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An Approach for Integrating and Analyzing Sustainability in Food-Based Dietary Guidelines

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International organizations, governments, researchers, and activists have proposed the need for deeper integration of sustainability considerations in national food-based dietary guidelines (FBDGs). Yet, as recent scholarship advances the conversation, questions remain around how to effectively frame and address the interconnectedness of multiple sustainability domains. Little systematic analysis has evaluated how current FBDGs have integrated complex messages about socially, environmentally, and economically sustainable consumption practices with nutrition and health messages. This study had two nested objectives: (i) to examine the validity of an existing sustainable diets framework by assessing how sustainability concepts have been framed and included in national FBDGs available from 2011 to 2019 and (ii) to describe a novel analysis approach that augments an existing framework which integrates sustainability domains and can be adapted for use by future FBDGs. A qualitative content analysis was used to examine sustainability concepts found in 12 FBDGs and supporting documents available in English that were developed for use in 16 countries across Europe, North and South America, and Asia as of 2019—from a global review of those published prior to 2016 and gray literature review of publications between 2016 and 2019. Health domains were the primary frame found across the FBDGs examined, but documents also commonly incorporated agricultural, sociocultural, and economic sustainability principles. Analyzed documents were used to adapt an existing policy analysis framework into a “Sustainability in FBDGs Framework.” This proposed framework contributes a novel analysis approach and has five core domains that are interconnected: health and nutrition, food security and agriculture, markets and value chains, sociocultural and political, and environment and ecosystems. This study adds to the growing body of literature related to sustainable food systems and dietary guidelines by presenting how sustainability framing in FBDGs can be used to further develop a comprehensive framework for integrating sustainability domains. While this project helps to validate previous work, further analyses of FBDGs which have emerged since this study and those not available in English are needed to improve the guidance approach described here and for assessing the incorporation of sustainability domains in future FBDGs. This work is useful in informing processes for policy developers to integrate sustainability considerations into their national FBDGs.

Keywords: dietary guidelines, sustainability, sustainable diets, integrated framework, food system

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INTRODUCTION

Global food systems are facing multiple sustainability challenges. Agriculture has pushed Earth's systems past planetary boundaries in biosphere integrity, biogeochemical flows, and land-system changes (Steffen et al., 2015). Sixty percent of fish stocks are completely depleted and 30 percent are over-fished (UN FAO, 2010). Estimates of 25–30% of global greenhouse gas (GHG) emissions are attributed to livestock and agricultural production (Tubiello et al., 2014). Given such challenges, global temperatures have risen and precipitation patterns have changed, perpetuating a negative feedback loop impacting food systems (Vermeulen et al., 2012).

There is recent recognition that dietary practices can improve environmental outcomes and the sustainability of the food system (Macdiarmid, 2013; Tilman and Clark, 2014; van Dooren et al., 2014; Hallström et al., 2015; Willett et al., 2019). “Environmentally-friendly” food choices and consumption patterns can have an impact on larger food systems; for example, buying direct from producers or purchasing more local foods disrupts globalized production and supply chains and can contribute to nutritious dietary practices at home (Mbow et al., 2019; Willett et al., 2019).

Calls have been made for more environmentally-sustainable diets over the last decade (Godfray et al., 2010; Foley et al., 2011; Tilman and Clark, 2014; Aleksandrowicz et al., 2016; Springmann et al., 2016; Willett et al., 2019). Plant-based diets incorporating whole grains, pulses, fruits and vegetables, and seeds and nuts, with reductions in ultra-processed and animal-based food are proposed as healthy and sustainable dietary patterns (Mbow et al., 2019; Willett et al., 2019). Still, many definitions of sustainable diets have been put forward. The existence of multiple definitions poses a challenge for developing a singular guiding recommendation for shifting dietary patterns. The study herein adopted the definition compiled by the UN FAO and Biodiversity International of healthy and 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” (UN FAO, 2018), p. 1.

Dietary guidelines have been proposed as one tool to promote sustainable dietary practices and address the complex challenge of shifting diets (Gussow and Clancy, 1986; Dye Gussow, 1999; Lang, 2017; Lang and Mason, 2017; Seed and Rocha, 2018; Willett et al., 2019). Recent evidence has shown that greater adherence to FBDGs has been correlated with more plant-based diets; further, diets following guidelines were associated with lower health costs, energy intake and environmental impact scores, more deaths averted, and less exposure to pesticides (Kesse-Guyot et al., 2020).

Abbreviations: GHG, Greenhouse gases; FBDGs, Food-based dietary guidelines; NNR, Nordic Nutrition Recommendations; SDGs, United Nations Sustainable Development Goals; UN FAO, United Nations Food and Agriculture Organization.

Food based dietary guidelines (FBDGs) are a tool to disseminate the policy guidance given by national governments, and can be the foundation of national dietary education, measurement, and monitoring activities (Seed and Rocha, 2018).

Recent political and scholarly discussions of sustainability—and its importance—in national-level nutrition policy and guidelines has grown. Members party to the Rome Declaration on Nutrition (FAO, 2014) and the United Nations (UN) Decade of Action on Nutrition (United Nations, 2017) have committed to incorporate sustainability considerations in national policy change for health and nutrition. Prior calls from scholars for sustainability in FBDGs have supported such policy transitions (Gussow and Clancy, 1986; Dye Gussow, 1999; Lang, 2017; Lang and Mason, 2017; Seed and Rocha, 2018; Willett et al., 2019).

Public health scholars and practitioners have acknowledged the need for food policy to include sustainability considerations (Sabaté et al., 2016; Wegener et al., 2018). Despite such discussions, little systematic work has evaluated how food-based guidelines integrate and frame sustainability considerations (Ahmed et al., 2019). A framework is needed for comparing progress across guidelines and as a guidance approach for future integration of multiple sustainability dimensions into FBDGs (Lang, 2017; Ahmed et al., 2019). Such a framework could be used to understand how food guides integrate sustainability considerations to meet broader international sustainability goals (Ahmed et al., 2019; Willett et al., 2019).

A shared framework for assessing and integrating sustainability into FBDGs has yet to be ratified by the larger scientific community (Lang and Mason, 2017). Studies on FBDGs where guidelines do include sustainability dimensions have found that human health aspects of sustainability (e.g., dietary diversity, limiting energy intake, plant-based foods) are more represented than socio-cultural and political, economic, and environmental aspects (Ahmed et al., 2019). Beyond health, movement toward integration of sustainability into FBDGs is limited by the lack of consensus on what constitutes and how to recommend a sustainable diet in different geographical and climatic areas and sociocultural contexts (Tuomisto, 2019; Zagmutt et al., 2019).

Framing is a form of political influence and is a theoretical and methodological tool for the study of problems and how they are discussed (Jenkin et al., 2011). Frames are important since they make some aspects of reality more salient by describing an issue, and frames offer the authors' description of the solution (Entman, 1993; Trevena et al., 2015). Framing has implications for the ways actors influence their world and make sense of issues and opinions. Given the edifying goals of FBDGs, an awareness of the way sustainability is framed is a step toward understanding how actions are being influenced toward sustainability (Trevena et al., 2015).

Some existing frameworks have been proposed as quantitative tools to inform the evaluation and modification of national food policies and dietary guidelines (Downs et al., 2017; Ahmed et al., 2019). Downs et al. (2017) developed a food policy framework and applied it to Nepalese food policy. Their framework is the first of its kind to interrogate the presence of sustainability dimensions and associated sub-dimensions in food policy. The

Downs et al. (2017) framework was developed to be applied to documents beyond Nepal. A second framework by Ahmed et al. (2019) was built upon the Downs et al. (2017). This second framework was developed specifically for examining the presence or absence of the human health, environmental, economic, as well as sociocultural and political sustainability dimensions in FBDGs (Ahmed et al., 2019). It has been noted that further use of these existing frameworks is needed to address the qualitative framing and interconnectedness of the various sustainability domains (Ahmed et al., 2019).

Frameworks intended to guide choice and policy need to acknowledge and navigate complexities of the food system (Ahmed et al., 2019; Mbow et al., 2019; Willett et al., 2019). Frameworks need a way to recognize the interconnectedness of food, health, and the environment in signaling needed environmental, policy, and system improvements. Such food system interconnections include environmental and socio-cultural dimensions (e.g., preference, food security) and do not assume consumption choices are driven solely by health (Rizvi et al., 2018).

The overall aim of this study was to examine how sustainability is framed in FBDGs. This study contributes a novel analysis approach to and validation of existing frameworks. Such adaptation applies existing frameworks to enable qualitative investigation of sustainability domains and examine complex interconnections in those domains for recommending healthy and sustainable diets. This study has two main, nested objectives. The first objective was to examine the validity of an existing sustainable diets framework by assessing how sustainability concepts have been framed and included in national FBDGs available from 2011 to 2019. This was done by focusing on: (i) how sustainability concepts were framed and included in FBDGs developed explicitly with sustainability considerations in guideline planning and writing prior to 2019; (ii) how concepts were interconnected in current FBDGs; and (iii) how the current analysis builds on recent literature regarding international sustainability framing in FBDGs. We aim to adapt existing frameworks and further apply a novel analysis approach to elicit a comprehensive framework which graphically depict the key domains, concepts, and their interconnections. The second objective uses the findings of the first objective to propose framework adaptations that graphically represent the overlaps and interconnections of diverse sustainability concepts.

MATERIALS AND METHODS

Document Collection and Inclusion Criteria

The initial selection of the FBDG documents analyzed in this study was based on the UN FAO global review of FBDGs in 2016 (Gonzalez Fischer and Garnett, 2016). The study identified 83 of the 215 countries worldwide (39 percent) as having FBDGs, of which 11 (representing 15 countries) included sustainability considerations. Though many other countries have FBDGs, the scope of this study applied only to those identified by the global UN FAO review with *explicit* sustainability considerations in planning and writing of the documents of those published prior to 2016 and our gray literature review of publications between 2016 and 2019.

The UN FAO review divided these eleven FBDGs into three categories related to the extent of integration of sustainability concepts (Gonzalez Fischer and Garnett, 2016). The first category identified four countries (Brazil, Germany, Qatar and, Sweden) that have official guidelines with explicit references to sustainability in their main messaging: “Official guidelines that include sustainability.” The second category of FBDGs described four documents (the Nordic Nutrition Recommendations, United Kingdom, France and, the Netherlands FBDGs) with “Quasi-official guidance that combines health and sustainability messaging.” Quasi-official guidelines were defined as “those that stem from government agencies or government funded entities” (p. 17). The final category consisted of three countries (Australia, China and, United States) with attempts to include sustainability. The meaning of attempts included those documents where “environmental considerations reach[ed] an advanced stage but [did] not achieve government endorsement” (p. 3).

National FBDG documents were sourced from the FAO database (Food Agriculture Organization of the United Nations, 2019). Documents were included in this analysis if the document was highlighted by the FAO review in one of the three above described categories. A review of the FAO database revealed no other FBDGs published after the UN FAO report with sustainability explicitly placed in their guide. However, the 2019 Canadian Dietary Guidelines document “for Health Professionals and Policymakers” was also included. The Canadian guidelines were released and added after an initial analysis because they included explicit language identifying the environmental impacts of diets as a consideration (Health Canada, 2019). Documents were excluded if not available in English (e.g., official French FBDG in French) or included no specific or explicit connection to sustainability integration. Ten official FBDGs and two supporting documents from 16 countries or regions were therefore analyzed; see document description in **Table 1**.

First Objective: Examine How Sustainability Has Been Framed in National FBDGs

This study followed the qualitative content analysis procedure from Mayring (2004) to examine the sustainability domains used in current FBDGs and how sustainability concepts are interconnected. Qualitative content analysis involves three main parts: (i) examining collected documents using content analysis categories formed from a foundational framework, (ii) building upon the framework with the data collected, and (iii) performing formative and summative checks of the content analysis categories used. To make use of the concepts and definitions in previous literature and the emergent data, this study used combinations of deductive and inductive coding in qualitative content analysis.

Within each document, line-by-line coding produced the qualitative data. Coding was completed through close reading of the documents where content was coded based on defined categories. Domains for this analysis were based on the pre-existing domains of sustainable food policy framework by the Downs et al. (2017), on which Ahmed et al.’s (2019) framework

TABLE 1 | Summary of Food-based Dietary Guidelines and related documents examined ($n = 12$), table separated by category of sustainability inclusion.

FBDG group	Country	Document	Year published	Publisher (reference)	Types of document development stakeholders
Sustainability in official FBDG	Brazil	Dietary guidelines for the Brazilian population	2015	Ministry of Health of Brazil (Ministry of Health of Brazil, 2015)	Ministry of health, Center for epidemiological research in nutrition of the university of São Paulo, Brazilian Pan American health organization office, experts from health, education, social protection, and agriculture, researchers, representatives of civil society groups (professional councils, associations, public policy social control councils, consumer protection organizations)
	Germany	Ten guidelines for wholesome eating and drinking from the German nutrition society	2013	German Nutrition Society (German Nutrition Society, 2013)	German nutrition society, ministry of health, ministry of agriculture
	Qatar	Qatar dietary guidelines	2015	Qatar Ministry of Public Health (Supreme Council of Health, 2015)	National dietary guidelines taskforce, public health and nutrition representatives, Qatar national food security program, academics, medical associations, research centers, supreme council of health
	Sweden	Find your way to eat greener, not too much and to be active!	2015	Swedish National Food Agency (Swedish National Food Agency, 2015)	National food agency, public health agency, Swedish board of agriculture, food industry, research centers, public health and nutrition experts, consumer organization, patient organizations
	Canada	Canada's dietary guidelines for health professionals and policymakers	2019	Health Canada (Health Canada, 2019)	Health Canada, policy makers, public consultations, experts
Sustainability in supporting/quasi-official FBDG	France	French national nutrition program (supporting the French food guide for all - avail. in French)	2011	Ministry of Health; National Institute for Prevention and Health Education (Department of Health, 2012)	French national nutrition and health program
	The Netherlands	Dutch dietary guidelines (advisory report)	2015	Health Council of the Netherlands (Health Council of the Netherlands, 2015)	"Expert committee;" health council of the Netherlands standing committee on public health; standing committee on health care (revised and endorsed report); Netherlands nutrition centre; national institute of public health and the environment
	Denmark, Estonia, Finland, Iceland, Norway (Sweden)	Nordic nutrition recommendations - 2012	2014	Nordic Council of Ministers (Nordic Council of Ministers, 2014)	Various ministries of health in Sweden, Finland, Denmark, Norway, Iceland
Sustainability attempts in FBDG	United Kingdom	United Kingdom eatwell guide booklet	2016	Public Health England (Public Health England, 2016)	Public health England, food standards Scotland, welsch government, food standards agency in Northern Ireland
	Australia	Australian dietary guidelines	2013	National Health and Medical Research Council (National Health and Medical Research Council, 2013)	National health and medical research council; leading experts in the fields of nutrition, public health, industry, and consumer issues; commonwealth department of health
	China	Chinese dietary guidelines and the food guide pagoda	2016	Chinese Nutrition Society (Wang et al., 2016)	Chinese nutrition society; "various stakeholders;" commission of experts from the Chinese nutrition society; ministry of health
	United States of America	2015–2020 Dietary guidelines for Americans	2015	U.S. Department of Health and Human Services; U.S. Department of Agriculture FBDGs (U.S. Department of Health, Human Services, and U.S. Department of Agriculture, 2015)	U.S. department of agriculture; U.S. department of health and human services; advisory committee (prestigious researchers and scientists in the fields of nutrition, health, and medicine)

was also based. The five domains identified were: nutrition and health, food security and agriculture, environment and ecosystems, markets and value chains, and sociocultural and political. Each domain has several concepts that were used to code document references (i.e., the data collected), indicating their inclusion in each domain. Collected data were organized by domain and concepts to understand the content covered and how sustainability concepts were included. For this analysis, all 60 concepts from the original Downs et al. (2017) framework were included to determine if there was inclusion of all concepts.

This qualitative research coding approach sought to elicit core, common themes from a large body of data. This study follows the single reviewer methods of policy analysis and single knowledgeable coder approaches, reproducible if other similarly knowledgeable coders apply the same method (Campbell et al., 2013; Seed, 2015). Using such a qualitative approach did not seek to provide quantitative assessments of reliability imbued with positivistic bias (Syed and Nelson, 2015). This approach was used as it is appropriate for seeking meaning and deep understanding of the data, not seeking quantitative reliability but complex understanding. To improve quality of coding, four readings were completed of each document, with reformulating and re-coding each time. The first author carried out all reading and coding which is supported by Krippendorff's position that having multiple coders "does not affect the measured reliability" (Krippendorff, 2004) p. 219.

The initial content analysis categories were the concepts and definitions from Downs et al. (2017). Concepts were then adapted and combined based on emergent data from the documents and from Ahmed et al.'s (2019) framework. In the combined deductive-inductive approach that was utilized in the study (Drisko and Maschi, 2015), the sources of each concept and examples of the coded data are provided below. Concepts covered in the documents that did not fit within the original framework were added from the data (i.e., the FBDGs examined) in an iterative and recorded inductive process. With each addition or shifting of the concepts, a review of the previously examined documents occurred to investigate the use and connections the given concept shifts.

To investigate the interconnection of concepts in the coded data, matrix coding queries were run in QSR International's NVivo12 Software for cross-concept comparison. Text segments that were coded under two or more concepts were highlighted and reviewed for their use across documents. Review of the text under two or more concepts also included investigation of the way that each piece of text overlapped with more than one domain.

Second Objective: Adaptation of the "Sustainability in FBDGs Framework"

The framework used in this study was informed by the domains and concepts from Downs et al. (2017) as well as concepts identified in the literature evaluating sustainable diets and food policy (Ahmed et al., 2019). The 12 documents (FBDGs and supporting documents) were examined for their inclusion of sustainability concepts based on those domains. A literature review of both peer-reviewed and gray literature in addition to Downs et al. (2017) was conducted. The literature reviewed,

based on Downs et al. (2017), informed the definitions and concepts included in considerations of sustainable diets such as *health influence of agriculture* (Garnett et al., 2014), *seasonal, local, and indigenous crops* (Burlingame and Dernini, 2012), *fossil fuel use* (Johnston et al., 2014), *water quality* (Behrens et al., 2017), *agricultural inputs* (Donini et al., 2016), *biodiversity* (Röös et al., 2015; Lang and Mason, 2017), and *adequate infrastructure and access to markets* (Gonzalez Fischer and Garnett, 2016).

Formative and summative framework checks—the final, iterative component of qualitative content analysis—were undertaken after the coded data from the national documents was analyzed. Checks were made for how accurate and complete the sustainability domains in the framework were as they related to food and diets. The formative framework checks guided concept fit into their respective domains and checked for relevancy through framework improvement and ongoing feedback. A summative check for validity was done after the process concluded by the first author employed a final review of all concepts and documents.

Formative feedback on the comprehensiveness of considering sustainability in FBDGs, areas of overlap of the concepts, and areas for improvement on the Downs et al. (2017) framework (i.e., where concepts were missing from their food policy context compared to FBDGs) was collected from a group of 12 food system sustainability professionals and educators. These food systems education experts were asked to review the framework in a focus group-style discussion based on their expertise as sustainable food systems practitioners after they had volunteered to participate, were made aware that this was an anonymous discussion for formative peer-review of the framework, and give verbal consent. Formative framework checks specifically asked the reviewers to consider: (i) identifying concept and sub-definition strengths and weaknesses (i.e., how accurately the description is of what defines the content of each concept) and target areas of work and, (ii) recognition of when concepts might be moved to different domains, cut, or added.

The *post hoc* summative framework check compared the adapted framework with the Ahmed et al. (2019) framework; our study addresses the call for a qualitative validation of their 2019 work. Following qualitative content analysis methodology, the domains of the framework herein were confirmed through comparison with the sustainability dimensions in the sustainability framework tool for evaluating FBDGs of Ahmed et al. (2019). See concepts confirmed by Ahmed et al. (2019) below (e.g., waste [solid, plastic, packaging], food system, and healthy weight).

RESULTS

First Objective

Inclusion of Sustainability Concepts in Documents

Table 2 presents selected examples (non-exhaustive) in each domain of text coded in multiple domains and describes the interconnectedness of each example from all 12 of the FBDGs. The five main sustainability domains, and 60 concepts defined within these domains used to guide this analysis, are described in depth in **Table S1** and encompass concepts related to diverse

TABLE 2 | Selected examples (non-exhaustive) of text coded in each domain and an indication of the other domains each example is interconnected with; color is included: blue for sociocultural and political (Sc+P), green for environment and ecosystems (E+E), red for health and nutrition (H+N), orange for food security and agriculture (FS+Ag), and purple for markets and value chains (M+VC).

Domain	Example text	Example reference	Domain(s) also coded under				
			E+E	FS+Ag	H+N	M+VC	Sc+P
Environment + ecosystems	Depending on their characteristics, the production and the distribution of foods can be socially and environmentally sustainable, promoting justice and protection of the living and physical world, or else may generate social inequalities and threats to natural resources and biodiversity.	Brazil FBDG		X		X	X
	Free-range beef and lamb can also have positive effects. In Sweden, for example, they help to produce a rich agricultural landscape and ensure that natural pastures are kept open. This benefits lots of species under threat.	Sweden FBDG		X			X
	The production and consumption of food, including processing, packaging, transportation, and waste disposal all affect our environment.	Qatar FBDG		X		X	
	Assessing and measuring the environmental impact of food choices can be complex and challenging. This is because all food production requires land, water, and energy. Further, the environmental impact of any food can vary greatly based on factors such as where the food comes from, the packaging, and how it is produced, processed, and transported.	Canada FBDG		X		X	X
	Use the Eatwell Guide to help you get a balance of healthier and more sustainable food. It shows how much of what you eat overall should come from each food group.	UK FBDG				X	
Food security + agriculture	Considering the multiple determinants of feeding practices and the complexity and challenges that are involved in the shaping of current food systems, the food guide reinforces the commitment of the ministry of health to contribute to the development of strategies for the promotion and realization of the human right to adequate food.	Brazil FBDG					X
	There are many different ways that these nutrient-dense foods can be chosen to contribute to nutritious dietary patterns that suit personal preferences. However, economic, social and cultural factors can affect the ability of individuals and groups to access nutritious foods.	Australia FBDG			X	X	X
	During ecological cultivation, no chemical pesticides are used, which decreases the total usage of chemicals and the spreading of these to the surrounding environment. This contributes to a poison-free environment and is positive for biological diversity, especially in large-scale agricultural landscapes. Certain aids are allowed, such as sulfur, soap water and lime. Further, weeds and pests are controlled through for example choice of type, crop succession, mechanical processing and a longer distance between plants.	Sweden supporting document	X				
	Food systems of indigenous peoples include the food plant and animal species that indigenous peoples acquire from land, water, and air using technologies and knowledge that have been adapted and passed through generations. This knowledge is key for sustainable harvesting and cultivation, as well as the preparation, storage, consumption and sharing of traditional food. Nevertheless, following the guidelines is not sufficient to significantly reduce food-related ecological burden; that would unquestionably require changes in the food production chain.	Canada FBDG	X				X
		Netherlands FBDG	X		X	X	
Health + nutrition	Adequate and healthy diet should be accessible both physically and financially, and harmonious in quantity and quality, meeting the needs of variety, balance, moderation, and pleasure. Furthermore, it should derive from sustainable practices of production and distribution.	Brazil FBDG	X	X		X	X

(Continued)

TABLE 2 | Continued

Domain	Example text	Example reference	Domain(s) also coded under				
			E+E	FS+Ag	H+N	M+VC	Sc+P
	Beyond nutritional benefits, children and teens who eat together with their families are more likely to get better grades in school, have a broader vocabulary, use less substances like tobacco, be less depressed, and contribute more to their community and society.	Qatar FBDG					X
	Over the past century, deficiencies of essential nutrients have dramatically decreased, many infectious diseases have been conquered, and the majority of the U.S. population can now anticipate a long and productive life. At the same time, rates of chronic diseases—many of which are related to poor quality diet and physical inactivity—have increased.	US FBDG				X	
	For example, Indigenous Peoples who live in remote, isolated, and northern communities often have limited access to nutritious foods (including traditional food). This may be negatively influenced by limited employment opportunities and low incomes; environmental changes affecting traditional food harvesting and consumption; lack of access to the land and resources; loss of cultural identities, traditional knowledge, and food practices; and the unreliable supply, quality, and high prices of store foods in remote communities.	Canada FBDG	X	X		X	X
	Eliminate waste and develop a new ethos of diet civilization. Treasure and prepare foods according to the need for consumption. Promote separate meals for individuals to eliminate waste. Food should be fresh and hygienic, and properly handled for cooking.	China FBDG	X				X
Markets + value chains	Support and find bargains at specialty shops, municipal and farmers' markets, street vendors, and other places selling fresh or minimally processed foods, including those produced by organic and agro-ecological methods	Brazil FBDG	X	X	X		X
	There is an urgent need to nationally monitor and sustainably address the factors affecting the price of nutritious foods, particularly for vulnerable groups who suffer a disproportionate burden of poor health. In urban areas there may be less access to supermarket foods and greater access to fast foods.	Australia FBDG	X	X	X		X
	In most parts of the world, the means of production and distribution of food has been changing, in ways that jeopardize the equitable distribution of wealth, the autonomy of farmers, the generation of employment and income opportunities, and the protection of natural resources and biodiversity, as well as production of safe and healthy food.	Brazil FBDG	X	X	X		X
	All sectors—including agriculture, environment, education, housing, transportation, the food industry, trade, as well as child, family and social services—have a role to play for Canada's dietary guidelines to have far-reaching and longstanding effects on the nutritional health of Canadians.	Canada FBDG	X	X	X		X
	Food systems, including food production, food consumption, export, import, transport, storage, and retail, account for about 20–25% of all greenhouse gas emissions in European countries. Emissions of CO ₂ are tied to the use of fossil fuels in the production and transport of food.	Nordic Nutrition Recommendations	X	X			X
Sociocultural + political	The expansion of the production of natural or minimally processed food, particularly those originating from agro-ecological agriculture, depends on increased demand. With the increased demand for these foods, there will be a corresponding increase in the number of producers and traders, and consequently, price reductions.	Brazil FBDG		X	X	X	

(Continued)

TABLE 2 | Continued

Domain	Example text	Example reference	Domain(s) also coded under				
			E+E	FS+Ag	H+N	M+VC	Sc+P
	High fiber vegetables are an eco-friendly choice. They have less of an impact on the environment than salad greens and can be stored for longer. Ecolabelling makes it easier to find fruit and vegetables that have been grown in eco-friendly ways. Only a very small number of chemical pesticides can be used in organic farming, and climate certification is helping to reduce climate impact.	Sweden FBDG	X	X	X		
	The Qatar dietary guidelines are part of the national nutrition and physical activity action plan 2011–2016. They lay the foundation for the promotion of healthy eating and the development of healthy food policy.	Qatar FBDG				X	
	Determinants of health: the key factors that influence health, including income and social status; social support networks; education and literacy; employment and working conditions; the social and physical environments; personal health practices and coping skills; healthy child development; biology and genetic endowment; health services; gender and culture.	Canada FBDG				X	
	Improving the environment with the aim of making healthy eating choices accessible to all is a fundamental public health strategy that is an essential complement to communication, information and nutritional education campaigns.	France supporting document	X	X	X		

topics such as food literacy, fossil fuel use, diverse production systems, healthy weight, food safety, and agricultural livelihoods.

The extent to which the FBDGs addressed the different concepts of the framework varied, but no document included fewer than 11 (17%) of the concepts.

Overall, the documents most frequently framed their recommendations using concepts from the health and nutrition domain. Health and nutrition framing brought in discussions of food choices and staying physically active for maintaining a healthy weight, as well as food safety and dietary diversity as important features of a healthy diet, tied to the sociocultural domain. Some concepts and framing in the sociocultural and political domain mostly addressed food literacy (e.g., reading labels) and consumer demand (e.g., overconsumption and ready-made foods), tied to the health aspects for example. Markets and value chains were a topic covered mostly in relation to access to markets and transportation as it related to GHG emissions, which was also tied to the environment and ecosystems domain. Most recommendations that were directly related to the environment included eating less meat and processed foods and some were framed through discussion of food and packaging waste and air and water quality as they related to the environment and health. Less frequently discussed, but still present were recommendations framed around food security and agriculture, which were mostly discussed in terms of nutritious, local, and seasonal food with a few mentions of diverse production systems and soil health.

Conceptual Complexity

To illustrate the interconnectedness of sustainability concepts and their inclusion in the texts, the framework adapted in this study reformats the Downs et al. (2017) framework (see

Figure 1). This reformatting adapted Downs et al.'s grouping of concentric circles by overlapping circles in a five-part Venn diagram that indicates a blurring of their heretofore distinct domains. This study thus presents an adaptation of the Downs' framework, in that it depicts interconnectivity through conceptual overlaps and definitions that encompass wider understanding of the concepts. Selected examples of interconnected text from each document examined are given in Table 2.

To visually depict the areas of frequent conceptual overlap, Figure 1 was used to indicate which of the five domains of the framework each concept was coded under: blue for sociocultural and political, green for environment and ecosystems, red for health and nutrition, orange for food security and agriculture, and purple for markets and value chains.

To illustrate this interconnectedness, the following three quotes demonstrate the interconnected nature of the concepts that inform the framework proposed here:

“Depending on their characteristics, the production and the distribution of foods can be socially and environmentally sustainable, promoting justice and protection of the living and physical world, or else may generate social inequalities and threats to natural resources and biodiversity” (Ministry of Health of Brazil, 2015), p. 18.

A second quote depicts the complex, interconnected use of the different domains in one main idea in this quote also from the Brazil FBDG:

“Adequate and healthy diet should be accessible both physically and financially, and harmonious in quantity

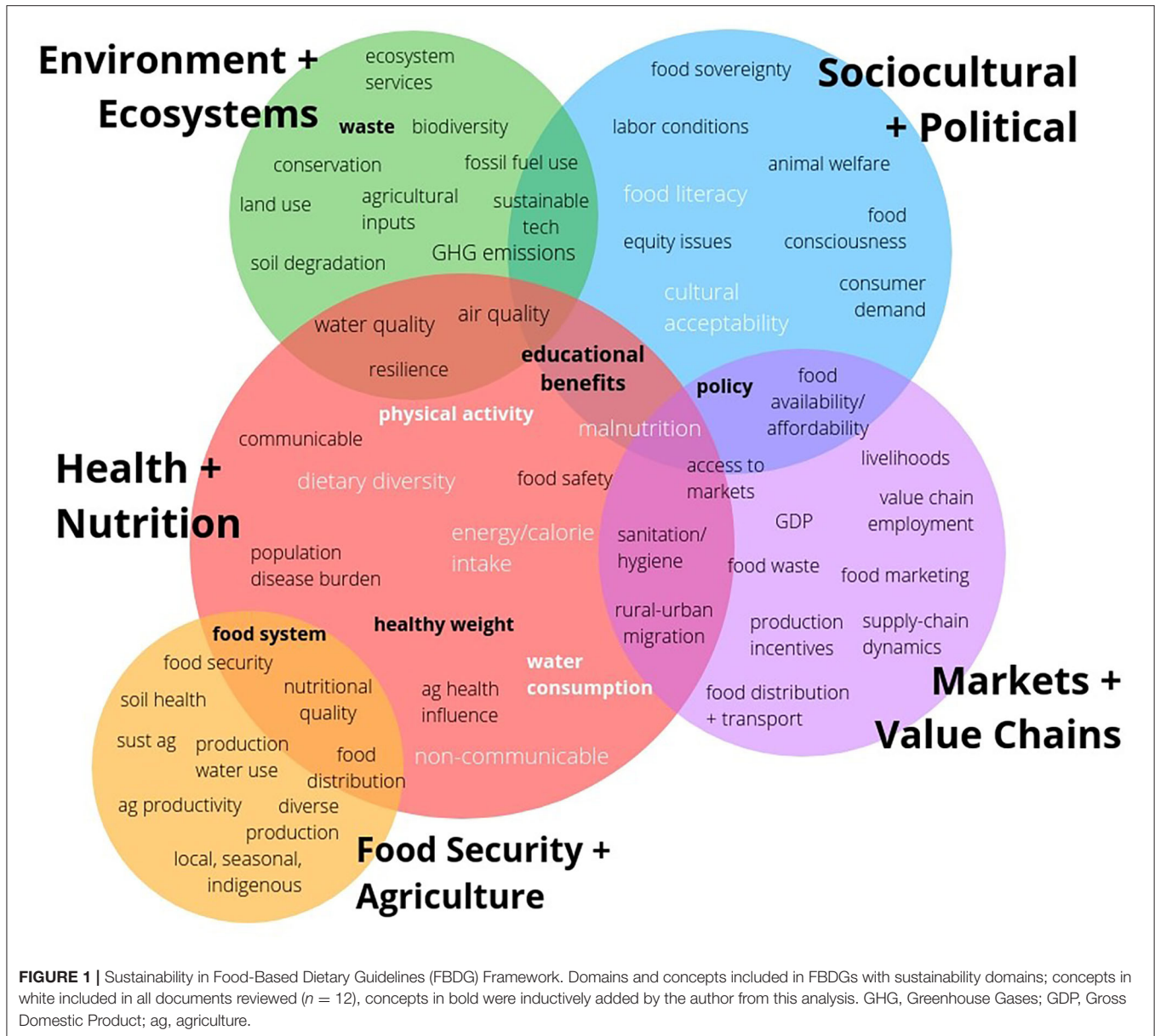


FIGURE 1 | Sustainability in Food-Based Dietary Guidelines (FBDG) Framework. Domains and concepts included in FBDGs with sustainability domains; concepts in white included in all documents reviewed ($n = 12$), concepts in bold were inductively added by the author from this analysis. GHG, Greenhouse Gases; GDP, Gross Domestic Product; ag, agriculture.

and quality, meeting the needs of variety, balance, moderation, and pleasure. Furthermore, it should derive from sustainable practices of production and distribution” (Ministry of Health of Brazil, 2015), p. 8.

“Food systems of Indigenous Peoples include the food plant and animal species that Indigenous Peoples acquire from the land, water, and air using technologies and knowledge that have been adapted and passed through generations. This knowledge is key for sustainable harvesting and cultivation, as well as for the preparation, storage, consumption, and sharing of traditional food” (Health Canada, 2019), p. 36.

The most recently published of all documents included in this study, the Canadian Dietary Guidelines (albeit, in the background documentation “for Health Professionals and Policymakers”) presents a unique and interwoven consideration of the food systems of Indigenous Peoples in Canada. The larger social determinants of health structures—especially as they pertain to Indigenous communities—are a consistent focus of their 2019 publication, which present challenges to sustainable food systems in the Canadian context:

The circles of the framework shown in **Figure 1** are overlapping, providing an indication of the interconnectedness among the different domains represented in the food guides (see also **Table 2**). **Figure 1** shows how the different aspects of food and eating (i.e., social, environmental, economic) overlap in complex ways. Overlapping circles and size of the circles in **Figure 1** were

driven by the percent overlap and number of references coded for each concept, respectively.

Second Objective: Adaptation of the “Sustainability in FBDGs Framework”

The framework was finalized into five domains and concepts within those domains. **Figure 1** represents the “Sustainability in FBDGs Framework.” Eight concepts were included in all 12 of the documents reviewed (i.e., physical activity, food literacy, cultural acceptability, malnutrition, dietary diversity, energy/calorie intake, water consumption, and non-communicable diseases). These are highlighted using white text in **Figure 1**. *Post hoc* framework comparison noted that several of the same domains and concepts were also evident in Ahmed et al.’s (2019) recent work, confirming the relevance of the addition of several concepts.

While most of the concepts included in the framework for FBDGs were based on Downs et al. (2017), a further seven were added as a result of the analysis in this study—waste, food system, educational benefits of diet, healthy weight, physical activity, water consumption, and policy. These concepts were not evident in the Nepalese food policy context, examined in Downs et al. (2017), but were identified in the 12 FBDG documents included this study and are represented as bold text in **Figure 1**.

Three concepts—stability, on-farm food loss, and land tenure—were included in the original Downs et al. (2017) framework, but none of the FBDGs reviewed in this study made any reference to them. As a result, these were not included in the final framework of this study.

DISCUSSION

Lessons Learned From Examining Sustainability in FBDGs

This study adapted a framework for integration of sustainability concepts into FBDGs based on Downs et al.’s (2017) work on food policy and further contributes to the validation of Ahmed et al.’s (2019) framework for FBDGs. Differing from Ahmed et al.’s (2019) approach, this study included FBDGs that have been identified as incorporating sustainability domains. The results of this analysis corroborate Downs and Ahmed finding that sustainability is a complex and interconnected concept and practice that is evident in recent national FBDGs (Ahmed et al., 2019). This work substantiates previous frameworks through a review of FBDGs which specifically include sustainability considerations and graphically depicts the key domains, concepts, and their interconnections for qualitative review of sustainability domains in FBDGs.

Adapting Downs et al.’s (2017) framework, this study explored how it could be possible to visually depict separate domains while also enabling inclusion of the interconnectivity of concepts in sustainability, a process which answers calls for a reapplication and development of their framework as a visual medium for further policymaking. These results represent findings building upon the Downs et al. (2017) framework and demonstrated conceptual complexity within current FBDGs. There has been a

rapid introduction and evolution of sustainability considerations in FBDGs since 2011 and more recently between 2016 and 2019, evidenced in this study. Despite the limitations of their temporal boundaries, this work examines an important set of FBDGs which add insight in an era of rapid development of dietary recommendations for sustainability. This finding was also evident and confirmed in Ahmed et al.’s (2019) work. Yet, distinct from these earlier frameworks, this study elicited many examples of overlapping coding (i.e., text that was coded into more than one domain) and included FBDGs identified by the FAO as explicitly incorporating sustainability considerations, indicative of the interconnected use of the concepts within the various domains. Recognizing that different components of a sustainable diet can have greater impacts on the environment, nutrition, or agriculture than others (Downs et al., 2017; Ahmed et al., 2019), there is no current consensus about the weight of the different trade-offs inherent in improving and promoting one aspect of sustainability at the potential cost of others.

Investigating the interconnectedness of concepts was possible through the use of text coded in two or more concepts and domains and elicited five domains and 57 total concepts. Many of the concepts were found to be relevant to multiple domains, and thus depicting the possibility of making complex sustainable and healthy dietary recommendations in current national FBDGs (see examples in **Table 2**). Regardless of the length of each document, all included at least four out of five domains and often included many concepts within each domain. While some of the FBDGs were identified by the UN FAO as having the most comprehensive inclusion of sustainability, that is Australian and Brazilian (Gonzalez Fischer and Garnett, 2016), there was not complete inclusion of all sustainability concepts within any single FBDG.

Overlapping coding was found in all documents in this study and gives further evidence to the interconnected inclusion of sustainability domains. These findings demonstrate the challenges of fitting concepts into one specific area, as their relevance is largely shared across domains. The results of this study visually represent the interconnected nature of food, health, and the environment. Such results yield recommendations for users (e.g., policymakers) applying this framework to acknowledge the conceptual complexity of sustainability domains and their interconnections. Though we recognize the need for parsimony in representing the interconnected aspects of sustainability, it is important that frameworks also find ways to represent and acknowledge such complexities.

When reviewing the food guidelines it was evident that the documents were more focused on the health and nutrition domain than food security, agriculture, and environment and ecosystem domains, which was expected as these were FBDGs, not food policies (Ahmed et al., 2019). For example, six of the eight concepts included in all of the documents reviewed relate mostly to health and nutrition: physical activity, malnutrition, dietary diversity, energy/calorie intake, water consumption, and non-communicable diseases; with the others, food literacy and cultural acceptability (also included in all documents reviewed), categorized in the sociocultural

and political domain. Yet, several of these concepts are also linked to other domains. For example, malnutrition is also connected to sociocultural and political structures and inequities (Ingram, 2011), and non-communicable diseases are also linked to pervasive food marketing, “fad diets,” and advertisements (McGinnis et al., 2006).

Integrating the health and nutrition domain with the other four in the framework is a step toward depicting the connections among food choices, health, sociocultural contexts, economies, and the environment. Such a step is important due to the many uses and impacts FBDGs have. Dietary guidelines can educate policy makers, program planners, researchers and the lay public about the interconnectedness of these domains, as well as the many, linked externalities of diets (e.g., more health issues and GHG emissions from animal products, food quality and soil degradation from monocultures, laborer health and animal welfare issues of factory farming). Education around such interconnections and impacts of diets—highlighted in part by FBDGs—has the potential to shift entire ontologies around food and consumption habits (Lang, 2017; Mazac and Tuomisto, 2020).

It is recognized that developing a framework for application internationally, especially across cultures and low-, middle-, and high-income countries, is challenging as there are different and multiple sociocultural, economic, and environmental factors in play (Downs et al., 2017; Ahmed et al., 2019). However, sustainable FBDGs will not mean “globally uniform diets, but culturally appropriate expressions of the same ecological and nutritional baselines” which could vary regionally and locally (Lang, 2017), p. 45. Using the Sustainability in FBDGs Framework and incorporating sustainability considerations in FBDGs will not mean an end to choice (as some might argue), but would, in fact, be a way for eaters to question the pervasive and strong influence over food tastes by commercial advertising and industry, who wield large budgets and lobbies to promote often unsustainable dietary patterns and foods (Lang, 2017).

The novelty of this study’s framework is in the way it makes it possible to compare FBDGs both to the framework and each other; to ask what has been included, what is missing, and to see how many concepts have been integrated in other FBDGs to date. This framework can be foundational for cultivating the idea that diets have many dimensions and are interconnected such that diets must be approached with a systems lens. Integrating interconnected sustainability concepts into food guidelines can provide a means for meeting international calls for sustainability and addressing global progress toward the UN’s 2015 Sustainable Development Goals (SDGs) (United Nations, 2015; Lang, 2017).

Applicability of the Sustainability in FBDGs Framework

This study supports the call proposed by Ahmed et al. (2019), to apply and develop integrative frameworks and addresses the lack of previous work depicting the interconnections of

sustainability dimensions/sub-dimensions. The application of this study’s framework can help those developing future FBDGs in the promotion of sustainable, bio- and culturally diverse diets that are appropriate to the country context. The framework may be used as an approach to assess the interconnected inclusion of sustainability domains in FBDGs that already exist (as illustrated by this study and by Ahmed et al., 2019).

This framework may also guide interconnected sustainability consideration in future FBDGs development. To apply the framework presented in this study, developers can begin by identifying the domains they wish to consider (e.g., health and nutrition & food security and agriculture), or any combination of such. Then, the concepts within those domains can be emphasized based on the context and considerations of that country. The definitions and examples of each domain (found in **Table S1**) can assist developers in selecting and formulating recommendations. Together with expert nutrition advice and rigorous evidence, this framework can be used to develop and guide recommendations for sustainable diets. Developers may apply the framework to assist in integrating sustainability domains into FBDGs through following examples given here, including various stakeholders as in these selected FBDGs, and applying this study’s coding process to check and add to the interconnected nature of statements for sustainability consideration.

Countries currently without food guides can use this framework to address the various components of sustainable dietary guidance in their development process when they engage with multiple sectors, ministries, and experts. When applying the framework in different countries (e.g., low-, middle-, and high-income) the framework will help developers to address different, potentially overlapping issues, reflective of the country context. However, recommendations of sustainable dietary practices in FBDGs must navigate contextual differences. FBDGs must reflect variations in local climate and agricultural practices, nutritional needs of the population, as well as present culturally relevant dietary advice. It is recognized that different countries, regions, and even communities and individuals will have different values, practices, and barriers when it comes to how and what to eat (Desmarais and Wittman, 2014; van Dooren et al., 2014; Lang, 2017; Lang and Mason, 2017; Willett et al., 2019), which will change or make irrelevant the implementation of this framework.

Study Limitations and Future Directions

The framework adapted in this study does not address or evaluate the strength of specific policies or recommendations for influencing a sustainable diet. For example, Germany’s FBDGs included four of the five domains, and 17% of the concepts. Yet, these numbers do not give an indication of the strength or impact of the recommendations made or exactly how explicit the connections to sustainability were. Simply finding the presence or absence of a concept does not compel or imply dietary change in a sustainable direction. A challenge of developing policies or guidelines is that they do not necessarily translate into immediate or effective action (Downs et al., 2017). Even

if we identify recommendations made in the guidelines that have actions associated with them, evaluating impact is often not straightforward.

The framework is limited to identifying concepts and domains included in FBDGs based on the emphases of sustainability explicit in the final, publicly available versions of the guidelines. We have no deeper indication of the possible sustainability considerations made by policymakers and guideline developers throughout the development process. For example, the concepts of land tenure and on farm food loss were not found in any of the FBDGs in this analysis and were removed from this framework. These concepts are perhaps not immediately relevant to food guidelines—as they may be for food policies upon which Downs et al. (2017) was formulated. Though it was designed to be useful in diverse settings with little normative language, when this framework is applied in the future in different situations, adaptations will need to be made to reflect the country context and level of FBDGs development in the past (from none in many developing countries to well-established in countries such as the United States) (Gonzalez Fischer and Garnett, 2016; Herforth et al., 2019).

This study is also limited in that there was only funding, time, and resources available for one English speaking coder to conduct the document review, leading to uncertainty in categorization of the concepts. With only one coder, there is a chance that differing interpretations of where concepts should be placed in the framework were overlooked. Further, this study was limited to the inclusion of one focus group with 12 food system sustainability experts; more and different groups may have added or subtracted from the framework creating different concept or domains. Therefore, future work would benefit by conducting a formal reliability assessment, including the examination of non-English language FBDGs, and cross validating the content of the framework domains. Still, the qualitative application and validation of previous work (Downs et al., 2017; Ahmed et al., 2019) is step forward adding nuance and confirming the key findings proposed by earlier work in this field. There remains a need for further studies to monitor future FBDGs progress and to compare changes over time. Studies which build upon these analyses may provide additional guidance on integrating sustainability concepts and informing future approaches for applying these frameworks to policymaking.

Another limitation is that there remains no agreement in the literature on approaches for weighting of the different concepts or what is most important to emphasize in sustainable dietary recommendations. Raw quantification of concept inclusion is therefore less relevant than deeper, qualitative examination regarding contextual inclusion of sustainability domains. Another approach would be to set thresholds for different factors as an aim to reach a desired state in all domains following the concept of doughnut economics (Raworth, 2017). The trade-offs and thresholds from the environment, health, and ethical perspectives would have to be addressed in greater depth in another analysis that would be a possible future direction.

Much more work is needed in the field, to identify the indicators of change and measure impacts of including sustainability in FBDGs. Further evaluation is needed of how and

why concepts related to sustainability were included or excluded. Such motivations behind concept inclusion are important for developing policy approaches which include sustainability domains in FBDGs in the future.

Conclusion: Beyond Sustainability in FBDG

Sustainability concepts have been recently included and published in at least 12 English-language FBDGs internationally, developed since 2011 in two supporting documents, and since 2016 in at least 10 official guidelines. This framework described here shows that sustainability was considered in FBDGs in interconnected ways. FBDGs internationally, such as in Qatar, Sweden, Brazil, Germany, and Canada, have included stakeholders and integrated interconnected domains that include sustainability in the guidelines for their respective countries.

We are at a critical juncture where there is some scholarship (Ahmed et al., 2019) and incorporation of sustainability in FBDGs, heeding earlier calls (Gussow and Clancy, 1986; World Health Organization Food Agriculture Organization of the United Nations, 1996) and recent recommendations made by international governing bodies and global reports (Gonzalez Fischer and Garnett, 2016; Willett et al., 2019). Embracing the possibility of “healthy diets from sustainable food systems” (Willett et al., 2019), p. 1, countries with dietary guidelines that include sustainability principles have started to address the crucial and immediate challenge of shifting diets (Mbow et al., 2019). Lessons from these countries can help to inform the continued international efforts needed to reduce the impact of food systems on sustainable futures for the planet.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

AUTHOR'S NOTE

The analysis for this study was originally carried out and based on work done by RM for an M.Sc. thesis (Mazac, 2019) and no additional funding was available to expand the sample to include non-English language FBDGs or those developed after the completion of the initial 2019 analysis.

AUTHOR CONTRIBUTIONS

All authors contributed to the conception and design of the study led by RM. RM organized the data collection, performed the qualitative analysis, and wrote the full manuscript. All authors contributed to study design, manuscript review and revision, and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fsufs.2021.544072/full#supplementary-material>

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Conflict of Interest: BS is the principal at B. Seed Consulting.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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