Growing Progress in the Evolving Science, Business, and Policy of Sustainable Nutrition

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ABSTRACT

A session was convened at the ASN Nutrition 2018 annual meeting to discuss the scientific evidence on what makes individual foods and dietary patterns both sustainable and nutritious, and the role of various stakeholders in the actions needed to implement food systems that deliver "sustainable nutrition." This commentary is a structured synthesis of the primary themes of the session, and concludes with a set of implications and research recommendations. Consumers are becoming increasingly aware of the environmental implications of what they eat, and there is growing momentum toward changes in the food system. However, ecological challenges persist, and although the literature is evolving, methodologic improvements are needed in the scientific approaches to address dietary patterns that meet nutrition needs in more holistically sustainable ways. The session concluded with encouraging evidence that consumers, businesses, scientists, and policy-makers are collectively "rising to the occasion," with cross-sectoral partnerships to address these issues. *Curr Dev Nutr* 2019;3:nzz059.

Introduction

In recent years, the companion themes of "sustainable nutrition" and "sustainable diets" have emerged where distinct streams of scientific literature have widened and begun to overlap, in the areas of global change, environmental science, agriculture, food security, sustainable development, nutrition, and public health (1). The intersection of nutrition and environmental sustainability has spawned a vigorous scientific, public, and political debate (in the United States and elsewhere) on the role that environmental considerations should play in shaping diet, including whether government-issued dietary guidance should explicitly include consideration of the relative environmental consequences of different foods and dietary patterns (2–5). Based on health and nutrition considerations alone, such guidance has consistently recommended a diet with higher amounts of nutrient-dense plant-based foods (e.g., fruits, vegetables, legumes, nuts, whole grains). A consensus is emerging in the scientific community that such diets are also associated with lesser environmental impact (6).

The idea of linking sustainability considerations to dietary patterns has existed in the scientific literature for at least 30 y (7), but the specific topic of "sustainable diets" first took prominence on the global stage at a major international conference co-organized by the FAO and Bioversity in Rome in 2010 (8). In plenary, the gathered experts endorsed the following definition:

> 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.

A common theme in much of the recent literature is the sharpening realization of the challenge that food systems face to deliver sustainable nutrition, due to multiple colliding constraints,

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including human population pressure, resource scarcity, ecosystem degradation, and climate change (9). The Fifth Assessment Report of the UN Intergovernmental Panel on Climate Change highlighted the effects of water scarcity and higher temperatures on crop yields, and the higher food prices and diminished food security that are likely to result (10). Unfortunately, the causality of these effects operates in both directions. The food system, writ large, is a significant source of greenhouse gas (GHG) emissions, both directly and indirectly (via land use change) (11).

It was against this back-drop that a special session was convened during the June 2018 meetings of the ASN: "Growing a Healthy Sustainable Plate: Understanding Scientific, Political, and Business Perspectives on Sustainable Nutrition." This commentary is a structured synthesis of the primary themes that emerged from the session, and it concludes with a set of implications and recommendations for the broader research community.

Environmental impacts of the global agrifood system

Agriculture has a large environmental footprint. It uses ∼11% of land globally (or 1.5 billion ha) (12), is the largest user of freshwater, and consumes significant quantities of other resources, including several (such as phosphorous) that are finite and nonrenewable. Agriculture is practiced on individual farms, and those farms are in communities, scattered across the world. It alters ecosystems and even climate at the landscape, regional, and global scales. However, the environmental footprint of the global agrifood system is much more than just about what happens on farms. A myriad of other activities in food supply chains also have major environmental impacts: transport, storage, processing, retailing, preparation, consumption, and emissions generated by food uneaten and discarded (1).

The question of whether these environmental impacts would be dramatically reduced if diets shifted in a healthier direction is driving a rapid increase in published research in this area. For example, a pair of formal systematic reviews (3, 5) on this topic were conducted only 18 mo apart, employed identical search strategies and terms, and demonstrated that the total amount of research on this had increased by ∼50% over that relatively brief period of time. As this growing body of scientific work is published, persistent questions are emerging, such as: What is the environmental burden of different diets or dietary patterns? Is it possible that as diets become more healthful or more nutritious, the corresponding environmental burdens of those diets decrease? A recent systematic review found that a dietary pattern higher in plant-based foods as well as lower in total energy offers improved health outcomes (reduced cardiovascular risk, less obesity, etc.) as well as a lesser impact on the environment (reduced GHG emissions, less land and irrigation water use, etc.) (5). This key finding is consistent with a somewhat earlier modeling study (6), which found that alternative diets (more plant-based) could reduce global agricultural GHG emissions, reduce land clearing and resultant species extinctions, and help prevent diet-related chronic noncommunicable diseases. Although this possible convergence of future dietary benefits is encouraging, neither the current health status of the planet nor our current public health is. Accordingly, the need for such research to move out of science journals and into the dietary patterns and other behaviors of all consumers is undeniably urgent.

Measuring sustainable nutrition through life cycle assessment

The environmental component of sustainable nutrition is generally characterized through some form of life cycle assessment (LCA), which—in its most comprehensive form—attempts to quantify the full suite of environmental impacts associated with a particular food or diet, beginning with the production of inputs and then including all of the intervening steps leading up to consumption and management of waste (13). In LCA modeling, defining the system boundary and scope are important first steps in comparative environmental impact assessments. LCA methodologies are governed by International Standards Organization standards (14), which enables them to rigorously and reliably characterize and compare various components of food systems, ranging from entire diets to individual food items.

Results are not always intuitive. For instance, the energy required to produce dried milk is high, but the cooling requirements and heavier transport weight for fluid milk lead to even higher energy requirements, with the net effect that the dried version may use less energy per unit of consumed milk in certain scenarios (15). As noted by Heller et al. (16), the full application of LCA to food systems requires the development of regionally specific life cycle inventory databases for food and agriculture, and the expansion of the scope of assessments beyond only GHGs (17–19). Other elements of LCA still lack consensus. For instance, the use of different functional units (calories, protein content, etc.) for reporting the relative environmental sustainability (carbon and water footprints, etc.) of different foods dramatically alters their apparent relative impacts (20). In addition to this important consideration when interpreting LCA results, it should be noted that methods to broaden LCA to include the relative economic and societal benefits of various foods are still in their infancy.

Two specific examples of LCA results were shared during the ASN session: almonds and mushrooms. The analysis for almonds has been reported previously in the literature (21, 22) and the summary given here is based on the ASN presentation. The focus was on production in California, which accounts for >80% of the entire world's commercial production. The system boundary for the LCA was from field to factory gate, and so encompassed establishment and removal of orchards; relevant field operations and agricultural inputs; emissions of GHGs and criteria pollutants from soils; and full accounting of important coproducts (hulls, etc.). The scope of impacts included in the LCA were energy use, GHG emissions, criteria air pollutants, and use of fresh water. The LCA results highlighted at the ASN meeting were the GHG emissions, which are 1.6 kg carbon dioxide equivalent per kg of raw almonds and associated coproducts, which is largely due to the amounts of nitrogen fertilizer and irrigation required for crop production. Opportunities to improve the environmental footprint of almonds include finding the best uses for coproducts, such as hulls used as feed for dairy cattle, and the generation of renewable electricity from the woody biomass waste produced by the orchard. It is important to note that publication of LCA results such as these is helping to motivate and accelerate environmental improvements throughout the industry. Almond growers are continually working to effect improvements by finding the best uses for coproducts, including efforts to improve soil health by making use of the recycled woody biomass from the orchard, and repurposing almond hulls and shells for animal and insect feed.

As with almonds, the mushroom LCA presentation has also been published in the scientific literature (23), with the highlights given in the ASN presentation briefly described here. Mushrooms present a unique case for the LCA, as they are grown without sunlight and usually under tightly controlled conditions. The analysis was for mushrooms produced in the United States, and relied upon the collection of primary data from a set of US-based producers representing a third of all domestic production. Results presented at the session showed a range of 2.13–2.95 kg carbon dioxide equivalent GHG emissions per kg of mushrooms, with electricity and fossil fuel use as the primary sources. These emissions are somewhat lower than the results of previously reported LCA studies covering production systems in Australia and Spain. The main opportunities to reduce GHG emissions in commercial mushroom production would involve onsite renewable energy generation, especially in the eastern parts of the United States, where the electricity grid is more dependent on coal.

These two examples of food LCAs highlight some of the challenges of quantifying environmental sustainability of food choices and the challenge of contextualizing or comparing foods. The first is that production systems are immensely variable—the perennial almond production system with important coproducts and the energy-intensive irrigation water, or the indoor, climate-controlled growing conditions of mushroom production (which are dependent on highly variable regional electricity grids) demonstrate just how different systems can be, and illustrate the problem of generalizing across foods and their life cycles. Similarly, although both mushrooms and almonds are nutrient-rich plant foods, comparing them on a mass or calorie basis, or defining a role in the human diet, is challenging. To make these kinds of assessments useful for informing dietary recommendations and potential food choices, future work should contextualize the results of food LCAs within nutrition-, meal-, or diet-level assessments.

Research Needs

Many activities and interventions are underway at local and regional levels in an attempt to enhance sustainable nutrition, but they are generally not well coordinated or resourced. Moreover, rigorous and quantitative analyses of the environmental sustainability of foods is not common, and not necessarily consistent. Broad questions related to choosing a functional unit (the basis for comparison) in LCAs of foods, requirements for the scope of analysis, and consensus on data collection or data sources could all improve the consistency and comparability of food LCAs. In addition, companies could play an important role in producing rigorous and objective LCAs at the product level. For example, although not yet standard practice in the United States, some food companies in Europe have developed Environmental Product Declarations (24). These Declarations are third-party verified LCA-based assessments, somewhat analogous to a nutrition label, but for environmental information, and may be an opportunity for food companies to take active measures to quantify and compete on the basis of the relative environmental sustainability of individual products. This is one potential pathway for companies to take active roles in providing the environmental information required for decision-making on sustainable nutrition choices.

Consumer, policy, and voluntary initiatives

Recent public polling information indicates that an increasing percentage (now 60%) of US consumers believe that environmental sustainability is very important when it comes to purchasing food (25). A subsequent survey (26) indicates that the most important element of sustainability continues to be pesticide use, but the factor that has now jumped to second place is "ensuring an affordable food supply." Overall, environmental sustainability is still a secondary concern for most consumers, falling well behind taste and price. However, more than half now say that recognizing all ingredients on the label and understanding how the food item has been produced are important factors in a food purchasing decision. More than a third of all consumers (38%) are willing to pay more for food and beverage products that they believe are produced sustainably, compared with 28% who are sure they would not pay more—leaving a third who are unsure. Consumers willing to pay more for sustainable foods tend to be better educated and in better health (26).

To collectively achieve sustainable nutrition at the national scale, all people must have access to a variety of nutritious foods; knowledge, resources, and skills for healthy living; prevention, treatment, and care for diseases affecting nutrition status; and safety-net systems for vulnerable subpopulations (27). The solutions are inherently trans-sectoral, engaging practitioners and experts across agriculture, rural development, and public health (28). Policy should support action along entire food supply chains (29), including the food consumption process as a whole, i.e., growing, purchasing, cooking, and eating (30). Ethical issues exist as well. Key ethical issues include how to make societal decisions and define values about food security that affect nutrition outcomes, and the ethical trade-offs between environmental sustainability and ensuring that individual dietary and nutritional needs are met (31). As policy is developed and implemented, it is essential for the entire spectrum of stakeholders to be intentionally engaged, in order to establish common understanding and improve the odds of success (32). Private-sector initiatives can arguably have a faster and greater impact. One example is "Menus of Change: The Business of Healthy, Sustainable, Delicious Food Choices," a leadership initiative launched in 2012 by the Culinary Institute of America and the Harvard TH Chan School of Public Health. It integrates optimal nutrition and public health, environmental stewardship and restoration, and social responsibility concerns within the food-service industry and the culinary profession (33).

The session alluded to signs the public is beginning to adopt such practices, but the pace of change is generally quite slow due to the immense size and complexity of the food system. However, some recent positive examples showing that relatively more rapid change is possible have taken place with school lunches, *trans*-fats, and "My Plate," from the most recent US Dietary Guidelines (4). It was highlighted that the private sector has a clear role to play in accelerating the pace of change such as the helpful actions recently taken by Danone (34), General Mills (35), Mars (36), and Walmart (37). Companies such as these can choose to reformulate, relabel, and market in ways that promote more healthy behaviors. In the end, because so much food is purchased from companies, positive change will only come when companies themselves change their practices. Government policy has a role, but is fleeting to the extent that it can be changed quickly after elections. Accordingly, the food system is shaped much more by the companies who are producing it in reaction to the consumers who are purchasing it—rather than by government policy. The consumer-business relation offers both barriers and opportunities. As of today, consumer actions are governed far more by price, availability, and health rather than by any thoughts about environmental impacts, a fact both public- and private-sector decision-makers must bear in mind.

Conclusions

Consumers have an essential role to play in the evolving science, business, and policy of sustainable nutrition. Current trends suggest that consumers are becoming increasingly aware of the environmental implications of what they eat, and there is a growing momentum to the ongoing changes in the food system. However, the ecological challenges associated with the global agrifood system are still daunting, and there is increasing pressure on all of society to meet its nutrition needs in more sustainable ways. There is also significant work to be done to address economic sustainability (especially the tension between farm income and lower consumer prices), as well as the many social aspects of sustainability (animal welfare, treatment of farm workers, etc.). Some of the key research needs for LCA include answering questions related to the choice of functional unit, the appropriate scope of the assessments, and how to achieve consensus on data sources. Assembling such data will make more advanced approaches possible, such as mathematical optimization of diets. The ASN session summarized here included ample evidence that consumers, businesses, scientists, and policy-makers are all rising to meet these challenges, particularly as they form novel, cross-sectoral partnerships that have already achieved much success. And the fact that this session was so well attended is also encouraging evidence that nutrition scientists themselves are becoming part of this growing global conversation about the need to transform food systems.

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