators (Level of Standardization of SFS Language, and Level of Opportunities for SFS Professional Development) that are increasing, which is directly related to the increasing outcome indicator measuring food literacy among dietitians (see Table 5 for the details of how variables are related). Figure 2 also illustrates how increasing food literacy may have impacts across scales and other variables in the socioecological system, which, through feedback loops, influences the cultural paradigm within the profession positively. Over an extended period of time, the variables will not increase infinitely (i.e., continue to increase the level of focus of the profession on SFS indefinitely). The diagram is a simplification of reality in the near future.
Table 5. Explanation of CLD links in Figure 2

<table>
<thead>
<tr>
<th>Link Number</th>
<th>Action or Process Represented</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>This link is positive. An increased level of focus on SFS in Canadian dietetic practice likely increases the level of standardization of language (terms and concepts) in the community, and the related indicator is currently increasing.</td>
</tr>
<tr>
<td>2</td>
<td>This link is positive. An increased level of standardization of language around SFS likely increases the level of RD SFS literacy in the profession, thus mitigating susceptibility to misinformation. As there is no adequate indicator for the level of RD SFS literacy identified for this article (listed as helpful but inadequate on its own in Table 4), and since this is considered difficult, the level of standardization of language is proposed to be used as a proxy.</td>
</tr>
<tr>
<td>3</td>
<td>This link is positive. An increased level of focus on SFS in Canadian dietetic practice likely increases the level of curricular integration of SFS into dietetic training in formal educational structures such as university and practicum curriculum. However, the related indicator is currently static. This is likely due to a delay as indicated in the diagram. There is significant inertia and lead time in formal educational structures.</td>
</tr>
<tr>
<td>4</td>
<td>This link is positive. An increased level of curricular integration of SFS into dietetic training likely increases the level of RD SFS literacy in the profession. This is also proposed to be used as a proxy.</td>
</tr>
<tr>
<td>5</td>
<td>This link is positive. An increased level of focus on SFS in Canadian dietetic practice likely increases the level of opportunities for SFS professional development through specific courses and resources (webinars, conference sessions, and other learning resources from DC), and the related indicator is currently increasing. Failure to further develop these resources would mean integration of SFS into dietetic practice would be slower, as it would then be more dependent on curricular integration in formal educational structures and new graduates from these entering the workforce.</td>
</tr>
<tr>
<td>6</td>
<td>This link is positive. An increased level of opportunities for SFS professional development likely increases the level of RD SFS literacy in the profession. This is also proposed to be used as a proxy.</td>
</tr>
<tr>
<td>Link Number</td>
<td>Action or Process Represented</td>
</tr>
<tr>
<td>-------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>7</td>
<td>This link is positive. If the level of RD SFS literacy increases, it will likely reinforce the cultural paradigm supporting SFS as a focus area for dietetic practice. That is, it will ‘institutionalise’ SFS as a priority. This reinforcing dynamic will be valid for some time. When the variables reach high levels, other dynamics will come in, which are now not represented in the diagram. Over extended time the variables will not increase infinitely. The diagram is a simplification of reality in the near future.</td>
</tr>
<tr>
<td>8</td>
<td>This link is positive. An increased level of RD SFS literacy likely increases the level of engagement in public education activities, through several mechanisms in Table 3: Identify and dispel common myths about SFS; Develop a case for sustainability using publicly accessible language; Educate for SFS literacy in public schools &amp; community, and advocate for curricular integration; Educate about satisfying food and nutritional needs in a way that is less reliant on energy intensive imports (which, for the purposes of this article we have modified to a more broad focus on resource use for all foods, not unique to imports); and, Advocate and educate for prioritizing cultural foods. However, the indicator for level of RD engagement in public education is static at zero: there are currently no resources that support public engagement processes (i.e., applied tools), and therefore none to download. Reasons for this could include lack of time and money at the organizational level to develop such tools, and hence the time delay in the diagram. Furthermore, the indicator is listed as helpful but inadequate on its own in Table 4. Action areas other than facilitating knowledge development have also been identified (32), and the development of related indicators for those would support stronger assessment.</td>
</tr>
<tr>
<td>9</td>
<td>This link is positive. With increasing efforts to translate knowledge, influence behaviour, and influence structural policies that support SFS, the level of public food literacy will likely increase. However, as discussed in link 8, the indicator for level of RD engagement in public education is static at zero. While helpful but inadequate on its own, this indicator points to likely low-to-no change at the tail end of this link. The indicator for the level of public food literacy is currently unknown. However, the related process (level of RD engagement in public education) indicator can be used as a proxy for this unknown. In the present state, that indicates that public food literacy, as defined in this paper, is likely low, as is the case community’s contributions to SFS. As such, this highlights a gap in both measurement and action, and thus highlights a strategic focus area for dietetic practice. Furthermore, there is significant inertia and lead time; once resources become available and are being downloaded and used, it will take time to influence behaviour and the change will not happen in a uniform manner. This is indicated as a delay in the diagram.</td>
</tr>
<tr>
<td>10</td>
<td>This link is positive. If the level of public SFS literacy increases, this likely increases broader public awareness and in turn the perceived importance of SFS in Canadian dietetic practice. This link is not further elaborated in this article.</td>
</tr>
<tr>
<td>Link Number</td>
<td>Action or Process Represented</td>
</tr>
<tr>
<td>-------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>11</td>
<td>This link is negative. If the level of RD SFS literacy increases, the professionals will be able to apply their skills to influence food systems and diets in a way that likely reduces climate change. This is an example where the effects would be amplified through links 8, 9 and 14. In this diagram we use climate change as an example, as food systems and diets have climate change mitigation potential (22). One example identified in the Delphi Inquiry process was through lowering energy use (32), which in Canada comes primarily from fuels that contribute to climate change. Indicators related to energy use in food systems and diets need to be identified. This link is not further elaborated in this article.</td>
</tr>
<tr>
<td>12</td>
<td>This link is positive. If climate change increases (worsens), this will likely influence both directly (link 11), and indirectly (links 12, 9), the perceived importance of SFS in Canadian dietetic practice. This link is not further elaborated in this article. However, measures of climate change exist (22, 47) and that outcome indicator is increasing. Also, exploratory surveys with DC members show that 78% felt that SFS is relevant to their day-to-day practice (48). This could be tracked as an indicator of perceived importance.</td>
</tr>
<tr>
<td>13</td>
<td>This link is positive. If climate change increases and impact the daily lives of more people, the perceived importance and relevance of food choices that mitigate climate impacts and related knowledge will likely increase, which is part of public SFS literacy. This link is not further elaborated in this article.</td>
</tr>
<tr>
<td>14</td>
<td>This link is negative. If the level of public SFS literacy increases, including knowledge about food habits that mitigate climate change, the level of climate change will likely decrease. While knowledge/literacy does not necessarily result in behaviour change, it is one important contributor. This link is not further elaborated in this article. However, sustainability consciousness is one factor influencing Canadians to consume less beef (49), which is one food product with high climate impacts (2, 3, 21).</td>
</tr>
</tbody>
</table>
4. Discussion

In line with the purpose of this paper, first the results are discussed with respect to how the procedure for community level assessment of contributions to SFS development addresses the two central challenges highlighted, and second, the results are discussed with respect to direct opportunities for RDs.

4.1. Challenge 1: A lack of methods and tools that support synergistic SFS progress among communities and across scales, while involving community in developing community relevant indicators

Using the Delphi Inquiry method was helpful for inviting the community to define their own vision and goals for SFS, as well as barriers, actions and relevant indicators for assessment purposes. This engagement is important for continued learning through contextually relevant knowledge (19,50,51), and Alrøe and colleagues emphasise the importance of learning opportunities that are created by SFS assessments (11). The Delphi Inquiry method used in this research (20,32) invited community members, as community experts with relevant knowledge to share, through iterative dialogue about SFS, between themselves, and with the research team. It exposed common, dissenting and diverging views in an anonymous way, such that they are open to discussion. As such, it was educational and contributed to the sharing of contextually relevant knowledge between participants and researchers.

Embedding learning is important as it enhances readiness to adapt to a continually changing set of conditions. As stated in the results, the vision of SFS and identified themes for measurement represent what was important to this community at the time the Delphi Inquiry process was conducted. As conditions of the system change, there will be continual need to reiterate the process—revisit the vision, actions and indicators and redefine as needed, and it is important that those be informed by a breadth
of different types of knowledge—researchers, community members, professional communities, etc. (52).

While it is important to invite communities to determine their own priorities and relevant ways of measuring progress toward those priorities, it is also important that there is overall alignment between communities. In today’s highly globalised food systems, and given the urgent calls for addressing important sustainability crises (53–55), there is also a need for collaborative, concerted efforts across scales. Framing data collection and analysis using the FSSD (38), and in particular, using the SPs as concrete parameters defining sustainability supported overall alignment between communities and across scales. The FSSD was used here to inform actions that can contribute positively toward sustainability by addressing a barrier articulated as a violation of one or more SPs, and to identify related process indicators used to monitor progress toward sustainability, regardless of scale. The FSSD also supported goals to involve community. It provided procedural support for co-creation of sustainable visions, assessment of the current reality, generation of possible actions to close the gap, and prioritization of such actions into strategic plans.

4.2. Challenge 2: The absence of adequate data, especially fine grained data relevant to the community

The complex network of variables that comprise the food system often create interactions across geographic scales. This means that a change in one variable can either moderate or amplify the state of a second variable that is far away, e.g., the weather in Southern Asia impacting crop production in Europe (33). Overall, the system behaves in ways that are the product of these many interactions, but like many other complex public health challenges (34), to examine the whole food system can be overwhelming or too time consuming (33), resulting in complexity paralysis. Conversely, it is limiting to examine individual parts of the system in isolation, for example, measuring the level of food literacy.
without also examining the many factors that impact food literacy, and those impacted by the level of food literacy. In fact, it is likely to mask an unintended consequence that result from well-intended actions. The CAT facilitated focus on a specific variable within the subsystem of interest (RD SFS literacy), and affiliated variables (ecosystem, human wellbeing, cultural paradigm). Mapping these variables using CLDs helps illustrate indicator relationships and thus, dynamic hypotheses about interactions between variables (at a chosen level of granularity) that drive the overall system behavior (56).

The CAT has limitations if causal relationships in the data are not known (see limitations), but the tool allows for other forms of knowledge to provide insight, i.e., practical/professional knowledge (52). If the expertise of the community (in this case RDs) agrees that there is a reasonable hypothesis to make, then one can proceed under that assumption. As such, the known data that interacts with a variable of interest can become a proxy measure by informing a dynamic hypothesis about its state—one that is subject to change where empirical data arises. In many cases, some data is available; often the available data relates to national or global level outcomes (e.g., climate change) and the use of the proposed methods can accommodate integration of data points that are, or become, available. In the case example, indicators for public food literacy are currently unknown. Related process indicators (level of RD engagement in public education) can be used as a proxy for this unknown. From a practical perspective, process indicators (i.e., those related to actions) are likely more available or easily gathered at a community level (see examples in Table 4). In the present state, it indicates that public food literacy, as defined in this paper, is likely low, as is the case community’s contributions to SFS. As such, this also highlights a gap in both measurement and action, and thus highlights a strategic focus area for dietetic practice.
Though from an assessment perspective it is quantitatively imperfect, in the absence of data, the use of the CAT helped to map informed and dynamic hypotheses about how actions will drive movement in the subsystem of interest, including across scales. It can do so in absence of detailed empirical data of two kinds. The first is empirical data measuring the state of the variable for which there is no currently validated measure for food literacy that could be used in this research, though some work is being done to develop a tool (57). The second is empirical data demonstrating the relationship between variables (e.g., SFS integration in dietetic education leads to increasing SFS literacy among dietitians).

A further advantage of focusing on process related indicators is that they help to elucidate the “role” of the community in driving change, one that might otherwise not be so clear in such complex issues. It also highlights that the issues are not the purview of dietetics alone (e.g., energy use). In this paper, we identify potential actions RDs might pursue that could contribute to positive change in food literacy. Many other potential actions exist and are strategic to a different community (geographic, professional or other), and the assessment process described in this article leaves space for collaborative opportunities. Additional process links driven by actions in other sectors and disciplines are easily added to the assessment process.

See Appendix A for the detailed (step-by-step) procedure used for community level engagement in, and assessment of, contributions to SFS development. It is informed by evidence and experience gained while working with the challenges highlighted in this paper and previous, related work (20,32). In Appendix A, the procedure in Step 2 (2.1–2.4) was not co-developed with the case community. It requires more research to test and improve on how it can support communities in assessing their contributions to SFS over time.
4.3. Opportunities for Dietitians in Contributing to SFS Development

In the example used in this article, we follow RD expertise that increasing RD SFS literacy will contribute to broader public food literacy, and potentially climate outcomes. Results show that in the present state, public food literacy is likely low, and that RD engagement with public education activities is also likely low. This also highlights a gap in both measurement and action, and thus highlights a strategic focus area for dietetic practice. Namely, there is a need for resources that support RDs to apply SFS in public education and outreach activities, such as those listed in Table 3:

- Identify and dispel common myths about SFS.
- Develop a case for sustainability using publicly accessible language.
- Educate for SFS literacy in public schools and community, and advocate for curricular integration.
- Educate about satisfying food and nutritional needs in a way that is less reliant on energy intensive imports, which, for the purposes of this article, we have modified to a more broad focus on resource use for all foods, not unique to imports.
- Advocate and educate for prioritizing cultural foods.

Furthermore, there is an opportunity to embed SFS concepts into RD education and training that is likely to have positive feedback on RD SFS Literacy and therefore uptake of resources and support for public outreach activities.

Because we have used an isolated example of knowledge development for measurement purposes, the importance of other actions in achieving these outcomes are not captured in this subsystem of interest, for example, advocacy for the prohibition of marketing unhealthy food to children, and systematic dismantling of income inequalities to address household food insecurity (32). A full assessment of this, or any community’s contributions to SFS, would require multiple iterations using the various
identified themes and indicators, and is beyond the scope of this paper. It would also contribute to a better understanding of the relationships in links 8 and 9 for both measurement and action purposes.

As outlined in the methods section, the CAT was developed to theorise the factors that contribute to our cultural adaptive capacity—in this example, the ability of the dietetics profession to respond to changing environmental conditions such as climate change, which signal a need for a higher level of importance to be placed on SFS. While not all members of this case community may share a worldview with a high level of focus on SFS, according to cultural adaptation theory, the success of our ability to foster and maintain sustainable communities (defined here using the SPs of the FSSD), rests on the ability to collectively develop embedded ways of thinking and doing that facilitate adaptive (as opposed to maladaptive) progress. The feedback loops in Figure 2 also highlight opportunity for intentionally shaping cultural adaptation. Decisions made at a community level have broader impacts in the socioecological system that, in turn, can create positive, or negative feedback to the state of cultural paradigms. This can up or downregulate the relative strength of the SFS focus within the community culture. For example, by embedding SFS concepts into RD education and training, this will increase the level of RD SFS literacy, which is likely to manifest in the many areas of dietetic interaction with the public, and theoretically strengthen community level infrastructure that, in turn, amplifies an SFS positive paradigm.

4.4. Limitations
In this research, the Delphi Inquiry process was facilitated using online survey software due to the geographically disparate community, and required that participants have internet access. This vehicle could affect the validity of future community work given a different context (e.g., without access to internet, literacy, etc.). The vehicle for the Delphi Inquiry
process can be adapted to the community context (e.g., meetings, interviews, etc.) and research resources.

The theoretical nature of the relationships between variables is a limitation of the methods used. There is a subsequent opportunity to study the nature of the relationships between the variables (i.e., correlated, causal, directional, magnitude, etc.) in order to continue to adapt the model and assumptions. The methods are also limited by the use of a subsystem of interest to illustrate the example. A comprehensive analysis would require examining many subsystems simultaneously, and may come with unforeseen challenges. In the context of the identified challenge, where fine grained community level indicators are not consistently available, it should be noted that data collection is still required. However, it is generally easier for communities to collect action oriented, or process data, such as audits of what is being done, than outcomes data like the greenhouse gas emissions of a specific community—although if available, it can easily be included.

5. Conclusions

The procedure described in this article has several advantages. The Delphi Inquiry method was a good fit for engaging diverse community members to contribute their expertise to planning for and assessing SFS. Integrating FSSD theory and methodological supports helped to anchor the community work in a concrete definition of sustainability (that is applicable across scales) in such a way that, if applied in other communities, would create alignment. Together, the FSSD, Delphi Inquiry, and CAT methods supported an engagement process that fostered learning. The specifics of how the procedure is executed can easily be adapted to fit the community context.
Application of the CAT through CLDs was helpful in zooming into a manageable system of interest, and hypothesizing indicator relationships such that assessors can make inferences in absence of all data points. Furthermore, CAT had additional benefits: it allowed for multiple types of knowledge to be used in indicator development; by using process indicators, it helped illustrate a role specific to the community’s contributions to SFS development; and it is flexible and could be used for collaborative action in other communities. Finally, the importance of cultural paradigms in a community’s capacity to adapt to changing environmental conditions is emphasised. In this research, facilitating SFS literacy within the profession is a first step in generating positive feedback loops that strengthen the SFS focus within the professional paradigm, and thus, how RDs can intentionally amplify adaptations for, and positive contributions to, SFS development.

The procedure outlined in this paper (for details, see Appendix A) may also be useful to other professional and research communities that want to contribute to, and collaborate on SFS work, and researchers interested in community level SFS action and measurement.

Acknowledgements: The authors would like to thank Anne Stieger, Jesper Dorph, Jacob Carver for their work on indicators, and to Robert Dyball and Federico Davila for their feedback on our application of the Cultural Adaptation Template.

Sources of Financial Support: The authors gratefully acknowledge financial support from VINNOVA (Swedish Governmental Agency for Innovation Systems), Acadia University Research Fund and Blekinge Institute of Technology.
References


## Appendix A

<table>
<thead>
<tr>
<th>Step</th>
<th>Method/ Tools</th>
<th>Brief Description</th>
<th>Advantages and Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Delphi Inquiry; FSSD Backcasting from SPs</td>
<td>Invite diverse members of the community to participate in panel to discuss: (A) a vision of SFS, (B) the barriers and supports in today’s reality for the community, (C) possible actions for moving toward the vision, and (D), which actions are strategic to prioritise. Include a question about relevant indicators to measure progress toward the vision.</td>
<td>Online survey software can ensure anonymous responses and encourage honesty. Technology access might be a barrier in some contexts and other formats for the dialogue are possible (e.g., meetings, interviews). The panel make-up should strive to include diverse disciplines, sectors, or knowledge domains. Maximise engagement, realizing that traditionally marginalized groups might take targeted efforts to engage. Indicators may not be available or of high quality, but this procedure can inform the development of relevant indicators.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step</th>
<th>Method/ Tools</th>
<th>Brief Description</th>
<th>Advantages and Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2</td>
<td>Delphi Inquiry; Qualitative analysis with FSSD (5LM; SP)</td>
<td>Questions asked iteratively in two-three consecutive rounds. After each round, analyse and organise data from each round using 5LM to separate, e.g., possible actions from visionary concepts. Concurrently analyse and organise data using SPs to evaluate comprehensiveness of the responses with respect to sustainability.</td>
<td>Iterative nature supports member checking, increases learning between all participants, including the research team (or any team facilitating the procedure, increases ownership and buy-in. Helps organise and structure input from diverse knowledge domains so that it is comparable. a priori theming will help important ideas emerge that may have been recorded under another question. SP analysis: supports facilitating dialogue about comprehensive sustainability. (Optionally) introduce SPs to participants, depending on context, time and appropriateness to audience (time is required to learn and work with SPs) Best to use it as part of the analysis here, but optional as it can be done as part of 1.6 and 1.7.</td>
</tr>
</tbody>
</table>

*Further reading: (20,32)*
<table>
<thead>
<tr>
<th>Step</th>
<th>Method/Tools</th>
<th>Brief Description</th>
<th>Advantages and Limitations (Further details, justification and discussion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3</td>
<td>Delphi Inquiry</td>
<td>Use analysis to provide a composite summary between each round for consideration by panel prior to answering questions again</td>
<td>Supports member checking, increases learning between all participants, including the facilitating team. Time consuming to produce. Be aware of that and plan accordingly. Further reading: (20)</td>
</tr>
<tr>
<td>1.4</td>
<td>Delphi Inquiry</td>
<td>In second and third rounds, explicitly ask for panel to amplify, disagree, or ask for clarification re: composite summary</td>
<td>Helps build trustworthiness in results, learning across knowledge domains, and highlight potential areas of tension that require addressing. Further reading: (20,32)</td>
</tr>
<tr>
<td>1.5</td>
<td>Delphi Inquiry; FSSD Backcasting from SPs</td>
<td>End Delphi Inquiry process with face-to-face workshop to finalise data, discuss outstanding issues. Finalise D-Step: facilitate conversations around which of the actions are “upstream” or high-leverage.</td>
<td>Helps build clarity and relationships. Breaks anonymity. May result in participant voices being “silenced” somewhat by group dynamics or ability to attend. Further reading: (20)</td>
</tr>
<tr>
<td></td>
<td>1.6-1.7 Can be done in advance of the concluding workshop, and further refined, or completed after the workshop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.6a</td>
<td>Qualitative open coding</td>
<td>Finalise list of multidimensional themes relevant to the community level that capture the vision of success (A) within SPs.</td>
<td>List of themes used to frame (outcome) indicators. Concrete definition of sustainability defines what is and is not sustainable within vision themes, and provides parameters to align visions and action across different communities and scales. Further reading: (20)</td>
</tr>
<tr>
<td>1.6b</td>
<td>Local-to-global assessment framework</td>
<td>Populate community layer of framework for local-to-global SFS indicators</td>
<td>Optional. Helps conceptualise relevant themes as related to themes established by global expert panel. Can add layer of complexity, may not be necessary. Further reading: (20)</td>
</tr>
<tr>
<td>Step</td>
<td>Method/Tools</td>
<td>Brief Description</td>
<td>Advantages and Limitations (Further details, justification and discussion)</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
<td>-------------------</td>
<td>---------------------------------------------------------------------</td>
</tr>
<tr>
<td>1.7</td>
<td>Qualitative analysis with FSSD (SPs)</td>
<td>Organise such that themes are related to key barriers to that theme, barriers are aligned articulated as SPs violations, and high-leverage actions are aligned with barriers.</td>
<td>Concrete definition of sustainability (parametres) that define what is and is not sustainable. Barriers articulated as SPs violations helps isolate how communities can, through barrier-specific actions, drive progress in a theme toward a more sustainable state, even across different communities and scales. Further reading: (32)</td>
</tr>
<tr>
<td>1.8</td>
<td>Delphi Inquiry</td>
<td>After the workshop, provide final summary report. If possible, include steps 1.6-1.8</td>
<td>Final summary report can be used as a strategic roadmap, or a foundation for similar strategic work (36,58). Further reading: (20,32)</td>
</tr>
<tr>
<td>1.1-8</td>
<td>Outcomes</td>
<td>As a result of Phase 1, the community will have defined: 1. A vision statement and list of themes which capture the important concepts in the vision. 2. Barriers to the vision, articulated as drivers of unsustainable conditions. 3. High leverage actions that address the barriers, and a list of potential and relevant indicators for both actions and the vision.</td>
<td></td>
</tr>
</tbody>
</table>

### 2. Apply systems thinking and tools to guide assessment and evaluation

<table>
<thead>
<tr>
<th>Step</th>
<th>Method/Tools</th>
<th>Brief Description</th>
<th>Advantages and Limitations (Further details, justification and discussion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>CAT; Causal Loop Diagrams</td>
<td>Use CAT to delimit a system of interest (can be one focus theme and several related themes) Refer to community identified barriers, actions related to that theme (step 1.7). Use CLDs to visualise the system of interest, guided by CAT</td>
<td>Helps to avoid complexity paralysis, highlight how finer grained (community level) subsystems are linked to broader goals. Can involve the community in this phase (in face-to-face workshop), but it can also be developed parallel, or afterwards, depending on appropriateness and resource capacity. CLDs informed by the CAT not exclusive of the role of other sectors and disciplines to contribute positive change. Multiple systems of interest possible.</td>
</tr>
<tr>
<td>Step</td>
<td>Method/Tools</td>
<td>Brief Description</td>
<td>Advantages and Limitations (Further details, justification and discussion)</td>
</tr>
<tr>
<td>-------</td>
<td>--------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2.2</td>
<td>Delphi Inquiry; CAT</td>
<td>Use community identified indicators that capture process (actions, D) and outcomes (vision themes, A) related to the system of interest</td>
<td>Using community identified barriers and indicators allows other forms of knowledge (other than academic) to be used to develop indicators. Process indicators help elucidate the 'role' of the community in driving change.</td>
</tr>
<tr>
<td>2.3</td>
<td>Local-to-global assessment</td>
<td>Screen indicators for: high-quality, practical, sufficient, necessary. Identify and collect suitable alternatives if needed.</td>
<td>Community identified may not meet screening criteria. Strive to develop or adjust indicators that meet criteria, while being true to the intention of community indicators.</td>
</tr>
<tr>
<td>2.4</td>
<td>Delphi Inquiry; CAT</td>
<td>Outcomes and process indicators become variables in the CAT-informed CLD. Evaluate increasing/decreasing state of outcome or process to understand whether actions drive toward or away from sustainable state, and where potential points of leverage (community level actions) may lie.</td>
<td>Data may still be missing. Process indicators help inform dynamic hypotheses about indicator interrelationships, including across scales, in the absence of data. CAT theory helps develop inferences about the influence of sociocultural norms, and opportunities to shape SFS-sensitive cultural paradigms. Requires familiarity with using and reading CLDs. CLDs of various subsystems can be combined to examine the overall behavior of a larger system with respect to sustainability.</td>
</tr>
<tr>
<td>2.1-4</td>
<td>Outcomes</td>
<td>As a result of Phase 2, the team and community will have defined: 1. A subsystem of interest (or multiple). 2. A revised list of relevant indicators that measure both actions (process indicators) and vision themes (outcomes indicators). 3. A “map/diagram” that conceptualises how actions at the community level contribute to the vision and broader global SFS development, such that assessments can be made.</td>
<td></td>
</tr>
</tbody>
</table>

Food systems are a part of dynamic socioecological systems. As such, this procedure is meant to be used iteratively, as time and resources allow. Iterative use will allow for continued follow-up between all stakeholders, as-needed revision of the strategic plan that it informs, and even perhaps the original vision.
Paper 5. Critical Dietetics and Sustainable Food Systems

Liesel Carlsson, Kaye Mehta, and Clare Pettinger

Paper 5 is published as:
Aims of Chapter and Learning Outcomes

In this chapter, we invite readers to consider a food system that is based on values where individual health, the health of the society (social system) and ecosystem health are of equal importance. With this as a lens, there is a clear need to move beyond the biosciences to consider transdisciplinary approaches as important for nutrition and dietetics in today and tomorrow’s reality.

This chapter begins by briefly highlighting historical engagement of the nutrition and dietetics community with food system sustainability, before moving to define foundational concepts of sustainability in food systems and diets, from a systems perspective. It then provides some examples of how some of today’s pressing nutritional challenges are sustainability challenges and examples of the interface between today’s dietetics and food system sustainability. This chapter ends with a discussion on the role of nutrition and dietetic practitioners in food system sustainability and the needs and challenges for dietetic education to support that role.

At the end of this chapter, readers should be able to:

(i) Clearly understand the concept of sustainable food systems (SFS).
(ii) Describe some emerging roles for nutrition and dietetic professionals in contributing to food system sustainability.
(iii) Consider engaging in deeper levels of inquiry about our responsibilities as a profession.
1. A Brief History of Sustainability in Dietetics

Issues of sustainability are not new to dietetics. One of the earliest (and best documented) “ecological nutritionists” was Ellen Swallow Richards. Richards was an early (human) ecologist, born in 1842. She worked as a chemist on issues such as water quality during an industrializing era and concerned herself with how that impacted public health. Richards was perhaps one of the first in North America to use the term “ecology”, which “[she] saw as… neatly capturing her broad concerns for human-created environmental conditions and the health consequences for people living in those conditions” (Dyball and Carlsson 2017). As a woman in her day, despite a long career as a chemist, she was persuaded to throw passions for ecology into the domestic sciences, later called home economics, focusing more on managing the economy (a term with Greek roots meaning “household management”) of the home. Subsequently, in many academic institutions, home economics evolved into the science of nutrition and dietetics, progressing from a practical focus on managing food as a family resource to an increasingly biomedical focus on the interrelationship between nutrients, health and disease.

Richards’ ecological systems approach to home economics lays the groundwork for what Rebrovick would call “eco-dietetics” (Rebrovick 2015) or a dietetics that concerns itself with the interactions between eating and environmental, social, economic and political systems and celebrating food for the pleasure it provides. Here we briefly cover some central contributions to the emergence of an eco-dietetics discourse before unpacking some terms and key concepts.

In 1986, two American dietitians, Gussow and Clancy, proposed dietary guidelines for sustainability (Gussow and Clancy 1986). While this is often referred to as a pivotal publication proposing sustainability within the remit of dietetics, it reflected decades of civic activism on the
responsibility of eaters to consider ecological sustainability. Though the ideas Gussow and Clancy put forth certainly did not lie dormant, biomedically driven dietetics dominated the focus of the profession for the following 20 years and, arguably, still does so today. In 2005, a framework referred to as the “New Nutrition Science Project” (Cannon and Leitzmann 2006) proposed reframing nutrition and dietetic research and practice around the interconnected biological, social and environmental dimensions of nutrition as a science (the term environmental here is used to mean the biological or natural world). The focus on the interconnected dimensions highlighted the need for a “systems approach” to addressing some of nutrition science’s more intractable challenges, such as malnutrition, in all its forms. The international support for the New Nutrition Science Project (albeit European Union driven and focused) helped gain attention for the involvement of nutrition in global dialogues on food system sustainability.

Ecological nutrition is a term also used to capture such a multidimensional and systems approach now broadly considered necessary to achieving sustainable diets (Mason and Lang 2017), which is now gaining policy traction in mainstream dietetics internationally, in Europe (British Dietetic Association 2017), North America (American Dietetic Association 2007; Carlsson et al. 2019); and Australia (Public Health Association Australia 2016). The concept is also emerging more broadly in public health as nations begin to incorporate aspects of sustainability to varying degrees. Qatar, Sweden and Brazil have taken radical steps to embed sustainability and social drivers and determinants into their national dietary guidelines. While dietetic curricula do pay some attention to the food system and sustainable eating, albeit to varying degrees of depth, the dominant focus of dietetic curricula today continues to be on biomedical aspects of nutrition and healthy eating, indicating that dietetic education is unlikely to equip graduates for work in the emerging field of sustainable eating.

There is wider consensus that sustainability is an important issue in higher
education and a need for all learners to acquire the knowledge and skills needed to promote sustainable development (United Nations General Assembly 2015). Despite this, growing community interest in sustainable eating, and calls for dietitians to bolster food system literacy (Palumbo 2016), barriers remain.

Inadequate time in the curriculum (Harmon et al. 2011) and practical training opportunities, including knowledgeable preceptors (Wegener 2018), are two significant barriers to developing competence in this area. Investing in student training and professional development that is grounded in a clear understanding of the terms, concepts and current issues is essential for practitioners to play a strategic role in the future.

2. Defining Key Terms and Concepts

Sustainable diets (see glossary) is a term that has received increasing attention in the past decade, with roots in these historical eco-dietetic schools of thought and practice; sustainable diets contribute to and are supported by food system sustainability (Meybeck and Gitz 2017). The FAO and Bioversity International define sustainable diets as “… those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations.

Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources” (Burlingame and Dernini 2012). The term sustainable diets places emphasis on the notion that human food choices (diets), and in particular those of “Western” and urban consumers, play a pivotal role in sustainable food systems.
Sustainable food systems is a broader, though clearly related, term that de-emphasises the eater while placing more weight on the complex network (sometimes described as a “food chain”) of actors that produce, process and distribute food to consumers, often across vast geographic scales. The Food and Agriculture Organization (FAO) defines SFS as those that “…[deliver] food and nutrition security for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised” (HLPE 2017).

Both definitions are informed by the broadly accepted concept that sustainability rests on three main, interconnected systems – (i) the environmental, (ii) social and, in our current reality, (iii) economic. This “systems perspective” helps to see and articulate food systems as a complex network of actors and factors (Norberg and Cumming 2008) interacting with these three domains; it is an important perspective for dietetics because if the implicit values at stake are that we nourish our populations in a way that does not compromise future generations, then there is a clear need for dietetic practice to reflect the interrelationship between human diets and the environmental, social and economic impacts of such diets.

While dietetic practice has always put human health as the end goal (and thus the underlying value is that human health is paramount), a true systems perspective requires human health to be balanced against the important needs and limitations of other actors and factors in the system (e.g. other and all people; oceans, soil and air; animals; etc.).

To further challenge dominant dietetic frameworks, one way a systems perspective can be conceptualised is as “nested interdependencies”. Fig. 7.1 illustrates the idea that the economy is nested within (dependent on) human society; similarly, society is nested within the environment. Food systems are nested within all three systems and here illustrated as a
constellation of various-sized actors and factors spanning those three systems.

This nested system perspective is not values-free; it does imply a hierarchy of importance between systems. It begs the question: “do the needs of the environment need to be prioritised above social and economic needs?” Further critical thought questions whether, in our current reality of over seven billion people on Earth, environmental integrity is not also dependent on human society being able to meet its own needs. That is to say, as humans we prioritise our needs at the expense of ecological integrity (e.g., we continue to use unsustainably high proportions of the Earth’s arable land for human food production at the expense of other needs in the ecosystem). One could argue that, similarly, we assign disproportionate weight and power to the “needs” of the economic system, above those of the social and environmental systems (e.g. governing food systems for profit over equitable access to livelihoods, human health and ecosystems). A systems perspective allows us to see these nested systems (i.e., there is a hierarchy of dependencies) as interdependent (i.e., the systems are interrelated and co-dependent in complex ways). A Critical Dietetics approach is framed by one that guides practice in a way that is knowledgeable and attentive to the needs and limitations that govern these nested systems.

![Figure 7.1. A Nested Systems Perspective of Food Systems](image)
3. Unsustainable Nutrition

Food systems are a driving force contributing to ill-health (IPES-Food 2017) and unsustainable conditions in our social and ecological systems.

3.1. Food Systems, Ill Health and Inequality

Food systems are contributing to social changes to eating. The food systems in developed countries, and to an increasing extent in developing countries, are largely corporatized and for-profit sitting squarely within capitalist and consumer-oriented societies (Konefal et al. 2005). Citizens are consequently exposed to many highly processed foods that are energy-dense and nutrient poor, which are also priced and marketed to encourage excessive consumption (Lang 2004). Together with social trends towards time pressure and search for quick, easy fixes, these highly processed foods offer convenient, tasty, albeit less healthy, options, which are seen in global dietary trends and concomitant health problems (Jabs and Devine 2006).

Direct relationships between “Western” diets (and the food systems that perpetuate them) and poor health have been well recognised for over 20 years (Drewnowski and Popkin 1997). Western diets are synonymous with diets excessively high in free sugars, salt, fats, meats, and high levels of processing. They are ubiquitous in industrialised nations and, increasingly, in industrializing nations. Transition towards more Western diets is well known to contribute to diet-related diseases, in particular higher risk of type II diabetes, cardiovascular diseases, hypertension (Drewnowski and Popkin 1997) and some cancers (Bouvard et al. 2015).

While over half the world struggles with diet-related, chronic disease, there are inequalities in food access (Lang 2015). We generate more than enough food to feed our current population, just over 7 billion (United Nations 2017), yet approximately 800 million people in the developing world are
undernourished, and about 2 billion are deficient in key micronutrients (FAO et al. 2017). Chronic or periodic undernutrition can lead to child stunting or wasting, respectively, which can have intergenerational consequences on the attainment of potential growth and development, with negative social and economic impacts. Deficiency in key micronutrients can lead to acute conditions including blindness and anaemia even in adults.

Consequently, the world is facing multiple forms of malnutrition (overnutrition, undernutrition and micronutrient deficiencies) that each carry health burdens. Industrializing countries are struggling with pandemic levels of each, often driven by the nutrition transition, towards Western diets.

3.2. Food Systems and Environmental Degradation

A growing human population is increasing demands on our food systems, and at the same time, food systems are stressed by environmental degradation of global ecosystems. But our current food system is also contributing to compromised ecosystem resources and services on which our ability to produce food depends (Tilman and Clark 2014). An estimated 20–50 % of greenhouse gas emissions (GHGe) are attributed to agricultural activities (Garnett 2011; GRAIN 2011). The bulk of research demonstrates that diets high in red meat (especially from ruminants: cows, sheep, etc.) have a substantial impact on GHGe, even when accounting for variability in production/grazing approaches (Garnett et al. 2017). These GHGe are of central concern to climate change scientists who confirm and predict that climate change is already and will continue to impact our ability to produce food diets that include higher amounts of animal-sourced foods (commonly meats and dairy products) also use significantly more water (Vanham et al. 2013) and require more land for both pasture and feed (e.g. soy) than would diets with proportionately higher amounts of plant-based foods (e.g. various forms of vegetarian and “flexitarian” diets). With
agriculture already using 92% of the global annual average water (Hoekstra and Mekonnen 2012) and land use for human food production at 60% of available land, there is little room to ‘grow’.

These three examples, GHGe, water and land use, provide a meaningful yet incomplete snapshot of the magnitude of food system-related environmental impacts. Taken together with the social and human health-related impacts in the previous section, it becomes clear that implementation of dietary solutions to the tightly linked diet–environment–health trilemma is a challenge on a global scale (Tilman and Clark 2014) requiring a “systems” approach (iPES Food 2015).

With possible co-benefits emerging, more sustainable nutrition lies at the intersection of public health, environmental health and the business of food (Garnett 2014). Food is a massive industry, and the many key players involved have very different interests. There is a call for stronger multi-sector leadership in championing a sustainable ecological approach to food systems (City University of London Centre for Food Policy 2018). Nutrition and dietetic professionals are in a strong position to participate in leading food system sustainability discourse and practice and have a clear role in safeguarding food and nutrition priorities. However, as is discussed in the next section, case examples from the UK, Australia and Canada show that there is a need for a better understanding of their strategic role, and role-specific priorities need to be more strongly articulated. A clearer picture of the professional role will inform training and professional development needs (Pettinger 2018).

For the past number of decades, nutrition and dietetic professionals globally have gained competency working to maximise the diet–health outcomes domain and applying Social Determinants of Health lens to address human health. However, despite the professional history of environmental engagement, addressing ecological determinants of health
(e.g., CPHA*ACSP 2015) is mostly considered “out of scope” for health practitioners including dietitians. This is influenced by the dominant neoliberal politics of many countries (including the UK, Australia and Canada), which privilege an individualist focus over a structural (systems) one (Jessop 2016). To guide nutrition and dietetic education, practice and scholarship, a conceptual framework that guides a transformative curriculum around SFS and diets is needed.

4. Sustainable Nutrition in Practice

In 2016, the International Congress of Dietetics adopted the theme of ‘going to sustainable eating’, demonstrating a growing level of interest among dietitians around the globe (and in particular in the European countries, who hosted the Congress). Despite weak and often ad hoc emphasis on the key concepts and issues in education, practice and scholarship in most countries, many dietitians are applying this lens to practice, stepping into non-traditional roles and leadership opportunities to forward this agenda. This section outlines examples from the field in the UK, Australia and Canada, outlining the current situation, (educational) action and outcome for each case presented.

4.1. The UK

In the UK, a recently updated sustainable diet policy statement by the British Dietetic Association (BDA) has stated that it believes the profession should be leading discussions on how food behaviours can affect both health and the environment (British Dietetic Association 2017). Dietitians, the policy states, are in a strong position to combine healthy eating messages and sustainable dietary advice. This aligns with the newly upgraded UK Eat Well Guide, which mentions sustainability in relation to meat and fish consumption. This BDA policy is accompanied by a practical “toolkit” to support dietitians in practice (BDA, 2018) recently
co-created by the BDA with an active group of “special interest” dietitians/nutritionists. Many UK dietitians and nutritionists are already engaged in sustainability advocacy across a range of sectors, for example, working with local food partnerships, a movement that is currently driven by the “Sustainable Food Cities (place based) Network.” Similarly, some UK dietitians and nutritionists have been involved in sustainability-driven settings-based award schemes, in schools and care home settings, which have seen positive outcomes. Notwithstanding, positive systems level activity and investment in dietetic student training is important.

Sustainability is being addressed in the dietetic curriculum at the University of Plymouth. An exploratory pedagogic workshop was run with final year dietetic students as part of their Public Health Nutrition module in October 2016 (Pettinger et al. 2018). Student participants (n = 26) attended a 2-h workshop, which included:

(i) delivery of learning materials by a sustainability specialist dietitian,
(ii) basic interactive survey,
(iii) group work (discussing potential roles of dietitians in different settings) and
(iv) plenary discussion.

The question template was designed based on previous research suggesting a lack of dietetic knowledge about sustainability (Webber and Sarjahani 2011) and supported by responses gathered from a LinkedIn ‘straw poll’ carried out in spring 2016 asking UK dietitians (n = 9) about their broad views on sustainability. This poll indicated above all a lack of definitional clarity around the term ‘sustainability’ for dietitians. Qualitative feedback was obtained from participating students who demonstrated a reasonable understanding of sustainable eating and could articulate practical roles for dietitians in promoting sustainability, for example, “liaising with [hospital] catering team and minimizing food/supplement waste” (student 10). They
were enthusiastic to learn about sustainable eating and felt that it should be more strongly embedded in the dietetic curriculum, for example, “it should just be throughout every subject … so in the ‘Dietetics in Practice’ module, when we’re talking about practical food advice, get us thinking about sustainability, e.g., less meat” (student 5). The views of the students concur with general UK student views (Cotton and Alcock 2013) including that a sustainability lens is needed for curricula that are “fit for the future” (Goodman and East 2014). Interactive participatory workshops align well with adult learning theories for healthcare professionals (Taylor and Hamdy 2013). They have been documented to motivate and energise students, empowering them in transformative learning experiences (Seale 2013). More research is needed to support this educational goal to enable students to be better prepared for the diversity of their future practice. This research is ongoing, currently investigating nutrition/dietetic students’ environmental attitudes and how these relate to their actual sustainability practices and behaviours.

4.2. Australia
The Dietitians Association of Australia and the Australian Public Health Association (PHAA) have interest groups that engage dietitians and nutritionists on nutrition and sustainability matters. Both groups focus on information sharing, professional development and advocacy. The PHAA has developed explicit policy statements which it uses for advocacy purposes. Public health dietitians advocated for inclusion of sustainable eating into the latest version of the Australian Dietary Guidelines, and, while this is not explicit in the key messages of the guidelines, it nevertheless informed the food modelling and was inserted in the appendices (NHMRC 2013).

Notwithstanding professional interest groups, the application of sustainable eating into professional practice by Australian dietitians and nutritionists is largely individualised and voluntary because sustainable
eating is not structurally embedded within government food-related policies. At the time of writing this chapter, (2018), Australian governments at all levels have reduced their investment in health promotion and prevention, thereby further marginalizing nutrition sustainability work (Moodie et al. 2016).

Flinders University of South Australia has had a long tradition of critically investigating the food system in its nutrition and dietetic curriculum. It is assumed that this topic is also addressed by other Australian universities. Apart from student education, in 2016, Flinders University academics from Nutrition and Dietetics and Public Health have trialled community education on food systems. They developed a 2-week online course, Food System Matters (FSM), which examined the food system through three lenses: environmental sustainability, fairness and equity and health and nutrition. The curriculum was delivered using a combination of text, videos, images, quizzes, activities, critical thinking questions and discussion forum.

The course was delivered through Flinders Learning Online (FLO), Flinders University’s internal education platform which limited the trial to staff and students of the university. The education program was evaluated for effects on knowledge about the food system literacy and attitudes to food choices for health (Mehta 2017).

Forty-seven staff and students participated in the course and were randomly allocated into one of two groups – (1) Intervention and (2) Control and Intervention.

Knowledge about the food system improved significantly for both Intervention groups from baseline (p < 0.001) compared to the Control group (p = 0.00). Attitudes to sustainable food choices improved significantly for both Intervention groups from baseline (p < 0.001; p =
0.005) but, however, were not statistically significant when compared to the Control group (p = 0.065; p = 0.43), although in a positive direction.

Following the quantitative evaluation, a qualitative evaluation was undertaken in 2017, of FSM participants’ engagement in sustainable eating behaviours and food system education. Nine tertiary-educated staff participated in the semi-structured interviews. The majority of participants were found to be in the later stages of health behaviour change, in other words, action and maintenance according to the trans-theoretical model of behaviour change (Glanz et al. 2015). The FSM course consequently reinforced their existing beliefs and practices about sustainable eating.

Participants were primarily motivated by ethics and benefits to broader society which aligns with a US study by Alkon (2008) but contradicts other studies which emphasised values of health, quality, freshness and taste (Hoek et al. 2017). The challenge for community food system literacy is common to all types of health education, namely, to reach those people who are less committed to change by dint of being in the contemplation and pre-contemplation stages of health behaviour change (Hirvonen et al. 2015). Even for the committed participants, time was reported as a barrier to their engagement, and time is known to be a common barrier to participation in health promotion (Linnan et al. 2001).

Food system literacy offers a novel approach to engage the public in a broader discourse on food and society (Lang 2005). Food system literacy has the potential to yield health benefits because food consumption behaviours oriented towards social and environmental sustainability will by default be healthier choices, favouring less meat and processed foods and more locally produced fruits and vegetables (Friel et al. 2014). Notwithstanding the positive outcomes of this pilot community education program, it is not supported by government policy or funding, thereby
providing graduates with few opportunities to hone their skills in this subject area.

4.3. Canada
In Canada, Dietitians of Canada is beginning to make strategic steps to support Canadian dietitians to be leaders in SFS. In 2015, the Board of Directors of Dietitians of Canada (DC) sets a strategic direction to raise the profile of dietitians as leaders in SFS that promote healthy diets and that involved building a common understanding of what this means, such that dietitians can participate in intersectoral innovations and advocacy. This strategic direction led DC to collaborate on research that began to fulfil these needs and to initiate a SFS Leadership Team to support DC in advocacy and action.

With partners from Acadia University (Canada) and Blekinge Institute for Technology’s Department of Strategic Sustainable Development (Sweden), in 2017 DC engaged in research to create common understanding of what we mean when we say “sustainable food systems” and begin to set a course for action. In the research, members of DC were invited to participate in an iterative dialogue through a modified Delphi inquiry process; Carlsson et al. 2019) which asked dietitians to envision a sustainable food system in Canada, describe current barriers and supports, describe high-leverage actions as well as suggest indicators to track progress.

This research was in part established to fulfil the needs of the DC SFS Leadership Team, which is currently focused on three key areas: policy and advocacy, education and communication. The outcomes of the research and the Leadership Team are tied. Of the 4885 DC members invited to participate in the research, over 50 dietitians participated in dialogue over the course of 6 months. Outcomes suggested that high-leverage action areas for dietitians include education, organizational
infrastructure/policies and public policy, and key action approaches highlighted the need for reflexive and collaborative approaches (Carlsson et al. 2019). Central to the aim of this chapter was that participating dietitians highlighted the need for education for SFS literacy among dietetic students, professionals and the public. Participating dietitians made it clear that while food systems and sustainability are listed as foundational knowledge statement requirements to which all accredited dietetics programs in Canada must adhere (Partnership for Dietetic Education and Practice 2014), dietitians are generally not adequately trained to step into multisectoral innovation for SFS. They identified a need for stronger integration of SFS in dietetic education and training, along with post-graduate professional development opportunities and resources to guide practice, such that dietitians are well equipped to lead the development of programming and policy that will strengthen public SFS literacy.

The need for such education is one of the areas the Leadership Team has chosen to focus on, who, at the time of writing, have developed an evidence review on plant-based diets and the environment, which will form the basis of future practice resources, and discussions at national conference on setting strategic directions, speaking about sustainability in language accessible to the audience, plant-based diets in institutions and the role of dietitians in sustainable diets.

The Leadership Team has also been actively advocating for national food policy that applies a systems lens, for example, through explicit messages about sustainability in national food guidance. While there is still much work to be done, the member-informed and member-led approach that Dietitians of Canada is taking shows promise for increasing interest in SFS as a practice area and competence to lead innovations for food system sustainability.
These three case study examples illustrate movement (in the right direction) globally in this essential field for dietitians. Yet, all three, highlight obvious educational gaps that need to be urgently filled, if the future dietetic workforce is going to be adequately equipped with the skills required to contribute to SFS.

5. Moving Forward

5.1. What Is the Role for Dietitians?
Dietitians have an important role in advising the public around sustainable diets as well as addressing the many challenges of building a more resilient and sustainable food system. In the US, this role is recognised and defined by the publication of the professional position paper ‘Standards for Professional Performance for Registered Dietitian Nutritionist in Sustainable, Resilient, and Healthy Food and Water Systems’ (Tagtow 2014).

Given some of the evidence reviewed under the section on Unsustainable Nutrition, linking food systems to human health, food culture and environmental degradation and given the globally interdependent nature of these complex issues, the role of nutrition professionals is more significant and pressing than ever, and international coordination is advisable. But for this to happen, there needs to be an agreement from international and national dietetic/nutrition professional bodies that sustainability/food system literacy is an essential part of education, training and practice.

The case examples in this chapter illustrate that there are several key leverage points where nutrition and dietetic professionals can make meaningful, systematic change: (1) advocacy and public policy, (2) influencing organizational policies and structures and (3) education and training for both nutrition professionals as well as the public. In this section we discuss the third leverage point – education and training—and explore
5.2. The Need for Education and Training

There are international and national level calls for general sustainability education to meet the United Nations Sustainable Development Goals, as well as specific calls related to health professionals. Currently dietetic education and training does not equip present and future professionals for leadership roles in SFS and diets (Pettinger). Harmon et al. (2011) has highlighted the need to develop foundational educational knowledge and skill competencies for nutrition professionals related to food systems and sustainability, and it has been described as an obligatory professional growth area by Wegener (2018).

There is emerging evidence that integration of even short-term sustainability education into formal education can be an effective tool for public education, as illustrated by the Australian case example, as well as dietetic trainees. Innes et al. (2018) looked at the integration of ‘environmental literacy’ in undergraduate nutrition programs in the USA and found that a 2-week food sustainability module improved student sustainable literacy levels. These two examples support the utility of formalised sustainability education, in particular in concentrated modules that may be easier and faster to implement than holistic curriculum changes, and an opportunity for dietetic education and training, as well as continued professional development models.

However, a Critical Dietetics approach would challenge dietetic educators to apply a more systematic approach – using a ‘sustainability lens’ through which to view the development of nutrition and dietetic education, practice and scholarship that are:
• Grounded in a clear understanding of the terms, concepts and current issues.
• Knowledgeable and attentive to the needs, limitations and interdependencies of the economic, social and environmental systems.
• Guided by a conceptual framework that facilitates critical analysis of complex systems approaches.

5.3. The Approach
A Critical Dietetics approach would also be reflexive – moving forward with new ways of thinking about evidence – and collaborative, with expanded notions of what other expertise is relevant to our work. New ways of thinking about evidence are necessary. There are some nutrition professionals already championing leadership in this area, who recognise the paradigm shift that accompanies the advancing wave of complexity thinking which emphasises “non-linear” contexts and promotes ‘systems thinking’ approaches to problem-solving. There is a fundamental challenge, however, for nutrition/dietetic education, which has its traditions in biomedical models of evidence-based practice relying on mainly reductionist research paradigms. Extending the remit of evidence-based practice to embrace more relational models of critical thinking is needed in all nutrition training and practice. The Critical Dietetics movement “seeks to explore new ways of framing how we educate, practice and research in dietetics, i.e., the professional discipline of nutrition” (Gingras et al. 2014). This postulates the need to expand traditional theoretical frameworks beyond current conventional thinking.

Nutrition professionals, therefore, should be bringing critical perspectives on food and health (in their broadest sense) to sustainability. Dietitians are accustomed to collaborating in multidisciplinary teams (e.g., other health professionals, community services, urban planning, etc.). In the area of food systems sustainability, collaborations with less familiar sectors can
present new challenges and opportunities, perhaps even conflicts of interest, if, for example, work is being carried out with the private sector (Johnston and Finegood 2015).

Regardless, an openness to knowledge, evidence and experience together with non-traditional knowledge domains and colleagues is important to meaningful learning and progress. We cannot be experts in all the relevant socioecological domains; but by learning to learn from and collaborate with others, practitioners and members of the public may approach a more reflexive, systems approach.

6. What Are the Barriers?

While arguing for systematic integration of a critical sustainability lens in dietetic education, and practice, we recognise that there are known barriers, which need to be acknowledged. These can be categorised as sociopolitical, professional and institutional.

6.1. Sociopolitical Barriers
The governments of Australia, the UK and Canada can be described as neo-liberal, to the extent that economics is at the heart of the conduct of government; free markets are perceived to be essential to the success of the sovereign state and its population (Dean 2010). Neo-liberalism maintains the governance role of the state at a level which is moderate, frugal and prudent. Not unexpectedly, in neo-liberal societies, the food industry exerts considerable influence on matters of governance (such as national dietary guidance), upholding its profit-making interests even when this conflicts with public interest. Citizens in neo-liberal societies are considered to be autonomous individuals, with the freedom to choose; however, these rights come with responsibilities for self-regulation, e.g. to make food choices that contribute to wellbeing (Bauman, 2009). Dietitians, as the experts using disciplinary knowledge and technologies,
reinforce food industry-informed, publicly encouraged (through, e.g., dietary guidance) behaviours through education, monitoring and surveillance of citizens. In this way, dietetics has adapted uncritically to the dominant individualistic discourse and evolved to work with the autonomous, self-regulating individual, rather than problematizing structures or systems. Further, this societal discourse presents a challenge as the public too is embedded in this discourse (Mehta 2013).

6.2. Professional Barriers
While there is evidence of growing interest and engagement, there are mixed levels of competence. Some researchers have found that there appears to be a reasonable understanding of the broad conceptual definitions of sustainable eating, while others indicate a lack of knowledge, practical skills and competence to work confidently on SFS. Predictably, a small sample of student dietitians reported that they do not have the confidence in their knowledge to apply it effectively (Pettinger et al. 2018), even though they wanted to engage with the topic.

This is exacerbated by the lack of clarity on the complex terms and concepts and reinforced by apparent conflicting perspectives about communicating information on sustainable diets and eating. Consumers are influenced by nutrition and health messages from a range of different sources, some of them with conflicts of interest, for example, between profit and consumer wellbeing and social or environmental outcomes. The sustainable diet agenda is likely to add to the plethora of messaging, and potentially confuse consumers further (Mason and Lang 2017), and thus an opportunity for dietitians, who are skilled in effective public education, to engage.

Furthermore, in the UK, the relevance of SFS and diets is not uniformly clear across different population groups (e.g. vulnerable groups) yet alone in the various dietetic practice settings and concern that these priorities
might conflict with nutrition therapy priorities. Perceived lack of relevance and cultural authority to act will be a barrier to meaningful integration of a SFS lens in how dietitians work with interns, colleagues (including those from other disciplines) and the public to frame problems.

6.3. Institutional Barriers
In most countries that offer accredited programs in universities, dietetic curricula are driven by professional standards. This offers significant advantages in terms of the credibility of the profession. But as discussed previously, one fundamental challenge is that these professional standards are shaped by scientific evidence rooted in biomedical models of evidence analysis, as well as neoliberal governance models, which don’t lend themselves well to complex socioecological challenges such as unsustainable nutrition.

Furthermore, practical issues such as time and space in the curriculum are perceived as significant barriers to expanding teaching on food systems and sustainability. Despite universal acknowledgement that a wide range of skills and knowledge are required to create an action-orientated sustainability-literate graduate body, many of these skills and attributes are inadequately addressed in dietetic curricula because the already tight curricula prioritise competency specifications of professional dietetic bodies.

7. Conclusion

While the barriers are many, the case examples in this chapter highlight examples of sustainability education being incorporated into dietetic and public education as well as practice. These demonstrate the potential of emerging examples of the application of a sustainability lens in dietetic education, the use of formal education approaches, settings-based motivational programs for public education on food systems sustainability
as well as efforts on the part of professional dietetic associations working to embed these issues into the organizational culture. To build on these, and other successes, there is a need for a Critical Dietetics approach: one that is based on values where individual health, the health of the society (social system) and ecosystem health are of equal importance; one that moves beyond the biosciences to a conceptual framework that guides transdisciplinary and transformative education for nutrition students, practitioners and the public.

8. Assignments

Level 1: Understanding key concepts.
Compile your own glossary of terms based on any concepts that are unfamiliar to you (try to make them evidence based where possible).

Level 2: Reflect on and apply key concepts in a new context.
Reflect on your experience as a nutrition and dietetics student thus far. In what ways could a Critical Dietetics approach to SFS and diets have been integrated into some of your learning opportunities (course work, practical training, etc.)? Imagine yourself practising within the following dietetic/nutrition settings. Describe opportunities to apply sustainable diet/food system thinking to your role: e.g., of roles (public health, industry, community, clinical, media or other role that is emerging or relevant in your home country)?

Level 3: Analyse and critique the concepts.
Moving beyond the focus on educational aspects, write a critical analysis of the nutrition professional/dietitian roles in (1) advocacy and public policy and (2) influencing organizational policies and structures.
9. Definition of Keywords and Terms

Ecological nutrition A term used to capture such a multidimensional and systems approach now broadly considered necessary to achieving sustainable diets.

Sustainable diets The FAO and Bioversity International define sustainable diets as “…those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations.

Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources”.

Sustainable food systems The Food and Agriculture Organization (FAO) defines SFS as those that “…[deliver] food and nutrition security for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised” (HLPE 2017).
References


CPHA*ACSP (2015) Global change and public health: addressing the ecological determinants of health. Canadian Public Health Association, Ottawa, ON


Garnett T (2011) Where are the best opportunities for reducing greenhouse gas emissions in the food system (including the food chain)? Food Policy 36:S23–S32. https://doi.org/10.1016/j.foodpol.2010.10.010


Mehta K (2013) Parents’ and children’s perceptions of food and beverage marketing to which children are exposed. Flinders University


NHMRC (2013) Australian dietary guidelines. National Health and Medical Research Council, Canberra


**Suggested Readings**

Food Climate Research Network’s Foodsource: Evidence-based resources on SFS. Foodsource’s purpose is to build the foundations for this understanding and for change towards more SFS, by increasing food systems literacy

Mason P, Lang T (2017b) Sustainable diets: how ecological nutrition can transform consumption and the food system. Earthscan, Abingdon