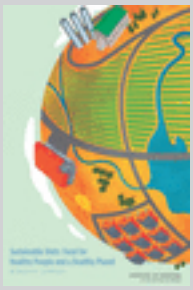


# Sustainable Diets: Food for Healthy People and a Healthy Planet: Workshop Summary

ISBN
978-0-309-29667-0

156 pages
6 x 9
PAPERBACK (2014)

Leslie Pray, Rapporteur; Food Forum; Food and Nutrition Board; Roundtable on Environmental Health Sciences, Research, and Medicine; Board on Population Health and Public Health Practice; Institute of Medicine

# Sustainable Diets: Food for Healthy People and a Healthy Planet

WORKSHOP SUMMARY

Leslie Pray, *Rapporteur*

Food Forum

Food and Nutrition Board

Roundtable on Environmental Health Sciences, Research, and Medicine

Board on Population Health and Public Health Practice

INSTITUTE OF MEDICINE
*OF THE NATIONAL ACADEMIES*

THE NATIONAL ACADEMIES PRESS
Washington, D.C.
**www.nap.edu**

**THE NATIONAL ACADEMIES PRESS 500 Fifth Street, NW Washington, DC 20001**

NOTICE: The workshop that is the subject of this workshop summary was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

This activity was supported by Contract Nos. HHSP233201200333P (Office of the Assistant Secretary of Health), HHSN26300002 (National Institutes of Health), and 59-1235-2-114, CNPP-IOM-FY2012-01, FS-IOM-FY2012-01, and AG-3A94-P-12-0088 (U.S. Department of Agriculture) and with the National Academy of Sciences. Additional support came from Abbott Laboratories, Cargill, Inc., ConAgra Foods, General Mills, Inc., Kellogg Company, Kraft Foods, Mars, Inc., McDonald's, Mead Johnson and Company, Monsanto Company, Nestlé Nutrition, PepsiCo, and The Coca-Cola Company. The views presented in this publication do not necessarily reflect the views of the organizations or agencies that provided support for the activity.

International Standard Book Number-13: 978-0-309-29667-0
International Standard Book Number-10: 0-309-29667-6

Additional copies of this workshop summary are available for sale from the National Academies Press, 500 Fifth Street, NW, Keck 360, Washington, DC 20001; (800) 624-6242 or (202) 334-3313; http://www.nap.edu.

For more information about the Institute of Medicine, visit the IOM home page at: **www.iom.edu.**



Printed in the United States of America

The serpent has been a symbol of long life, healing, and knowledge among almost all cultures and religions since the beginning of recorded history. The serpent adopted as a logotype by the Institute of Medicine is a relief carving from ancient Greece, now held by the Staatliche Museen in Berlin.

Cover credit: Design by Casey Weeks.

Suggested citation: IOM (Institute of Medicine). 2014. *Sustainable diets: Food for healthy people and a healthy planet: Workshop summary.* Washington, DC: The National Academies Press.

*"Knowing is not enough; we must apply.*
*Willing is not enough; we must do."*
—Goethe



INSTITUTE OF MEDICINE
*OF THE NATIONAL ACADEMIES*

**Advising the Nation. Improving Health.**

# THE NATIONAL ACADEMIES

*Advisers to the Nation on Science, Engineering, and Medicine*

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Ralph J. Cicerone is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. C. D. Mote, Jr., is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Harvey V. Fineberg is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Ralph J. Cicerone and Dr. C. D. Mote, Jr., are chair and vice chair, respectively, of the National Research Council.

**www.national-academies.org**

## PLANNING COMMITTEE ON A WORKSHOP ON SUSTAINABLE DIETS: FOOD FOR HEALTHY PEOPLE AND A HEALTHY PLANET[1]

**ERIK D. OLSON** (*Chair*), Natural Resources Defense Council, Washington, DC
**KATHERINE L. CLANCY,** University of Minnesota, St. Paul, and Johns Hopkins University, Baltimore, MD
**RICHARD A. FENSKE,** University of Washington, Seattle
**ROBERT C. POST,** FoodMinds, LLC, Washington, DC
**PAMELA STARKE-REED,** National Institutes of Health, Bethesda, MD
**ANNE M. SWEENEY,** Texas A&M University, College Station
**G. DAVID TILMAN,** University of Minnesota, St. Paul
**PARKE E. WILDE,** Tufts University, Boston, MA
**DEREK YACH,** The Vitality Group, New York City, NY

*IOM Staff*

**HEATHER COOK,** Co–Study Director
**LESLIE J. SIM,** Co–Study Director
**ANDRÉS GAVIRIA,** Research Associate
**GERALDINE KENNEDO,** Administrative Assistant

[1] Institute of Medicine planning committees are solely responsible for organizing the workshop, identifying topics, and choosing speakers. The responsibility for the published workshop summary rests with the workshop rapporteur and the institution.

## FOOD FORUM[1]

**FRANCIS F. BUSTA** (*Chair*), University of Minnesota, St. Paul
**NELSON ALMEIDA,** Kellogg Company, Battle Creek, MI
**MARK ANDON,** ConAgra Foods, Omaha, NE
**ARTI ARORA,** The Coca-Cola Company, Atlanta, GA
**PAUL M. COATES,** National Institutes of Health, Bethesda, MD
**DAVID B. COCKRAM,** Abbott Laboratories, Columbus, OH
**RICHARD F. D'ALOISIO,** Mondelēz International, East Hanover, NJ
**ERIC A. DECKER,** University of Massachusetts, Amherst
**CAROLINE SMITH DEWAAL,** Center for Science in the Public Interest, Washington, DC
**SAMUEL GODEFROY,** Health Canada, Ottawa, ON
**DAVID GOLDMAN,** U.S. Department of Agriculture, Washington, DC
**CINDY GOODY,** McDonald's USA, LLC, Oak Brook, IL
**DANIELLE GREENBERG,** PepsiCo, Purchase, NY
**SONYA GRIER,** American University, Washington, DC
**BRENDA HALBROOK,** U.S. Department of Agriculture, Alexandria, VA
**JACKIE HAVEN,** U.S. Department of Agriculture, Alexandria, VA
**JERRY HJELLE,** Monsanto Company, St. Louis, MO
**KATE J. HOUSTON,** Cargill, Inc., Washington, DC
**VAN S. HUBBARD,** National Institutes of Health, Bethesda, MD
**LEE-ANN JAYKUS,** North Carolina State University, Raleigh
**GORDON L. JENSEN,** Pennsylvania State University, University Park
**RENÉE JOHNSON,** Congressional Research Service, Washington, DC
**WENDY JOHNSON-ASKEW,** Nestlé Nutrition, Florham Park, NJ
**MICHAEL M. LANDA,** Food and Drug Administration, College Park, MD
**JOHN A. MILNER,** U.S. Department of Agriculture, Beltsville, MD
**S. SUZANNE NIELSEN,** Purdue University, West Lafayette, IN
**ERIK D. OLSON,** Natural Resources Defense Council, Washington, DC
**RICHARD OLSON,** U.S. Department of Health and Human Services, Rockville, MD
**STEVEN W. RIZK,** Mars, Inc., Hackettstown, NJ
**SARAH ROLLER,** Kelley Drye & Warren LLP, Washington, DC
**SHARON ROSS,** National Institutes of Health, Rockville, MD
**SYLVIA ROWE,** SR Strategy, LLC, Washington, DC
**KARI HECKER RYAN,** Kraft Foods, Glenview, IL
**PRISCILLA SAMUEL,** Tate & Lyle, Hoffman Estates, IL
**MAHA TAHIRI,** General Mills, Inc., Minneapolis, MN

[1]Institute of Medicine forums and roundtables do not issue, review, or approve individual documents. The responsibility for the published workshop summary rests with the workshop rapporteur and the institution.

*Forum Staff*

**HEATHER COOK,** Co–Study Director
**LESLIE J. SIM,** Co–Study Director
**GERALDINE KENNEDO,** Administrative Assistant
**ANN YAKTINE,** Interim Director, Food and Nutrition Board

## ROUNDTABLE ON ENVIRONMENTAL HEALTH SCIENCES, RESEARCH, AND MEDICINE[1]



[1]Institute of Medicine forums and roundtables do not issue, review, or approve individual documents. The responsibility for the published workshop summary rests with the workshop rapporteur and the institution.

**NSEDU OBOT WITHERSPOON,** Children's Environmental Health Network, Washington, DC
**HAROLD ZENICK,** U.S. Environmental Protection Agency, Research Triangle Park, NC

*Roundtable Staff*

**CHRISTINE COUSSENS,** Roundtable Director (until August 2013)
**ERIN RUSCH,** Associate Program Officer
**ANDRÉS GAVIRIA,** Research Associate (until August 2013)
**HOPE HARE,** Administrative Assistant
**ROSE MARIE MARTINEZ,** Director, Board on Population Health and Public Health Practice

# Reviewers

This workshop summary has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published workshop summary as sound as possible and to ensure that the workshop summary meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the process. We wish to thank the following individuals for their review of this workshop summary:

**Mark Bomford,** Yale University
**Richard A. Fenske,** University of Washington
**Jillian Fry,** Johns Hopkins University
**Michael W. Hamm,** Michigan State University

Although the reviewers listed above have provided many constructive comments and suggestions, they did not see the final draft of the workshop summary before its release. The review of this workshop summary was overseen by **Georges C. Benjamin,** American Public Health Association. Appointed by the Institute of Medicine, he was responsible for making certain that an independent examination of this workshop summary was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this workshop summary rests entirely with the rapporteur and the institution.

# Contents

# 1

# Introduction[1]

One of the many benefits of the U.S. food system is a safe, nutritious, and consistent food supply. However, the same system also places significant strain on land, water, air, and other natural resources. A better understanding of the food–environment synergies and trade-offs associated with the U.S. food system would help to reduce this strain. Many experts would like to use that knowledge to develop dietary recommendations on the basis of environmental as well as nutritional considerations. But identifying and quantifying those synergies and trade-offs, let alone acting on them, is a challenge in and of itself. The difficulty stems in part from the reality that experts in the fields of nutrition, agricultural science, and natural resource use often do not regularly collaborate with each other, with the exception of some international efforts. The Institute of Medicine's (IOM's) Food Forum and Roundtable on Environmental Health Sciences, Research, and Medicine convened a public workshop on May 7-8, 2013, to engender dialogue between experts in nutrition and experts in agriculture and natural resource sustainability and to explore current and emerging knowledge on the food and nutrition policy implications of the increasing environmental constraints on the food system. The experts explored the relationship between human health and the environment, including the identification and quantification of the synergies and trade-offs of their

[1] The planning committee's role was limited to planning the workshop, and the workshop summary has been prepared by the workshop rapporteur as a factual summary of what occurred at the workshop. Statements, recommendations, and opinions expressed are those of individual presenters and participants, and are not necessarily endorsed or verified by the IOM, and they should not be construed as reflecting any group consensus.

impact. The workshop explored the role of the food price environment and how environmental sustainability can be incorporated into dietary guidance. Finally, experts considered research priorities, policy implications, and drivers of consumer behaviors that will enable sustainable food choices. Although the focus of the meeting was on the U.S. food system, workshop participants were asked to keep in mind the global context of sustainability issues.

This workshop summary is drawn from the material that was presented and discussed at the May 2013 meeting, based on meeting transcripts and presentations. This document summarizes the statements of workshop participants and is not intended to be an exhaustive exploration of the subject matter. The reader should be aware that the materials presented here express the views and opinions of individuals participating in the workshop either as presenters, discussants, moderators, or audience members, and not the deliberations or conclusions of a formally constituted committee. The objective of the workshop was not to reach consensus on any issue or make recommendations for future action. The goal was to illuminate the issues and advance the dialogue.

**Meeting Purpose**

- To explore current and emerging knowledge on the food and nutrition policy implications of the increasing environmental constraints on the U.S. food system, keeping in mind the context of global sustainability issues.
- To engender dialogue—between stakeholders who are concerned about environmental sustainability and natural resource use and those concerned about the nutritional value of the food supply and dietary guidance policy—that will advance the discussion of dietary guidance and environmental sustainability in the United States.

## ROADMAP FOR THIS REPORT

The organization of this report is parallel to the organization of the workshop (see Appendix B for the workshop agenda). This introductory chapter summarizes the major overarching themes of the workshop discussion and the keynote presentation by Kathleen Merrigan. Chapter 2 summarizes the Session 1 presentations and discussion aimed at identifying relationships between eating patterns and the environment. Chapter 3 summarizes the Session 2 presentations and discussion on quantifying synergies

and trade-offs between health and the environment. Chapter 4 summarizes the Session 3 presentations and discussion on sustainable commodity sourcing and the food price environment. Chapter 5 summarizes the Session 5 presentations and discussion on options and approaches to enable sustainable food choices.

The text boxes in Chapters 1 through 5 highlight major overarching themes of the workshop as a whole (Chapter 1) and key themes of individual sessions (Chapters 2-5) were compiled by the rapporteur.

Twice during the workshop, at the end of Day One (Session 4) and again at the end of Day Two (Session 6), Lisa Eakman from the Chicago Council on Global Affairs, was invited to reflect on what she perceived as key "take-home" messages. Her remarks are summarized in Chapter 6. Also included in Chapter 6 are additional remarks by the workshop planning committee chair Erik Olson and moderator Derek Yach, as well as a summary of George Loewenstein's presentation on consumer behavior.

Appendix A provides a list of abbreviations and acronyms used in this workshop summary. The workshop agenda is provided in Appendix B and biographical sketches for the speakers can be found in Appendix C.

## KEYNOTE PRESENTATION[2]

Kathleen Merrigan, former Deputy Secretary of Agriculture, U.S. Department of Agriculture (USDA), was the keynote speaker for the event. Merrigan identified local and regional agriculture as a place where the nutrition and sustainable agriculture agendas converge and where the two "silo" communities could be brought together in a way that builds a powerful coalition for change. In Merrigan's opinion, USDA has done a great job translating the dietary guidelines into a more usable form, with the MyPlate graphic sending a single leading message: half a plate of fruits and vegetables. "It's simple. We get it," Merrigan said. "The challenge is, how do we get there?" The U.S. population is not nearly at half a plate of fruits and vegetables, a finding that cuts across all socioeconomic classes.

One route may be through domestic agriculture. A growing percentage of fruits and vegetables consumed in the United States are imported. Even when bananas, which account for about 50 percent of fruit imports yearly, are removed from the data, the percent of consumed fruits that are imported jumped from 12 percent in 1990 to 25 percent in 2008 (USDA, 2012a). More recent data show that the percentage is even higher today. Likewise, with vegetables, including frozen vegetables, the percent of consumed vegetables that are imported jumped from 8 percent in 1990 to 15

[2] This section summarizes the keynote address by Kathleen A. Merrigan, Ph.D., former Deputy Secretary of the U.S. Department of Agriculture, Washington, DC.

**Major Overarching Themes of Workshop Discussion[a]**

- **Diet impacts the environment.** A couple of workshop participants described how different diets have different environmental impacts with respect to greenhouse gas (GHG) emissions and the use and contamination of air, water, and other natural resources.
- **Although there are several tools available for quantifying the environmental impacts of the U.S. diet, workshop participants expressed caution that results not be over-interpreted.** Several participants considered the newness of some of the methodologies being used; the unreliability of some data sources; the inappropriate use of global averages to evaluate regional situations; and the importance of not mistaking the relative end results of life-cycle assessment for absolute answers.
- **Much of the discussion of the environmental impacts of diet focused on meat, with many workshop participants agreeing that meat has a significantly greater environmental impact than other food groups.** Some participants provided quantitative estimates of GHG emissions and other environmental outcomes associated with meat consumption and how those outcomes would change if Americans were to eat less meat. The estimates triggered several questions and comments from audience members and, in some cases, disagreement.
- **Although most of the workshop discussion revolved around the environmental impacts of food and diet choices, the trade-offs are two-way. The environment also impacts diet.** A couple of workshop participants considered the loss of agricultural biodiversity and its impact on micronutrient availability.

percent in 2008 (USDA, 2012b). Merrigan argued that many of the fruits and vegetables being imported could be grown domestically, especially given that many imported fruits and vegetables are imported in the middle of their U.S. growing seasons. "That seems crazy to me," Merrigan said, "when we've got rural communities struggling and farmers and ranchers not making their payments in the smaller and midsize operations. It seems there's a really glorious opportunity there to build a food system that provides economic opportunity to them."

Moreover, American agriculture is undergoing a transition, Merrigan opined, with the average age of farmers and ranchers nearing 60 (Bureau of Labor Statistics, 2013). A new generation of individuals is entering agriculture not by seeking capital to purchase a 5,000-acre commodity-producing farm, as earlier generations did, but rather by seeking high-value crops that can be grown on small acreage. Local agriculture is the most likely stepping stone for most new farmers and ranchers.

- **Drawing on lessons learned from the European Union, the U.S. Department of Agriculture, the United Nations, and elsewhere, many workshop speakers considered a multitude of potential policy, research, and other approaches and options for reducing the impact of the U.S. diet on the environment.** Much of the policy discussion focused on the U.S. dietary guidelines, with several participants calling for future guidelines to be based on environmental as well as nutritional considerations. There were several calls put forth for the public sector in the United States to become more concerned and engaged in diet sustainability policy and research.
- **The challenge of addressing sustainable diets is complex.** Many workshop participants touched on the wide range of issues relevant to understanding and managing health and environmental synergies and trade-offs associated with the U.S. food system, including social justice challenges (e.g., access to food, exposure to environmental impacts), consumer behavior at the point of purchase, and the significant environmental cost of food waste.
- **What is a "sustainable diet"?** No single definition of "sustainable diet" was provided or developed for use during this workshop, with some concern expressed that the term was being used in different ways by different people. There was one call for a broadening of the notion beyond what most people think of when they think of something as being sustainable and another call for a working definition of "sustainable diet" for use in developing new U.S. dietary guidelines.

[a] There are issues related to the fields of nutrition/diet and environmental sustainability that were not covered or fully explored at the meeting due to limited time and scope of the workshop and limited perspectives of the participants in the workshop.

The question is, assuming that American dietary patterns are changing for the better (i.e., that Americans are eating more fruits and vegetables), how can the need for healthy food be met with domestic production? Merrigan described the intersection of healthy food and domestic production as the "'Venn diagram for the crowd here today" (see Figure 1-1).

### USDA Efforts to Meet the Need for Healthy Food with Domestic Production

USDA has initiated several programs within that Venn diagram. First are Electronic Benefit Transfer (EBT) programs at farmers' markets; many farmers want EBT availability so that they can accept Supplemental Nutrition Assistance Program; Special Supplemental Nutrition Program for Women, Infants, and Children; and senior market coupon benefits. A number of foundations have been advocating for EBT at farmers' markets as

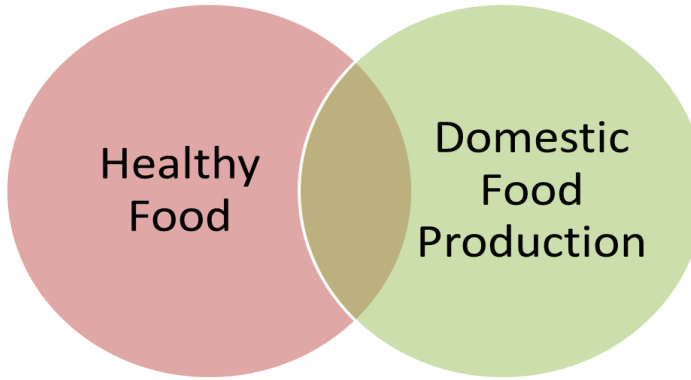



**FIGURE 1-1** The intersection of healthy food and domestic food production as the focus of some efforts of the U.S. Department of Agriculture.

a way to simultaneously address food access issues and farmer economic viability issues. Merrigan described the efforts as "successful," with both farmers' markets and nutrition benefit redemptions skyrocketing. "And I think we've only scratched the surface," she said.

Second are USDA-invested mobile markets. There has been a lot of recent discussion about food deserts, that is, areas of low access to food. In many rural parts of the country, there are not enough people to sustain a grocery store that is open 24 hours per day or 7 days per week, or even one that is open 5 days per week. Food deserts exist in both rural and urban areas. In many inner cities, people are buying food at corner stores and sometimes liquor stores, paying more money for less healthful foods. USDA has been investing in mobile markets to make sure that people are getting access to the food they need. Merrigan mentioned a mobile market in Chicago[3]: an old bus that was retrofitted to provide food, especially fresh produce, to inner-city communities. The question is, how can the concept be expanded out to make sure that *everyone* is getting access to the food they need?

Commercial kitchens are a third USDA-funded effort aimed at using domestic production to meet healthy eating needs. Farmers are using commercial kitchens for value-added food production, while communities are using them for cooking classes and demonstrations, canning, and other activities. USDA commercial kitchens are bringing people into the kitchen in exciting ways, in Merrigan's opinion. She mentioned Michael Pollan's compelling argument for families cooking together and gathering around

[3] See http://www.freshmoves.org (accessed December 6, 2013).

the dinner table and observed that commercial kitchens could play a role (Pollan, 2012).

A fourth USDA effort of relevance is the Farm to School program. Children who are engaged in garden-based learning are more science literate and more environmentally aware, according to Merrigan. More importantly, they are willing to try and consume different types of fruits and vegetables. Much of the USDA's focus has been on elementary school, while some has been on high school. Now, efforts need to be directed at the preschool level, where eating habits initially form. In Merrigan's opinion, there are many opportunities at that level for small and midsize regional farmers who are seeking institutional outlets.

A fifth opportunity, still largely on the drawing board, would be to combine USDA's food bank and food hub investments. USDA funds both food banks, including food bank delivery trucks, and food hubs. A food hub is a central place where small farmers bring their products to be aggregated or lightly processed for further distribution to institutional buyers. Merrigan suggested that the food bank delivery trucks could also be used to pick up food from the food hub farmers, en route, and deliver that food to a food hub. This would allow transportation to be shared, as well as cold storage and other services. Merrigan suspects that strengthening the links between food banks and food hubs would result in a sizeable increase in farm donations to food banks. She said, "That's the kind of innovation I think we need when we're talking about the Venn diagram and bringing these communities together."

Finally, Merrigan observed plentiful opportunity in Supplemental Nutrition Assistance Program Education (SNAP-Ed). She acknowledged that some policy makers are advocating for the elimination or reformation of SNAP-Ed. However, she views the program as an opportunity to "work harder and better in that Venn diagram."

### Affordable, Accessible Healthy Eating

When asked by a member of the audience what specifically could or should be done with SNAP-Ed, Merrigan replied that figuring out how to get SNAP-Ed dollars to work harder is the task of the workshop participants. She cautioned that the "elephant in the room" is the notion that sustainable agriculture equals more expensive food, and she recalled hearing many federal government leaders saying that if people were to eat more healthfully by eating more fruits and vegetables, for example—it would be a "budget buster" for the federal government. However, studies from the USDA Economic Research Service and elsewhere have demonstrated that many fruits and vegetables, especially seasonal fruits and vegetables, are in fact quite inexpensive (Bishop and Wootan, 2013; Stewart et al., 2011). In

Merrigan's opinion, that kind of thinking—that a more sustainable food system would price poor people out of the food they need—has hurt reform efforts for decades.

Another member of the audience commented on a recent study in South Africa, where a 25 percent discount on healthy foods led to a fairly large shift in diet over the course of 2 years (An et al., 2013). The study involved approximately 350,000 individuals. Although the price change led to increased consumption of fruits and vegetables and a decline in meat and fried food consumption, it did not have much impact on obesity. According to the audience member, one reason for the lack of impact on obesity was that portion size issues were not included in the messaging. The results of the study raise questions about how food quality and quantity can both be improved simultaneously.

Merrigan responded that empowering women should be part of the agenda, given that in many countries women are the ones who guide their families' eating choices. She emphasized early education, noting that dietary patterns are set early, and mentioned FoodCorps,[4] an offshoot of AmeriCorps. FoodCorps service members encourage school children to make healthful eating choices through efforts such as cheering kids on at the lunch line. Although Merrigan was unsure how such a program would be scaled up at either the domestic or global level, she said, "against all the onslaught of convenience and processed food, healthy food—good eating—needs a cheerleader."

Keynote speaker Kathleen Merrigan identified local and regional agriculture as a place where the siloed nutrition and sustainable agriculture communities could come together to build a powerful coalition for change. U.S. farmers would fare better, and Americans would have greater access to healthy foods.

## REFERENCES

An, R., D. Patel, D. Segal, and R. Sturm. 2013. Eating better for less: A national discount program for healthy food purchases in South Africa. *American Journal of Health Behavior* 37(1):56-61.

Bishop, K., and M. G. Wootan. 2013. *Healthy bargains. Fruits and vegetables are nutritious and economical*. Washington, DC: Center for Science in the Public Interest.

Bureau of Labor Statistics. 2013. *Labor force statistics from the Current Population Survey.* http://www.bls.gov/cps/occupation_age.htm (accessed September 26, 2013).

[4] See https://foodcorps.org (accessed December 6, 2013).

Pollan, M. 2012. *Cooked: A natural history of transformation*. New York: Penguin Press.

Stewart, H., J. Hyman, J. C. Buzby, E. Frazao, and A. Carlson. 2011. *How much do fruits and vegetables cost?* Economic Information Bulletin No. EIB-71. Washington, DC: U.S. Department of Agriculture, Economic Research Service.

USDA (U.S. Department of Agriculture). 2012a. *Fruit and tree nuts. Trade.* http://www.ers.usda.gov/topics/crops/fruit-tree-nuts/trade.aspx#.Ui8Lu9LkuSo (accessed September 10, 2013).

USDA. 2012b. *Vegetables and pulses. Trade*. http://www.ers.usda.gov/topics/crops/vegetables-pulses/trade.aspx#.Ui8OA9LkuSo (accessed September 10, 2013).

# 2

# Defining Relationships: Synergies and Trade-Offs Between Health and Environmental Impacts

A major goal of this workshop was to bring nutritional and environmental scientists together and advance the discussion about the intersection of health and the environment as it pertains to food. To initiate the workshop discussion, the first session was focused on defining the relationship and identifying the synergies and trade-offs between healthy eating and environmental impacts. This chapter summarizes the presentations and discussions that occurred during that session. Workshop participants considered the environmental costs of the food system, how those costs might change if nutrition was improved and the U.S. dietary guidelines were met, and the bi-directional relationship between health and the environment (i.e., the understanding that while diet impacts the environment, the environment also impacts diet).

The first speaker, Dr. Barbara Burlingame from the Food and Agriculture Organization (FAO) of the United Nations (UN), viewed the subject from a global perspective, emphasizing the important role of ecosystems and food biodiversity in sustaining healthy diets. She described the FAO's recognition of the link between biodiversity and nutrition and presented several examples of disappearing food biodiversity. Disappearing food biodiversity is more than an environmental loss; it is also a loss of micronutrient resources. Burlingame was also the first of several speakers who emphasized the environmental implications of food waste, along food chains and in food systems, including "metabolic" food waste associated with consumption in excess of requirements manifested as with overweight and/or obesity.

Are there enough fish in the sea? Cynthia M. Jones from Old Dominion University discussed U.S. dietary recommendations for fish and shellfish and the likely environmental implications of meeting the recommended daily intakes of fish and shellfish (i.e., two servings of fish per week) from fish available from U.S. waters. Currently, the United States imports a majority of the seafood that is consumed. She concluded that U.S. dietary recommendations may exceed current U.S. domestic fish production, and overall global production does not meet global need. Although Jones foresees more sustainable production in the future, she is not hopeful that the increased global production will be enough to bridge the gap.

The final speaker of the session, Frank Mitloehner from the University of California, Davis, discussed greenhouse gas (GHG) emissions associated with the consumption of animal protein (eggs, meat, milk), emphasizing country and regional variation in the percentage of overall GHG emissions contributed by the livestock sector. He strongly urged not using global average data on GHG emissions to develop policies. He explained how this variation reflects variation in production due to differences in breeding, diet, and veterinary care (i.e., some animals produce more meat products than others) and the generally inverse relationship between production and GHG emissions (i.e., animals that produce more emit less per unit of production). He argued that "sustainable intensification" can help to decrease the number of animals required per kilogram of product.

Also included in this chapter is a summary of the discussion sparked by these presentations. Most of the discussion focused on the livestock GHG emissions data that Mitloehner presented, with a couple of additional questions about the fisheries data presented by Jones about FAO strategies for addressing natural resource issues related to food.

**Key Themes of This Chapter[a]**

- The trade-offs between eating patterns and environmental impact are two-way. Eating patterns impact the environment, but the environment also impacts dietary choice (e.g., loss of food biodiversity impacts the availability of micronutrients). (Burlingame)
- There are not enough fish in U.S. waters for all U.S. consumers to meet the recommended daily intake for fish. Global production is partially filling this gap, but the hazards associated with the methods being used for fish production are unclear. (Jones)

- Greenhouse gas (GHG) emissions from livestock production as a percentage of total GHG emissions vary regionally and nationally, partly because of geographic differences in deforestation rates but also because of differences in productivity (i.e., some animals produce more GHG emissions per unit of production than others). (Mitloehner)
- Care should be taken when choosing which data to use when measuring GHG emissions as environmental impacts of the food system. (Mitloehner)

[a] Key themes identified during discussions, presenter(s) attributed to statement indicated by parenthesis "( )."

## PRIORITY AGRICULTURE–ENVIRONMENTAL–NUTRITION LINKAGES FOR SUSTAINABLE DIETS[1]

Barbara Burlingame provided a global perspective on health and environmental benefits, synergies, and trade-offs, emphasizing the role of biodiversity in sustaining healthy diets. She began by illustrating the consequences of current diet, environment, and agriculture practices. Approximately 900 million people worldwide are hungry, 2 billion people have micronutrient deficiencies, and another 1.5 billion people are overweight or obese (Burlingame and Dernini, 2012; FAO, 2012a). Ecosystems have been degraded and biodiversity lost, in some cases forever. In other instances agriculture has been made unsustainable by monoculture,[2] intensive livestock industries, and excessive use of agricultural chemicals, inefficiencies, and waste. She stated that dietary patterns and some environmental and agricultural practices in current use are no longer sustainable.

### Unsustainable Diets

The FAO has been monitoring the number of hungry people worldwide for a couple of decades. From the early 1990s to the present, much of the world has seen a reduction in the number of hungry people, with

[1] This section summarizes information presented by Barbara Burlingame, Ph.D., Food and Agriculture Organization, United Nations, Rome, Italy.

[2] Monoculture is the agricultural practice of producing or growing a single crop or plant species over a wide area and for a large number of consecutive years. It is widely used in modern industrial agriculture, and its implementation has allowed for large harvests from minimal labor.

significant exceptions being sub-Saharan Africa and, lately, western Asia and North Africa (FAO, 2012a). At the same time, a growing number of those countries still experiencing under-nutrition are also showing increases in the prevalence of overweight and obesity (see Figure 2-1). Across the entire spectrum of under-nutrition and overweight, Burlingame observed a resistance to solving micronutrient malnutrition problems. Even in countries where the quantity of food is sufficient and dietary energy supplies are adequate or even more than adequate, micronutrient malnutrition remains a high-risk problem (Thompson and Amoroso, 2011). In her opinion, this reflects a huge problem in diet quality.

### UN Recognition of Agriculture–Environmental–Nutrition Linkages

Biodiversity serves an important role in sustaining diet quality. As summarized by Burlingame, the link between biodiversity and nutrition became a formal FAO activity when, in 2004, the Convention on Biological Diversity's (CBD's) Conference of the Parties (COP), the governing body of the CBD, formally recognized the linkages between biodiversity, food, and nutrition and the need to enhance sustainable use of biodiversity to combat hunger and malnutrition. The COP requested the CBD's Executive Secretary, in collaboration with FAO and the former International Plant Genetic Resources Institute, now Bioversity International, to undertake a cross-cutting initiative on biodiversity for food and nutrition (CBD, 2013). Later that same year, the Commission on Genetic Resources for Food and Agriculture also requested that FAO evaluate the relationship between biodiversity and nutrition. In 2005, eight high-priority actions and another six lower-priority actions were identified (FAO, 2005). In 2006, the COP adopted the Framework for a Cross-Cutting Initiative on Biodiversity for Food and Nutrition (CBD, 2006).

In order to better understand the role of biodiversity in the broader context of ecosystem services, not just in the context of nutrition, FAO conducted a survey of primarily mainstream nutrition scientists worldwide. Survey participants were asked which of several features are not compatible with sustainable diets. Burlingame described these unpublished results. Overwhelmingly respondents identified agricultural chemical inputs as unsustainable. They also identified monoculture agriculture, intensive livestock industries, and transgenic modification to food, plants, and animals as unsustainable. Survey participants were also asked which of several features were necessary for a sustainable diet. The same respondents identified as necessary increasing the use of food biodiversity for addressing the problems of nutrition and better diets, enhancing the resilience of food systems, using agricultural practices that respect the environment, consuming less

meat, making greater use of biodiversity to meet nutrient requirements, and promoting healthy dietary patterns through local food systems. After the survey was completed, FAO, Biodiversity International, and other partners conducted a technical workshop on biodiversity in sustainable diets (FAO, 2010). Then, in 2010, an international scientific symposium on biodiversity and sustainable dies was convened in Rome. The 2010 symposium led to a consensus definition of "sustainable diet" (Burlingame and Dernini, 2012, p. 294):

> 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.

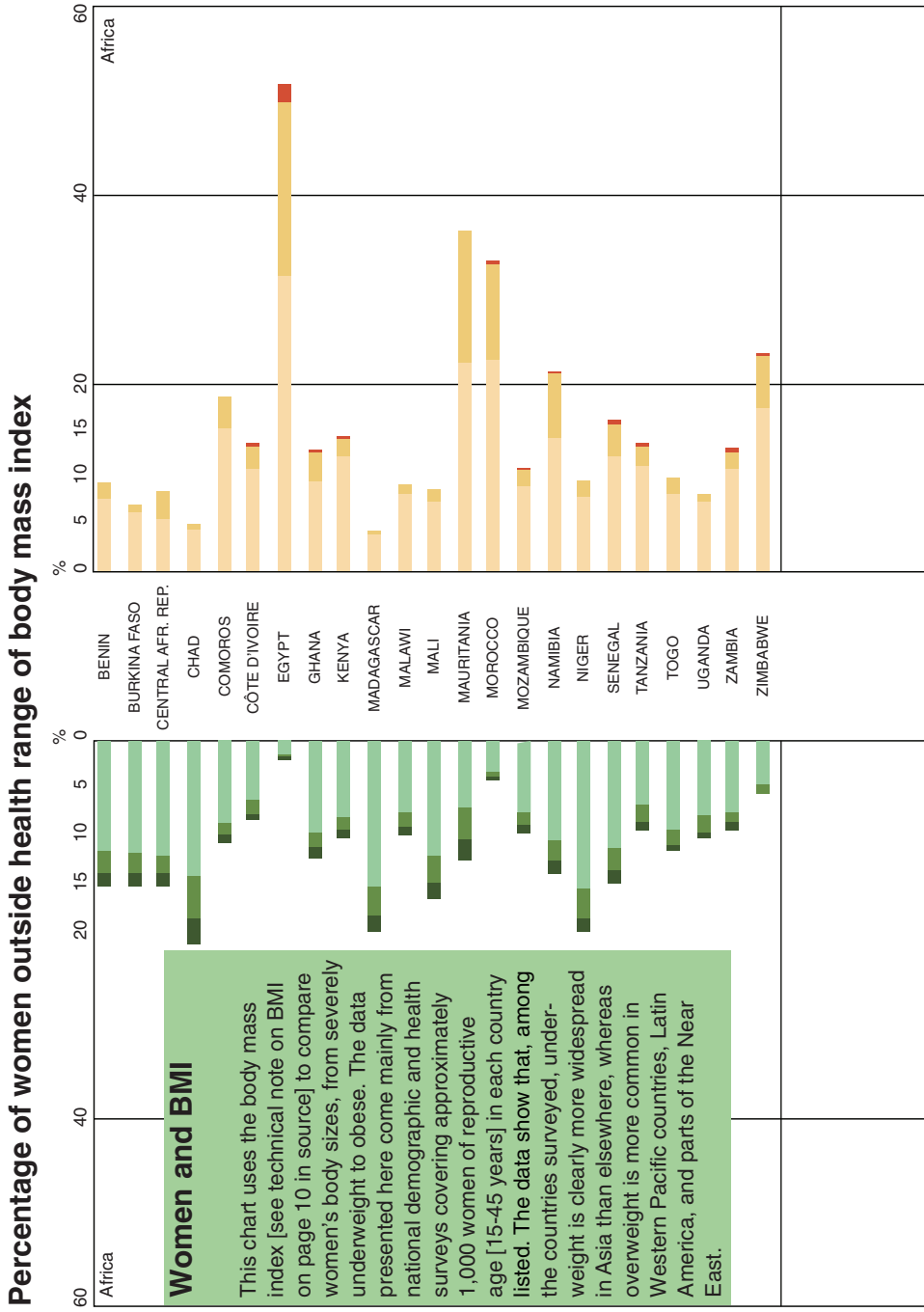
In addition, the 2010 symposium led to a draft code of conduct for sustainable diets, the preamble of which was modeled on what Burlingame described as probably the most powerful code of conduct ever developed for the nutrition world, that is, the *International Code of Marketing of Breast-Milk Substitutes* (WHO, 1981). In the preamble, it is recognized that the health of humans cannot be isolated from the health of ecosystems; food, meaning unprocessed or moderately unprocessed food, is an unequaled way of providing ideal nutrition for all ages and life stages; and conservation and sustainable use of food biodiversity is an important part of the well-being associated with health and the environment (Burlingame and Dernini, 2012).

As described by Burlingame, shortly afterward, the Rio+20 UN conference led to the UN Secretary General's Zero Hunger Challenge. The challenge was intended to serve as a follow-up to the Millennium Development Goals, with the "100 percent access to adequate food all year round" and "all food systems are sustainable" goals being compatible with the first and the seventh Millennium Development Goals. An additional Zero Hunger Challenge goal is "zero loss or waste of food" (UN, 2012).

## Food Biodiversity[3]

The global food supply relies on very few crops to provide nutrients and dietary energy; food biodiversity in many common species of food

[3] Burlingame identified three levels of biodiversity: (1) the ecosystem, (2) the food species within an ecosystem, and (3) genetic diversity within a species (e.g., different breeds of an animal species, different varieties of a plant species). Here, she was referring mostly to genetic diversity within a species.



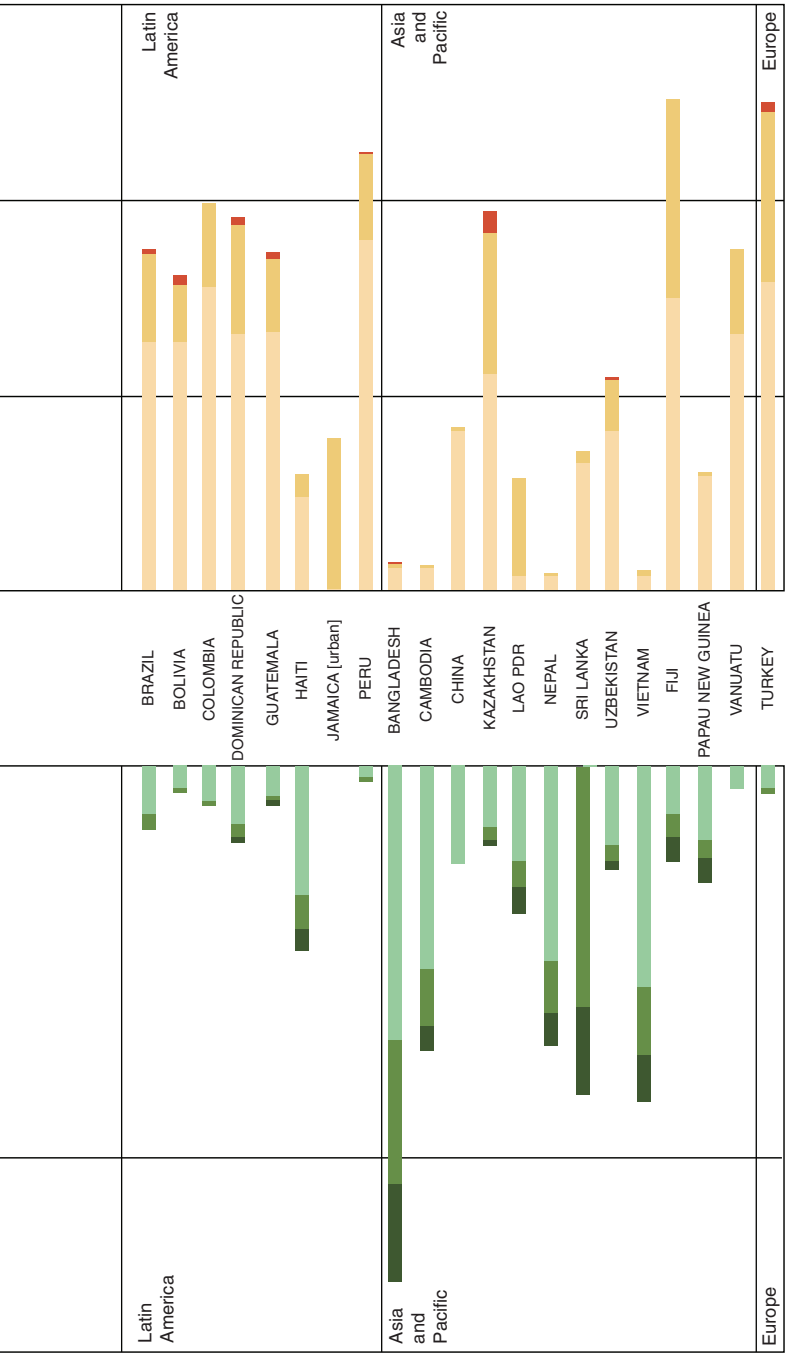



**FIGURE 2-1** Percentage of women outside the healthy range of body mass index, with many countries having a high prevalence of both undernourished and overweight or obese individuals.
SOURCE: FAO, 2000.

plants is much more vast than what is currently utilized. For example, Burlingame identified at least 4 species and more than 100 varieties of wheat, as well as more than 140 varieties of apricot. Burlingame explained that preventing loss of food plant biodiversity is important not only from an environmental perspective, but also because different varieties and cultivars (i.e., genetic diversity within species) represent significant nutritional variation. The protein content of wheat varies based on variety, with different varieties containing different individual amino acids, B vitamins, individual fatty acids, and vitamin E. Likewise, with apricots, different varieties reflect nutritionally significant variations in beta-carotene, lutein, lycopene, anythocyanins, and vitamin C.

Grapes are one of the more interesting examples of food biodiversity, in Burlingame's opinion. There are several different grape species, with *Vitis vinifera* being the most important grape wine species. In fact, in Europe *V. vinifera* is the only species of grape allowed to be grown for wine in Europe (EU, 2008). Even within *V. vinifera*, there are thousands of varieties, each with a unique nutritional fingerprint (e.g., variation in vitamin C, organic acids, anthocyanins, resveratrol, many other phytochemicals) (Iacopinia et al., 2008).

Burlingame identified sweet potatoes as another crop plant with significant nutritional differences among its many varieties. In many parts of the world, including in countries where vitamin A deficiency is commonplace, sweet potato varieties with low beta-carotene content have been promoted by agricultural extension workers for their yield and disease resistance; however, the beta-carotene content of many sweet potato varieties is low (Huang et al., 1999).

Bananas, too, vary nutritionally, with varieties having anywhere from almost 0 to more than 5,300 micrograms of provitamin A carotenoid (which is converted into vitamin A) per 100 grams (Englberger et al., 2003). Interestingly, Burlingame noted, bananas with high provitamin A carotenoid content used to be neglected in countries where they grow wild, with fruits falling to the ground and rotting. Today, they are being valued and promoted; for example, Micronesia promotes different varieties of bananas on its postage stamps. Bananas are 1 of 12 case studies of indigenous people's food systems worldwide being examined by FAO, in collaboration with the Centre for Indigenous Peoples' Nutrition and Environment and other partners.

Such tremendous nutritional biodiversity exists not just within fruits and vegetables, but also within staple crops. Consider rice. Although plant breeding programs have focused on yield and disease resistance, thousands and thousands of varieties of rice exist (IRRI, 2006). More than 4,000 varieties of rice used to be grown for food in Korea. Today, only 12 variet-

ies can be identified. In Thailand, some 16,000 varieties of rice used to be grown for food. Today, only 37 varieties can be identified, with 50 percent of rice cultivation areas comprising only 2 varieties. As with other food species, different types of rice provide significantly different nutritional value. Although the protein content of rice is usually cited as being 8 percent, in fact protein content ranges from about 5.5 percent to almost 15 percent (Kennedy and Burlingame, 2003). Burlingame argued that talking about rice as if it is a product with an average nutrient content does not do justice to its biodiversity. She said, "It behooves us as nutritionists to really identify where we have nutritionally significant differences in the foods that people are eating."

Not only does rice have tremendous biodiversity, but so do rice ecosystems. A number of edible species live within the aquatic rice ecosystem. More than 100 species of edible fish, crustaceans, mollusks, amphibians, insects, reptiles, and aquatic plants inhabit the Cambodian rice ecosystems (Balzer et al., 2002). For the rural populations that rely on rice ecosystems for their food sources, although the rice itself provides dietary energy, it is those other food species that provide micronutrients. Burlingame noted that by intensifying the rice ecosystem, many sources of micronutrients are lost, so much so that the International Rice Commission recommended to its membership (rice producers worldwide) that they promote sustainable development of aquatic biodiversity in rice-based ecosystems, that policy decisions enhance the living aquatic resource base, and that attention be given to the nutritional contribution of aquatic organisms and the diets of rural people who produce or depend on rice (FAO, 2002).

Burlingame identified another example of a local food ecosystem that provides necessary micronutrients to the rural community dependent on that ecosystem: Mongolia, a chronically food-insecure, landlocked country. The main dairy animal in Mongolia is a local breed of horse that feeds on a family of small mint plants, among other grassland species. Together, the genetic traits of the horse and the indigenous plants of the grazing lands provide milk and meat that provide much of the n-3 fatty acids (omega-3) in the population's nutrition. If even a single element of this ecosystem were changed—for example, by introducing a new feeding regime to increase production of horse milk, or a higher producing breed of dairy animal—the net result would be that the human population would need a supplement in order to meet the daily n-3 fatty acid requirement.

Burlingame briefly mentioned a couple of efforts aimed at increasing food biodiversity. First is the Biodiversity for Food and Nutrition Project's Mainstreaming Biodiversity Conservation and Sustainable Use for Improved Human Nutrition and Well-being initiative, with the aim of

characterizing agro-ecological zones for their ability to provide humans with nutrient requirements.[4] Another effort is use of the Barilla Center for Food and Nutrition double pyramid.[5]

## Food Waste

A number of studies have identified extremely high food waste and loss in many parts of the world (see Figure 2-2). For example, cereal food waste and loss in Europe and North America is very high at the household level of consumption; in sub-Saharan Africa and South Asia, it is high at the agriculture and postharvest levels (Gustavsson et al., 2011). Burlingame noted that these losses and waste represent a huge amount of resources, not just the food itself, but also the natural and human resources used to produce that food.

Food is also wasted through overconsumption. Obesity is a relatively new phenomenon in the world. Great Britain's first reported morbidly obese man,[6] who lived in the early 19th century, was such a phenomenon that he charged admission for people to see him. Today, the prevalence of morbid obesity in the United States is about 8.0 percent for women and 4.5 percent for men, and growing (CDC, 2013). In Burlingame's opinion, obesity is an agriculture issue, not just a health sector issue.

## Conclusion

In conclusion, Burlingame reiterated the central role of biodiversity in sustainability and called for more researchers worldwide to contribute to the evidence base. Although the dietary energy supply, which is considered a proxy for hunger, can be satisfied without biodiversity, the same is not true of the micronutrient supply. More than 10 years ago, a Zambian delegate to the Conference of Parties, Convention on Biological Diversity said, "Agricultural biodiversity is a matter of life and death for us.... We cannot separate agrobiodiversity from food security." That still rings true today (Zambian Delegate to the Conference of Parties, May 1998).

[4] See http://www.b4fn.org/about_us.html (accessed December 6, 2013).

[5] See http://www.barillacfn.com/en/bcfn4you/la-doppia-piramide (accessed December 6, 2013).

[6] A body mass index above 40 is considered morbid obesity, or Class III obesity.

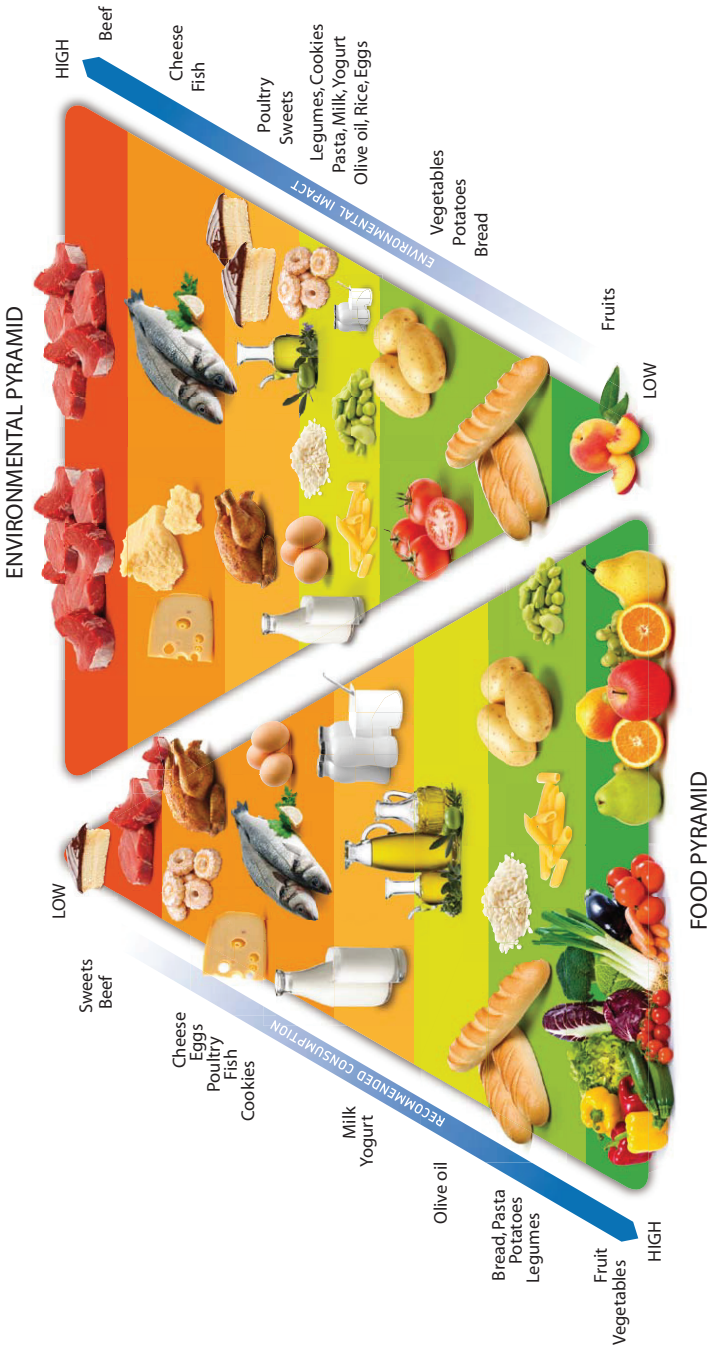



**FIGURE 2-2** Cereal food losses and waste worldwide.
SOURCE: Gustavsson et al., 2011.

## FISH, FISHERIES, AND FOOD SECURITY[7]

Are there enough fish in the sea? Cynthia Jones discussed U.S. dietary recommendations for fish and shellfish and the likely environmental implications of meeting the recommended daily intakes of fish and shellfish. She also considered climate change and its expected impact on seafood productivity.

### Recent Dietary Recommendations for Seafood

Jones first summarized that, by and large, most public health organizations and professionals (e.g., the American Heart Association, the Association of Reproductive Health Professionals, and the Harvard School of Public Health) recommend that both adults and children consume between 6 and 12 ounces of seafood, preferably fatty fish and not top predators, each week (American Heart Association, 2013; Association of Reproductive Health Professionals, 2008; Harvard School of Public Health, no date; IOM, 2007). Two servings of 3 to 6 ounces weekly translate to 0.375-0.75 pounds of fish per week. Some organizations and professionals also claim that the greater the consumption, the better. Those weekly recommendations translate to approximately 20 to 39 pounds of fish per person per year. Jones noted that the average U.S. citizen consumes only about 15 pounds per year, below what is recommended.

Given that there are about 315 million people in the United States, Jones calculated that those per person recommendations translate to somewhere between $6 \times 10^9$ (6 billion) and $12 \times 10^9$ pounds (12 billion) pounds of fish per year for the entire U.S. population. Those 6 to 12 billion pounds refer to processed fish, for example, fish sticks and fish fillets. The figure does not include bones and other parts of fish that are not actually eaten. According to the seafood manager at a Whole Foods grocery store in Virginia Beach, fillets constitute only about 50 percent of whole unprocessed fish. According to FAO statistics, the range of usable yield is approximately 30 to 65 percent (FAO, 1987). Jones used the 50 percent figure quoted by the Whole Foods seafood manager for her "back-of-the-envelope" calculations. Thus, 6 to 12 billion pounds of processed fish is equal to 12 to 24 billion pounds of landed, whole fish.

[7] This section summarizes information presented by Cynthia M. Jones, Ph.D., Old Dominion University, Norfolk, Virginia.

### U.S. Fish Production

Sources of fish harvest include both commercial and recreational capture fisheries (i.e., wild-caught fish) and aquaculture. Jones described aquaculture as any process that involves taking fish from the wild and modifying their growth in some way. In the United States, most landed whole fish comes from capture fisheries, with only about 10 percent coming from aquaculture. Combined, U.S. commercial landings and aquaculture production totaled 8 and 10 billion pounds per year in 2010 and 2011, respectively (NOAA, 2012a).

Jones referred workshop participants to two articles highlighting a current debate among fisheries scientists about whether catch data accurately reflect how much wild fish is actually available (Pauly et al., 2013; Worm et al., 2006).

By and large, domestic fisheries are well managed and in good condition (see Table 2-1) (NOAA, 2013a). The leading source of capture fisheries harvest in the United States is pollock. Jones described the harvest of pollock as sustainable, that is, it is neither currently overfished nor has it been overfished in the past. The second leading source of harvest is menhaden, which is not a fish that most people eat. Menhaden are an important source of omega-3s and are used in fishmeal and in other ways to feed other sources of food. Although menhaden were not overfished in the past, they are currently being overfished. Salmon is the third most predominant source of domestic harvest by volume (not value). Whether salmon has been overfished or is being overfished varies, depending on the population. Although the large Alaskan salmon are neither overfished nor have they been overfished, salmon fisheries in California are running into some problems.

In sum, all U.S. landings total $9.9 \times 10^9$ (9.9 billion) pounds, or 4.5 million metric tons. The reduction fishery, which includes menhaden, ac-

**TABLE 2-1** Top 10 Sources of U.S. Capture Fisheries Harvest

| Rank | Species | Pounds ($10^3$) | Overfished | Overfishing |
|---|---|---|---|---|
| 1 | Pollock | 2,826,692 | No | No |
| 2 | Menhaden | 1,875,035 | No | Yes |
| 3 | Salmon | 780,088 | Varies | Varies |
| 4 | Flatfish | 707,360 | Varies | Varies |
| 5 | Cod | 681,895 | Varies | Varies |
| 6 | Hakes | 521,246 | No | No |
| 7 | Crabs | 369,152 | Varies | No |
| 8 | Squid | 331,343 | No | No |
| 9 | Shrimp | 312,658 | Varies | Varies |
| 10 | Herring | 276,341 | No | No |

SOURCES: NOAA, 2012b, 2013a.

counts for $1.9 \times 10^9$ (1.9 billion) pounds. The edible fish and seafood landings account for $7.9 \times 10^9$ (7.9 billion) pounds, or 3.6 million metric tons (NOAA, 2012b). In relationship to what is needed to meet the U.S. dietary guidelines (i.e., 12 to 24 billion pounds of landed whole fish), Jones said, "We're falling short."

Recreational fisheries are "fun," Jones said, with the striped bass and speckled trout being the top two species, but they do not make a nearly sufficient difference. They account for $2.01 \times 10^8$ (201 million) pounds per year. Marine and inland U.S. aquaculture contributes $7.5 \times 10^8$ (7.5 million) pounds (NOAA, 2012a).

### Domestic Production and Consumption

Again, anywhere from 12 to 24 billion pounds of whole landed fish are needed to meet U.S. population needs for recommended dietary intakes of fish and shellfish. But only 8.851 billion pounds are available ($7.9 \times 10^9$ pounds of edible fish and seafood landings + $2.01 \times 10^8$ pounds of recreational fisheries landings + $7.5 \times 10^8$ pounds of aquaculture). The take-home message is, in Jones's words, "We are not producing enough fish in the United States to meet the dietary requirements that the Institute of Medicine and other sources recommend for us.… If we were to rely on fish from the U.S. only, we do not have food security for our own country.… We could eat other things. We could figure out how to eat menhaden, for example, or other species." To offset some of this gap, currently the United States imports more than 85 percent of its seafood, including shrimp and other fish (NOAA, 2013b).

### Global Production and Consumption

Jones again reiterated that two servings of 3 to 6 ounces of fish per week amounts to 19.5 to 39 pounds, or 8.9 to 17.8 kilograms, per person per year. At the current global census of $7 \times 10^9$ (7 billion) people, that amounts to between 63 and 126 million metric tons of processed fish (fillets, etc.) per year. Given that processed fish constitutes about 50 percent of whole unprocessed fish, that amounts to between 120 and 240 million metric tons of landed whole fish per year.

What's available? Most worldwide production is marine capture, with contributions from marine and inland aquaculture growing, and very little harvest from inland capture. Jones warned that global statistics are not very reliable, but total global fish landings are estimated to be about 148 million metric tons per year (FAO, 2012b). That includes reduction fisheries (e.g., sardines and other fish that are used for fishmeal). Available fresh, frozen, and cured fish amounts to about 128 million metric tons per year. Thus,

global production would barely meet global need if product were evenly distributed.

Could more fish be harvested if fisheries were better managed? Pauly et al. (2013) argued that productivity of overexploited stocks (~14 percent of all stock) could be improved through better management. Sumaila et al. (2012) argued that it would take about 12 years for the economic cost of better management to equal the economic benefit and that the gain would be about 10 percent. "That's simply not enough," Jones said. Better management will lead to initial loss of production, followed by eventual gain, but the gain will not be enough to meet dietary needs. Some experts predict that aquaculture, which has been growing worldwide, but mostly in Asia, could potentially exceed 60 percent of total fish production and make up some of the difference (Fishbio, 2012).

### Climate Change and Productivity

An article by Cheung et al. (2013) reported that climate change will shrink fish size by up to 25 percent, thus shrinking the amount of food available. In addition, the Marine Stewardship Council has made statements that climate change will not only change the number of fish, but it will also change their distribution, physiology, seasonality, and other components of their biology (Marine Stewardship Council, 2013). As just one example, the Atlantic menhaden, an important reduction fishery source, has been showing not just a steady population decline, but also distributional changes in an ongoing unpublished study by Jones. Other fish ranges are changing as well. The Atlantic croaker, which used to never travel much beyond Delaware Bay, is now spawning in New Jersey and even further north. The spotted sea trout, the second most important U.S. recreational species, relies very heavily on its sea grass nursing grounds, which are at a historic low, raising questions about whether the spotted sea trout might disappear (Jones, 2013).

### Conclusions

Jones highlighted three key conclusions. First, U.S. dietary suggestions may exceed current U.S. domestic fish production. Second, she is not hopeful that changes in management and aquaculture can bridge the gap. She foresees more sustainable production in the future, but not enough. Although some experts predict that aquaculture potentially could bridge the gap, Jones cautioned that there are hazards to aquaculture. Third, the effects of climate change on fish production are unknown. In sum, she said, "There are not enough fish in the sea."

## ENVIRONMENTAL IMPACT OF MEAT: GREENHOUSE GAS EMISSIONS[8]

Comparing the environmental impacts of beef, pork, and poultry is not an easy task, in Frank Mitloehner's opinion. Mitloehner is currently serving as chair of the FAO Livestock Environmental Assessment and Performance partnership, a project aimed at establishing an internationally agreed-on scientific methodology for determining the environmental impact of livestock in all regions of the world and among different producers within regions. The project has brought together not only many national governments, but also the entire livestock industry, as well as the World Wildlife Fund and other nongovernmental organizations. The project is based on a belief that developing a globally harmonized methodology is a first step toward assessing potential mitigation options.

FAO's interest in resource issues related to the animal protein sector stems from concerns about world population development and related nutrition issues. The global population is expected to continue to sharply increase, reaching almost 10 billion people by 2050, with most growth occurring in developing countries (Rekacewicz, 2005). Consumption of animal protein (eggs, meat, milk) in developing countries is growing rapidly as well (FAO, 2009). Meat consumption is generally driven by income, with greater consumption associated with greater disposable income (FAO, 2009). Meat production is growing particularly rapidly in parts of east and southeast Asia, but also in Latin America (FAO, 2009). Milk production is following the same trend, particularly in south Asia. Mitloehner observed that many people think of the United States as a "heavy hitter" in terms of livestock production, but in fact the fastest-growing livestock sectors are in China and India (FAO, 2009).

As animal protein consumption and meat production are growing, so too is general political pressure to eat less meat, particularly in developed countries. Mitloehner remarked on a comparison recently made on public television, in which the moderator compared the livestock sector with transportation—stating that driving a Hummer and being a vegetarian is better than driving a Prius and eating meat. Such statements make the public believe that transportation choices are not that consequential as long as your diet is right. Additional examples Mitloehner identified included a campaign in Sweden that compared the carbon footprints of a tofu burger versus a turkey burger versus a beef burger and a Prius advertisement comparing a Prius and a sheep with a scale showing the Prius is "greener."

In Mitloehner's opinion, although scientists would agree that food

[8] This section summarizes information presented by Frank Mitloehner, Ph.D., University of California, Davis.

choices are an important environmental emission source, they would also agree that food choices pale in comparison to transportation choices or energy production and use choices. To illustrate his point, Mitloehner cited a U.S. Environmental Protection Agency estimate that 33 percent of all GHG emissions are associated with production and use of energy and 27 percent are associated with use of transportation (EPA, 2013). Compare those figures to GHG emissions in the United States from the entire livestock sector, all species, based on life-cycle assessment[9] at 3.4 percent (EPA, 2012). According to Mitloehner's calculations, of that 3.4 percent, approximately 1.8 percent comes from the beef sector. Thus, GHG emissions from livestock in developed countries are dwarfed by carbon footprint contributions from other, larger sectors (e.g., transportation, energy, industry). The same is true of other developed countries. Mitloehner questioned the impact of "Meatless Mondays" or "Beefless Mondays." If 300-plus million people were to go beefless on Mondays, that would cut the 1.4 percent figure by a factor of 7 (number of days in the week), which would amount to a 0.2 percent reduction in the total greenhouse gas footprint. Mitloehner said, "While this is not nothing … it will not even compare to what we see from the transportation sector."

GHG emissions from livestock in developing countries, on the other hand, can be a dominant contributor due to deforestation (i.e., the clear-cutting of trees removes what was once a sink for GHGs and replaces it with forage land[10]), as well as developing countries' relatively smaller transportation and energy sectors. Moreover, GHG emissions of livestock vary greatly worldwide as a result of variation in production efficiency. For example, the average cow in California produces approximately 20,000 pounds of milk per year, while the average cow (of the same breed) just across the border in Mexico produces approximately 4,000 pounds of milk per year (USDA, 2013; Wattiaux et al., 2012). Thus, it takes five Mexican cows to produce the same amount of milk as one Californian cow. Compared to the single Californian cow, those five cows in Mexico produce much more enteric gasses and waste, need significantly more land and water, and consume more feed. In sum, they are less efficient. Cows in India are even less efficient. According to Mitloehner, it takes 20 Indian cows to produce the same amount of milk as 1 Californian cow.

Regionally, North American cows have the smallest carbon footprint per unit of milk produced. Mitloehner credited the veterinary care that North American herds receive, minimizing parasite load, their high "genetic merit," and optimized nutrition. Generally, GHG emissions from livestock are plateauing across the developed world (FAO, 2006). In developing

[9] See pages 4 and 5 of Pitesky et al. (2009) for description of methodology.
[10] Deforestation may also occur as a result of growing feed crops.

regions, by contrast, they are increasing sharply as a result of fast herd growth (FAO, 2006).

Variation in percentage of carbon footprint contributions from the livestock sector calls into question the use of global averages, such as the 2006 FAO report stating that livestock contributes 18 percent of all GHG emissions (FAO, 2006). The 18 percent figure is a global average, Mitloehner explained, spanning all livestock species. It is misleading to use global averages when discussing livestock emissions, he argued. More problematic, in his opinion, was that the 2006 FAO report concluded that livestock GHG emissions were greater than those from the transportation sector. The comparison was inappropriate because livestock emissions were analyzed using a true life-cycle assessment, whereas transportation emissions were analyzed using only tailpipe emissions. Yet, the report was well publicized by the media and has served as the basis for public policy decisions.

Mitloehner elaborated on the relationship between production efficiency and not just methane emissions, but also overall emissions. Comparing dairies in the United States in 1944 versus 2007, Capper et al. (2009) found that the modern dairies require 21 percent fewer animals, 23 percent less feed, 35 percent less water, and 10 percent less land to produce the same 1 billion kilograms of milk. Emissions have also been reduced since 1944, with today's dairies producing 43 percent less methane and almost 60 percent less nitrous oxide, another very potent greenhouse gas (Capper et al., 2009). However, that modern dairies are more efficient than older dairies does not mean that the current situation is sustainable. Mitloehner noted that high performance has created some unsustainable situations. For example, because high-performing dairy cows tend to have reduced reproductive performance, the herds require more replacement animals, that is, animals not currently milking but waiting to enter the milking herd. Those additional replacement animals eat and excrete, contributing to environmental costs.

Although some people advocate replacing conventional meat production with organic meat production, Mitloehner cautioned that conventional meat production is associated with increased production efficiency and a smaller GHG emission per unit of product produced (Stackhouse et al., 2012). It takes much larger herds of organic animals to produce 1,000 tons of milk or meat compared to herds of conventional animals.

### Sustainable Intensification

The fact that production and emission intensities are inversely related (i.e., the less an animal produces, the more it emits per unit of production) does not mean that concentrated animal feeding operations (CAFOs) are the solution to sustainability. CAFOs raise concerns in the areas of

animal welfare and food safety, as well as other issues. Instead of CAFOs, Mitloehner called for what he refers to as "sustainable intensification," that is, not reducing intensiveness, but becoming more sustainable about intensification. He identified four tools that can be used to make intensification sustainable: (1) improve fertility, (2) improve health, (3) improve genetics, and (4) provide better diet (Gill et al., 2010). Together, these tools can help to decrease the number of animals required per kilogram of product.

He also suggested considering new ways to manage the 30 to 40 percent of food purchased in the United States that goes to waste. The University of California, Davis, operates a biogas energy plant, a digester that receives different kinds of biomass, including food leftovers, and converts it into fuel. A village in Germany is using a similar digester to convert food waste, green clippings, animal waste, and other biomass into enough power to run the entire village off the grid. Through an underground pipeline system, every household is provided warm water and heat.

In conclusion, Mitloehner showed a photograph with an animal farm on one side of a fence and a housing development on the other. He stated that the GHG emissions impact of the housing development is much greater than the GHG emissions impact of the animal farm because of the fertilizers and pesticides that people use on their lawns and gardens, the fossil fuels that people use when they drive their cars or fly in planes to visit their relatives, and so on.

## PANEL DISCUSSION WITH THE AUDIENCE

In the panel discussion following Mitloehner's presentation, workshop participants asked questions and commented on several topics, including other evidence indicating that animal products in the diet impact climate change in more or different ways than described by Mitloehner; GHG emissions of livestock today versus those of bison in the past; problems and limitations with global fisheries data; and FAO strategies for dealing with natural resource issues associated with food.

### Other Evidence Indicating That Animal Products in the Diet Impact Climate Change in Different Ways Than Described by Mitloehner

An audience member pointed out a recent study in the *Proceedings of the National Academy of Sciences of the United States of America* stating that reducing U.S. consumption of animal products could have a significant impact on climate change (Pelletier and Tyedmers, 2010). The audience member asked Mitloehner to comment and state whether the evidence he presented was based on a whole life-cycle analysis. Mitloehner responded that he used data from the 2012 and 2013 EPA emission invento-

ries (EPA, 2012, 2013). These are the official U.S. livestock figures, he said, and they are based on total life-cycle assessment.[11] The total contribution of agriculture in the emission inventory is about 3.4 percent, that is, animals and crops combined contribute about 3.4 percent of the U.S. carbon footprint (EPA, 2013). Again, transportation accounts for 27 percent and energy production and use 33 percent.

Mitloehner emphasized that livestock emissions represent a significant contribution to the U.S. carbon footprint and that a change in eating habits could affect its portion of the carbon footprint. However, he cautioned that forgoing meat (e.g., beef) 1 day per week will have an impact of only about 0.2 percent. If people make that choice, they should be aware that the expected impact is often exaggerated. Equating driving a Prius and eating a burger per week to driving a Hummer "might sound cute to people," Mitloehner said, "but I think it's dangerous." In his opinion, these types of exaggerated statements suggest that transportation choices do not matter and that food choices do. "I think that's sending us in the wrong direction," he said.

Another audience member asked about the numerous externalities that Mitloehner did not address in his talk, particularly those associated with the intensification of meat production. Examples include water contamination from animal waste, especially in drinking water for rural populations; pesticide use for feed production; antibiotic use and resistance and the spread of antibiotic resistance to workers and consumers; and air quality issues associated with animal crowding. Mitloehner agreed that externalities exist. But they also exist for animals roaming freely and in situations where there is no control over their excrement. In intensive production situations, waste streams can be collected and managed (e.g., manure can be collected and used in a digester to produce power and nutrients can be extracted and applied to crops). Mitloehner's statement prompted a heated response from the questioner, who said, "I think it is important for the audience to understand that the arguments put forth on the non-importance of reducing meat intake in the U.S. is very narrow. I'm very concerned that the audience here is not hearing about the other human health and environmental concerns associated with meat production, especially intensification of meat production."

### GHG Emissions of Livestock Today Versus Those of Bison in the Past

Another audience member asked Mitloehner how the GHG footprint of modern dairy and beef herds across North America compares to the estimated GHG footprint of the indigenous bison herds of the 17th and 18th

[11] See pages 4-5 in Pitesky et al. (2009) for description of the methodology used.

centuries. Mitloehner referred to a recent paper comparing today's beef herd with historic bison herds that reported slightly lower emissions from the historic bison herd due to lower numbers (Hristov, 2012). Although emissions were slightly lower than today's beef herd emissions, they were still high because bison eat 100 percent roughage, which is what produces the methane gas that animals belch out. Also, bison have long lives. Beef animals do not live very long, particularly if they are finished in feed lots and entered into packing plants between 14 and 18 months.

### Problems and Limitations with Global Fisheries Data

An audience member asked Jones whether the global data she shared on fish factored in the overfishing of predator species (e.g., shark, tuna). Jones reiterated Mitloehner's cautionary note about using global averages. Different countries manage the harvesting of their fisheries differently. Most developing countries use a precautionary maximum sustainable yield approach, that is, they maintain their fisheries at a midway point where they are most productive. Most developed countries, on the other hand, opt to maintain their populations at lower levels of harvest and higher levels of abundance. Not only do different countries manage harvesting differently, making it difficult to use global averages, but some parts of the world, like Africa and China, have very poor fisheries statistics. With respect to predator overfishing, Jones referred workshop participants to work by Ray Hilborn (Hilborn et al., 2005). Although improving the situation for top predators changes the system because predators influence the species mix, it will not likely make a difference in terms of boosting general productivity. Managing lower-level species will probably be more impactful in terms of boosting productivity—because overfishing predator's prey can leave them without adequate food to sustain their populations.

### FAO Strategies for Dealing with Natural Resource Issues Associated with Food

Burlingame was asked what strategies FAO is using to address natural resource issues associated with food. Burlingame identified sustainable production intensification, as described by Mitloehner, as one. Conservation agriculture is another. She emphasized that the choice of strategy is based on an assessment of the agroecological zone in question and an identification of which techniques and strategies can be used in that particular zone to maximize production and minimize environmental damage. Burlingame considered food losses and waste as one of the most important issues to consider when discussing natural resource issues associated with food. According to studies by FAO and the World Wildlife Fund, food wasted in

the developed world reflects a waste of resources in developing countries where many of those wasted foods are produced (Chapagain and Orr, 2008). Conservation agriculture and other similar techniques can help to minimize food losses and waste. More generally, she encouraged being mindful that production and consumption are coupled. She opined that advocating Meatless Mondays without addressing livestock production will not solve the problem.

Another audience member commented on Burlingame's discussion of biodiversity and emphasized the importance of cultivar-level biodiversity and the "incredible amount of knowledge" that indigenous people have about that biodiversity.

## REFERENCES

American Heart Association. 2013. *Fish 101*. http://www.heart.org/HEARTORG/GettingHealthy/NutritionCenter/Fish-101_UCM_305986_Article.jsp (accessed September 30, 2013).

Association of Reproductive Health Professionals. 2008. *Fish consumption to promote good health and minimize contaminants*. Washington, DC: Association of Reproductive Health Professionals.

Balzer, T., P. Balzer, and S. Pon. 2002. *Traditional use and availability of aquatic biodiversity in rice-based ecosystems. I. Kampong Thom Province, Kingdom of Cambodia*. Awareness of Agricultural Biodiversity FAO/Netherlands Partnership Programme. ftp://ftp.fao.org/fi/cdrom/awarnessagrbiodiv/Kampong%20thom%20reportA.pdf (accessed August 14, 2013).

Burlingame, B., and S. Dernini, eds. 2012. *Sustainable diets and biodiversity: Directions and solutions for policy, research and action*. Rome: Food and Agriculture Organization and Bioversity International.

Capper, J. L., R. A. Cady, and D. E. Bauman. 2009. The environmental impact of dairy production: 1944 compared with 2000. *Journal of Animal Science* 87(6):2160-2167.

CBD (Convention on Biological Diversity). 2006. *Agricultural biodiversity: A cross-cutting initiative on biodiversity for food and nutrition*. https://www.cbd.int/decision/cop/default.shtml?id=11037 (accessed August 14, 2013).

CBD. 2013. *COP 7 decision VII/32*. http://www.cbd.int/decision/cop/default.shtml?id=7769 (accessed September 26, 2013).

CDC (Centers for Disease Control and Prevention). 2013. *Health, United States, 2012: With special feature on emergency care*. Hyattsville, MD: National Center for Health Statistics.

Chapagain, A. K., and S. Orr. 2008. *UK water footprint: The impact of the UK's food and fibre consumption on global water resources*. Godalming, UK: Water Footprint Network-UK.

Cheung, W. W. L., J. L. Sarmiento, J. Dunne, T. L. Frolicher, V. W. Y. Lam, M. L. D. Palomares, R. Watson, and D. Pauly. 2013. Shrinking of fisheries exacerbates impacts of global ocean changes on marine ecosystems. *Nature Climate Change* 3:254-258.

Englberger, L., J. Schierle, G. C. Marks, and M. H. Fitzgerald. 2003. Micronesian banana, taro, and other foods: Newly recognized sources of provitamin A and other carotenoids. *Journal of Food Composition and Analysis* 16(1):3-19.

EPA (U.S. Environmental Protection Agency). 2012. *Inventory of U.S. greenhouse gas emissions and sinks: 1990-2008*. Washington, DC: EPA.

EPA. 2013. *Inventory of U.S. greenhouse gas emissions and sinks: 1990-2011*. Washington, DC: EPA.

EU (European Union). 2008. Council regulation (EC) No 479/2008. *Journal of the European Union* 6.6.2008 L (148).

FAO (Food and Agriculture Organization). 1987. Yield and nutritional value of the commercially more important fish species. In *Yearbook of fisheries statistics*, Volume 64. Rome: FAO.

FAO. 2000. *Food security: When people live with hunger and fear starvation*. Rome: FAO.

FAO. 2002. *Report on the International Rice Commission. 20th session. Bankok, Thailand, 23-26*. http://www.fao.org/fileadmin/templates/agphome/scpi/SCPI_Compendium/20th_Session_IRC.pdf (accessed September 27, 2013).

FAO. 2005. *Report of the third session of the Intergovernmental Technical Working Group on Plant Genetic Resources for Food and Agriculture*. http://www.fao.org/fileadmin/templates/agphome/documents/PGR/ITWG/ITWG3/P3rep_e.pdf (accessed September 27, 2013).

FAO. 2006. *Livestock's long shadow*. Rome: FAO.

FAO. 2009. *The state of food and agriculture. Livestock in the balance*. Rome: FAO.

FAO. 2010. *Biodiversity in sustainable diets*. Technical Workshop Report. http://www.fao.org/ag/humannutrition/24994-064a7cf9328fbe211363424ba7796919a.pdf (accessed August 14, 2013).

FAO. 2012a. *The state of food insecurity in the world 2012*. Rome: FAO.

FAO. 2012b. *The state of world fisheries and aquaculture*. Rome: FAO.

Fishbio. 2012. *Aquaculture to top 60% of fish production*. http://fishbio.com/fisheries-news/marine-fisheries-news/aquaculture-to-top-60-of-fish-production (accessed September 30, 2013).

Gill, M., P. Smith, and J. M. Wilkinson. 2010. Mitigating climate change: The role of domestic livestock. *Animal* 4:3(323-333).

Gustavsson, J., C. Cederberg, U. Sonesson, R. van Otterdijk, and A. Meybeck. 2011. *Global food losses and food waste*. Rome: FAO.

Harvard School of Public Health. No date. Fish: Friend or foe? *Nutrition Source*. http://www.hsph.harvard.edu/nutritionsource/fish (accessed October 3, 2013).

Hilborn, R., J. M. Orensanz, and A. M. Parma. 2005. Institutions, incentives and the future of fisheries. *Philosophical Transactions of the Royal Society Biological Sciences* 360:47-57.

Hristov, A. N. 2012. Historic, pre-European settlement, and present-day contributions of wild ruminants to enteric methane emissions in the United States. *Journal of Animal Science* 90:1371-1375.

Huang, A. S., L. Tanudjaja, and D. Lum. 1999. Content of alpha-, beta-carotene, and dietary fiber in 18 sweet potato varieties grown in Hawaii. *Journal of Food Composition and Analysis* 12(2):147-151.

Iacopinia, P., M. Baldib, P. Storchic, and L. Sebastiania. 2008. Catechin, epicatechin, quercetin, rutin and resveratrol in red grape: Content, in vitro antioxidant activity and interactions. *Journal of Food Composition and Analysis* 21(8):589-598.

IOM (Institute of Medicine). 2007. *Seafood choices: Balancing benefits and risks*. Washington, DC: The National Academies Press.

IRRI (International Rice Research Institute). 2006. *How many rice varieties are there?* http://irri.org/index.php?option=com_k2&view=item&id=10341:how-many-rice-varieties-are-there?&lang=en (accessed September 27, 2013).

Jones, C. M. 2013. Can we predict the future?: Juvenile finfish and their seagrass nurseries in the Chesapeake Bay. *ICES Journal of Marine Science*. doi: 10.1093/icesjms/fst142.

Kennedy, G., and B. Burlingame. 2003. Analysis of food composition data on rice from a plant genetic resources perspective. *Food Chemistry* 80:589-596.

Marine Stewardship Council. 2013. *Climate change and fish*. http://www.msc.org/healthy-oceans/the-oceans-today/climate-change (accessed October 3, 2013).

NOAA (National Oceanic and Atmospheric Administration). 2012a. *Fisheries of the United States 2011*. Current Fishery Statistics No. 2011. Silver Spring, MD: National Marine Fisheries Service, NOAA, U.S. Department of Commerce.

NOAA. 2012b. *Menhaden*. http://chesapeakebay.noaa.gov/fish-facts/menhaden (accessed September 30, 2013).

NOAA. 2013a. *Fishwatch. U.S. seafood facts*. http://www.fishwatch.gov (accessed September 30, 2013).

NOAA. 2013b. *Outside the U.S*. http://www.fishwatch.gov/wild_seafood/outside_the_us.htm (accessed October 11, 2013).

Pauly, D., R. Hilborn, and T. A. Branch. 2013. Fisheries: Does catch reflect abundance? *Nature* 494(7437):303-306.

Pelletier, N., and P. Tyedmers. 2010. Forecasting potential global environmental costs of livestock production 2000-2050. *Proceedings of the National Academy of Sciences of the United States of America* 107(43):18371-18374.

Pitesky, M. E., K. R. Stackhouse, and F. M. Mitloehner. 2009. Clearing the air: Livestock's contribution to climate change. In *Advances in agronomy*, Volume 103, Edited by D. Sparks. Burlington, VT: Academic Press. Pp. 1-40.

Rekacewicz, P. 2005. *World population development*. http://www.grida.no/graphicslib/detail/world-population-development_29db (accessed October 3, 2013).

Stackhouse, K. R., C. A. Rotz, J. W. Oltjen, and F. M. Mitloehner. 2012. Growth-promoting technologies decrease the carbon footprint, ammonia emissions, and costs of California beef production systems. *Journal of Animal Science* 90(12):4656-4665.

Sumaila, U. R., W. Cheung, A. Dyck, K. Gueye, L. Hunag, V. Lam, D. Paul, T. Srinivasan, W. Swartz, R. Watson, and D. Zeller. 2012. Benefits of rebuilding global marine fisheries outweigh costs. *PLoS ONE* 7(7):e40542.

Thompson, B., and L. Amoroso, eds. 2011. *Combating micronutrient deficiencies: Food-based approaches*. Rome: FAO and CAB International.

UN (United Nations). 2012. *Zero hunger challenge*. http://www.un.org/en/zerohunger/challenge.shtml (accessed August 14, 2013).

USDA (U.S. Department of Agriculture). 2013. *Milk production, disposition, and income. 2013 summary*. Washington, DC: National Agriculture Research Service.

Wattiaux, M., J. Blazek, and J. de Jesus Olmos Colmenero. 2012. *Bird's eye view of the Mexican dairy industry and on-the-ground assessment of production systems in the highlands (Los Altos) of Jalisco, Mexico*. Madison, WI: The Babcock Institute for International Dairy Research and Development. http://babcock.wisc.edu/sites/default/files/documents/productdownload/dp_2012-2.pdf (accessed October 17, 2013).

WHO (World Health Organization). 1981. *International code of marketing of breast-milk substitutes*. Geneva: WHO.

Worm, B., E. B. Barbier, N. Beaumont, J. E. Duffy, C. Folke, B. S. Halpern, J. B. C. Jackson, H. K. Lotze, F. Micheli, S. R. Palumbi, E. Sala, K. A. Selkoe, J. J. Stachowicz, and R. Watson. 2006. Impacts of biodiversity loss on ocean ecosystem services. *Science* 314(5800):787-790.

# 3

# Quantifying Synergies and Trade-Offs: Moving Forward from Conceptual Links to Empirical Data

Developing evidence-based food policy within an environmental sustainability context requires more than identifying the synergies and trade-offs between health and the environment associated with food production, consumption, and waste. It also requires quantifying those synergies and trade-offs. This chapter describes the workshop presentations and discussion that revolved around quantitative data and methodologies. A major focus of the presentations and discussion was how various hypothetical changes in the typical U.S. diet, such as an increase in the amount of fruits and vegetables consumed or a decrease in the amount of meat consumed, would impact the environmental consequences associated with the nation's food system. Another overarching theme was whether and how quantitative synergy and trade-off data could be used to develop future U.S. dietary guidelines.

Emily Cassidy from the University of Minnesota quantified the environmental impacts of different diet preferences using three metrics: land use, water use, and greenhouse gas (GHG) emissions. Specifically, she quantified the land, water, and GHG emissions of the typical U.S. diet, which includes far more meat than is nutritionally recommended, and the projected land, water, and GHG emissions if Americans were to reduce their meat consumption by 75 percent. She also considered how environmental impacts would change if meat consumption decreased by 75 percent and beef was completely eliminated from the diet and if meat consumption remained the same but beef was completely eliminated from the diet.

Christian Peters from Tufts University described several ways to pre-

dict changes in land use with various hypothetical shifts in diet, including work by the U.S. Department of Agriculture (USDA) Economic Research Service (ERS) and his own work. Peters cautioned that assumptions made about what constitutes healthy eating with respect to meat are important in terms of trying to understand what the impacts will be on land use. He also discussed how actual land use changes can be tracked and evaluated and suggested that it is appropriate to begin considering environmental impacts when developing U.S. dietary guidelines but to do so within the bounds of available evidence.

Finally, Martin Heller from the University of Michigan considered how life-cycle assessment (LCA) has been used to study food and agricultural systems. He emphasized that LCA is "just a tool" and that its end results are relative measures, not absolute answers. To advance food-related LCA work, Heller encouraged an interdisciplinary dialogue to establish an appropriate functional unit (basis for relative assessment) for use in food LCAs and made a case for more data and improved ways to weight different environmental impact categories.

The three presentations prompted several questions from the audience about ways that analyses of environmental impacts can be expanded to include the full range of U.S. diets, including plant-only diets, processed foods, functional foods, and different types of animal production systems. Audience members also expressed concern about the quality of the data be-

**Key Themes of This Chapter**[a]

- Several data sources and methodologies are available to quantify the environmental impacts of diet and to predict how those impacts would likely change with shifts in diet. (Cassidy, Heller, Peters)
- Regardless of methodology used, results generated thus far generally indicate that a reduction in the animal protein content in the U.S. diet would reduce greenhouse gas emissions, land use, and other environmental impacts. (Cassidy, Heller, Peters)
- Classifying situations, or choices, as either "ethical synergies" or "ethical dilemmas" is a helpful way to frame the weighing of health versus environmental benefits. Eating more legumes is an example of an ethical synergy: it would improve health and reduce land use by reducing the reliance on meat as a protein source. Increasing fish consumption is an example of an ethical dilemma: it would improve health but have a negative effect on fish stocks. (Heller)

[a] Key themes identified during discussions, presenter(s) attributed to statement indicated by parenthesis "( )."

ing used in the various analyses described by the speakers and the confusing use of "sustainability" and some other words. These questions and concerns and the panelists' responses are summarized at the end of this chapter.

## QUANTIFYING ENVIRONMENTAL IMPACTS OF DIETS[1]

Efforts by Cassidy and colleagues in Jonathan Foley's laboratory at the Institute on the Environment, University of Minnesota, to quantify the environmental impacts of diet rely on a combination of census and satellite data to determine the yields and distributions of more than 170 crops worldwide (Monfreda et al., 2008). Cassidy described some of the results of her lab's efforts, emphasizing the predicted changes in environmental impact that would occur with shifts in the animal protein content of the typical U.S. diet. She pointed workshop participants to www.earthstat.org, where all of the crop yield and distribution data she discussed are freely available. Although agricultural productivity is usually measured in terms of tons per hectare, members of the Foley lab have been investigating ways to translate agricultural productivity into terms that describe actual food delivery to humans, specifically food types, calories, and protein.

In a study on global crop allocations, Cassidy et al. (2013) found that only about 59 percent of calories produced globally end up actually being delivered to people as food (see Figure 3-1). The 41 percent of calories lost are lost mostly to animal conversions to meat and dairy, but also increasingly to biofuels. Globally, 36 percent of calories produced by cropland are used for animal feed, as opposed to food production (see Figure 3-2). The average conversion efficiency of grain to livestock is about 10 percent, which means that only about 10 percent of all calories fed to livestock are actually delivered to humans in the form of either meat or dairy. Conversion efficiencies vary among different types of livestock: efficiencies are about 40 percent for dairy, 22 percent for eggs, 12 percent for chickens, 10 percent for pigs, and 3 percent for beef (Cassidy et al., 2013). The low conversion efficiency of beef cattle is due, in part, to the fact that only about 60 percent of the total live weight of beef cattle is edible (FAO, 1972).

In the United States, about 67 percent of calories produced are used for animal feed on average. Most of those feed calories are being consumed domestically but about 10 to 20 percent are exported (as feed). So, of all calories produced in the United States, only about 34 percent actually become food for humans (Cassidy et al., 2013). In Cassidy's opinion, the 34 percent figure (compared to the 59 percent globally) is not very surprising given higher per capita meat consumption in the United States compared to

[1] This section summarizes information presented by Emily Cassidy, B.S., Institute on the Environment, University of Minnesota.

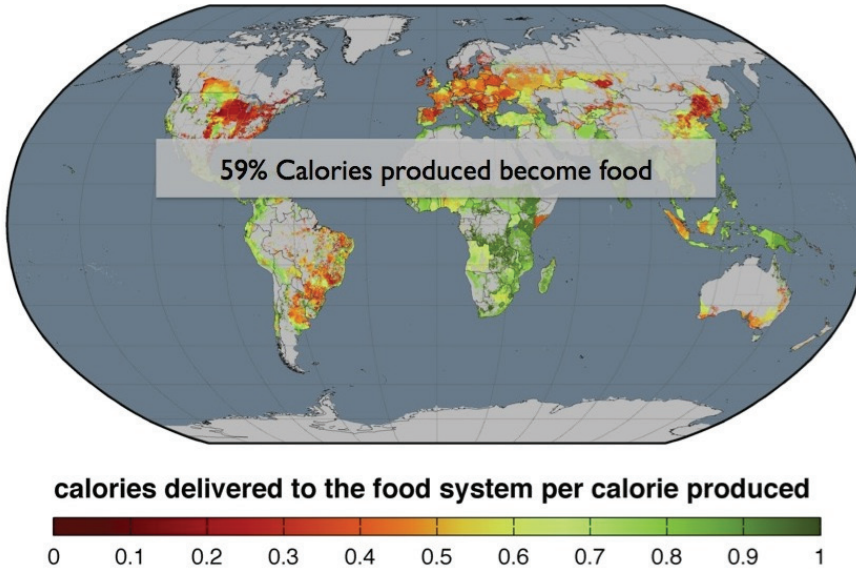



**FIGURE 3-1** Proportion of total cropland calories produced that actually end up being delivered to people as food. Green areas on the map are areas where a high proportion of calories produced are directly delivered to people as food. Red areas of the map, like the U.S. Midwest, are areas where only a small proportion of calories produced are directly delivered to humans as food.
SOURCE: Cassidy et al., 2013.

most other countries. Americans consume, on average, about 123 kilograms of meat per capita per year (FAO, 2013).

According to the 2006 Institute of Medicine report *Dietary Reference Intakes: The Essential Guide to Nutrient Requirements* (IOM, 2006), about 0.6 grams of protein per day are recommended per kilogram of body weight. So for a 200-pound, or about 90-kilogram, person, that equates to about 54 grams of protein per day or 20 kilograms per year. Many developed countries consume more meat than is nutritionally recommended.

### Environmental Impacts of Typical U.S. Diet

Cassidy used land, water, and GHG emission metrics to explore the likely environmental impacts if the typical U.S. diet were to shift toward less protein. According to FAOSTAT, in 2008 the typical U.S. diet (in terms of weight) included about 30 percent dairy, 15 percent meat (including beef, poultry, and pork), 14 percent fruits and vegetables, and smaller pro-

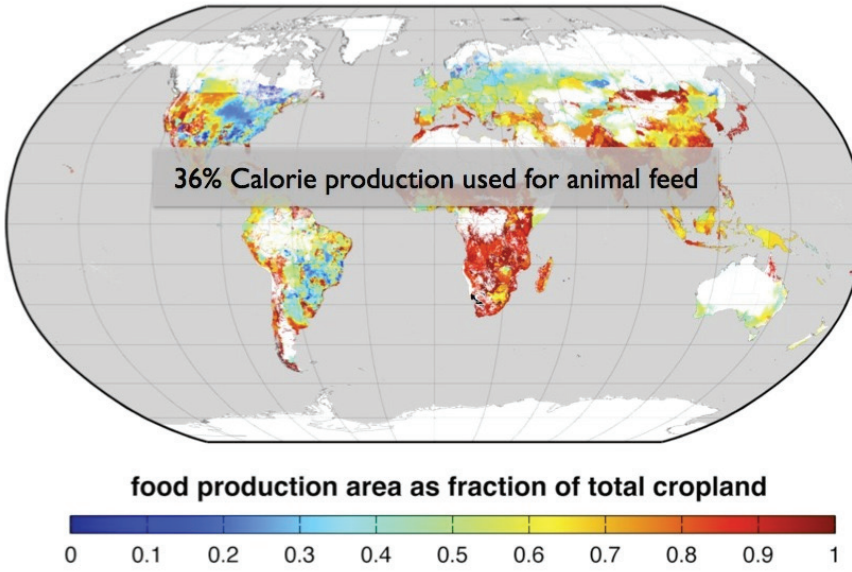



**FIGURE 3-2** Proportion of total cropland calories used for animal feed, with areas in blue producing the greatest proportions of animal feed.
SOURCE: Foley et al., 2011.

portions of various other food groups (FAO, 2013). She emphasized that measuring these metrics is different for vegetable products versus animal products, with the latter requiring taking into account not only what the animals are eating but also how what they are eating is converted into meat or dairy (Bouwman et al., 2005).

To measure land requirements for different diets, Cassidy used both census and satellite data to determine the yields and distributions of major crops grown globally and in the United States. She assessed land requirements for 100 grams each of various food products, categorizing her findings using the same groups Food and Agricultural Organization uses (beef, pig, chicken, egg, dairy, oil crops, vegetable, fruit, cereals, sugars, tree nuts, starchy roots, pulses). Her recent measurements indicated that although meat comprises only 15 percent of the typical U.S. diet, it accounts for 44 percent of U.S. land being used for food production. Although beef comprises only 5 percent of the typical U.S. diet, it accounts for 26 percent of U.S. land being used for food production. Beef requires much more land than any other food group (see Figure 3-3).

For water metrics, Cassidy referred to Mekonnen and Hoedkstra

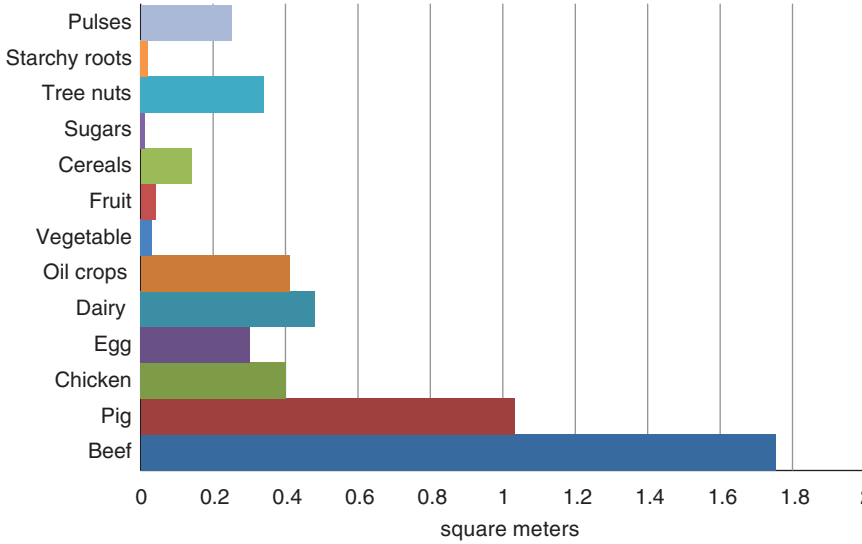



**FIGURE 3-3** Land requirements (square meters per 100 grams produced) for various food groups, based on Food and Agriculture Organization food categories. SOURCE: Unpublished results from Cassidy.

(2012), which she described as an "amazing" database of water footprints for crops and animal products, including U.S.-specific footprints. The water story is similar to the land story, with meat accounting for almost half of the water footprint of the typical U.S. diet and beef accounting for a disproportionately large portion of that.

Measuring GHG emission footprints is "tricky," Cassidy said, as data for different types of products come from different sources. She cited Vermeulen et al. (2012), who estimated that agriculture accounts for roughly 19 to 29 percent of global anthropogenic GHG emissions, with about 80 to 86 percent of agricultural emissions occurring during the production stage and associated with fertilization (nitrous oxide emissions) or enteric fermentation (methane emissions). Thus, Cassidy calculated GHG emission footprints based on nitrous oxide and methane emissions. Her calculations did not include GHG emissions associated with land use change (e.g., deforestation). Specifically, she used data from Mueller et al. (2012) on the amount of nitrogen applied per ton of crop to estimate nitrous oxide emissions of various crops per ton or per kilogram of production. Based on the European Union Integrated Pollution Prevention and Control's assessment that 1 percent of nitrogen applied is emitted as nitrous oxide (with nitrous oxide having about 310 times more global warming potential than

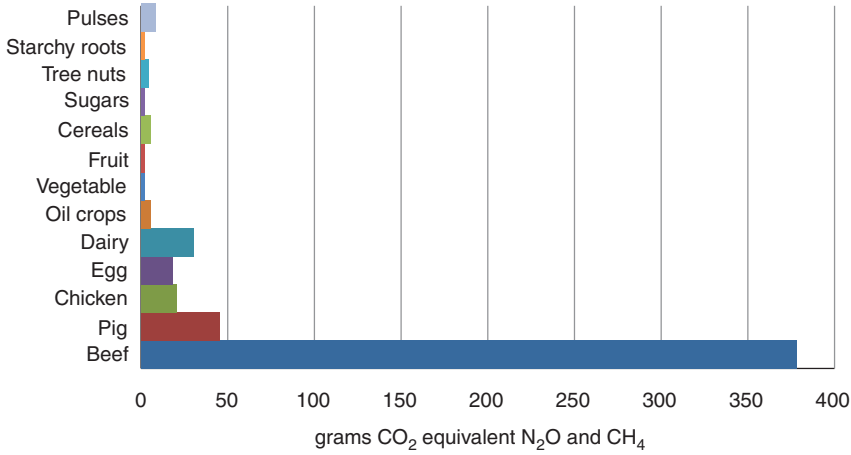



**FIGURE 3-4** Greenhouse gas (GHG) emission footprints (grams GHG per 100 grams produced) for various food groups, based on nitrous oxide (fertilizer) and methane (enteric fermentation) data. Emissions associated with land use change (deforestation) are not included.
SOURCE: Unpublished results from Cassidy.

carbon dioxide), and also taking into account enteric fermentation (with methane having about 21 times more global warming potential than carbon dioxide), Cassidy reported that beef has a much larger footprint than any other food group, accounting for 56 percent of GHG emissions associated with the typical U.S. diet (see Figure 3-4). An estimated 85 percent of beef GHG emissions are enteric methane emissions, and the remaining 15 percent are from feed production for the beef cattle. Overall, meat accounts for 64 percent of the typical U.S. diet's GHG emissions.

### How Can New Guidelines Impact Environmental Footprints?

Americans consume a lot of meat, more than 110 kilograms per person per year,[2] even though the nutritionally recommended amount is only about 23 kilograms per person per year (FAO, 2013). If meat consumption were to be reduced by 75 percent, to 30 kilograms per person per year, with the lost weight being compensated by fruits and vegetables, cereals, and other foods, what would happen to the environmental footprint of the U.S. diet? Cassidy's calculations suggest that such a reduction would significantly

[2] This statistic does not include losses due to household waste.

change the environmental impacts associated with the U.S. food system (see Figure 3-5). Specifically, a 75 percent reduction in meat consumption would result in a 27 percent reduction in land use, a 31 percent reduction in water use, and a 46 percent reduction in GHG emissions.

If beef consumption were eliminated entirely, a 75 percent reduction in overall meat consumption would result in similar land and water use reductions but even a greater GHG emission reduction (59 percent). If overall meat consumption were to remain the same but beef consumption were eliminated entirely, land use would be reduced by 15 percent, water use would be reduced by 19 percent, and GHG emissions would be reduced by 52 percent. So, consuming the same amount of meat (123 kilograms per person per year)—but with no beef in the diet—would still result in significant reductions in GHG emissions (unpublished data from Cassidy).

Although a meat reduction shift in diet would have a significant environmental impact, what is happening in reality? What efforts are under way to promote healthy eating, and what will be the environmental impacts of those efforts? Cassidy mentioned the South African Healthy Food Benefit effort to subsidize healthy food purchases (Sturm et al., 2013). The program covers more than 300,000 participants. Cassidy is collaborating with Derek Yach and Darren Segal of Discovery Vitality to assess changes in food purchased by enrollees in the program. Based on 2009-2012 data, they found that subsidizing fruits and vegetable purchases led enrollees to increase their purchases of fruits and vegetables by 5.7-8.5 percent and to decrease their purchases of processed sugary and fatty foods by 5.6-7.2 percent (Sturm et al., 2013).

Additionally, preliminary purchase weight data show a decrease in beef and pork purchases (by weight) and an increase in fruit and vegetable purchases (again, by weight). Based on an analysis similar to the one she performed for the U.S. food diet, Cassidy estimated the environmental impact of the observed shift in purchases by weight. Preliminary results show an 8-13 percent decrease in land requirements, a 7-12 percent decrease in the water footprint, and an 8-10 percent decrease in greenhouse gas emissions. Cassidy suggested that these results show promise for healthy food benefit programs in the United States, such as the Supplemental Nutrition Assistance Program.

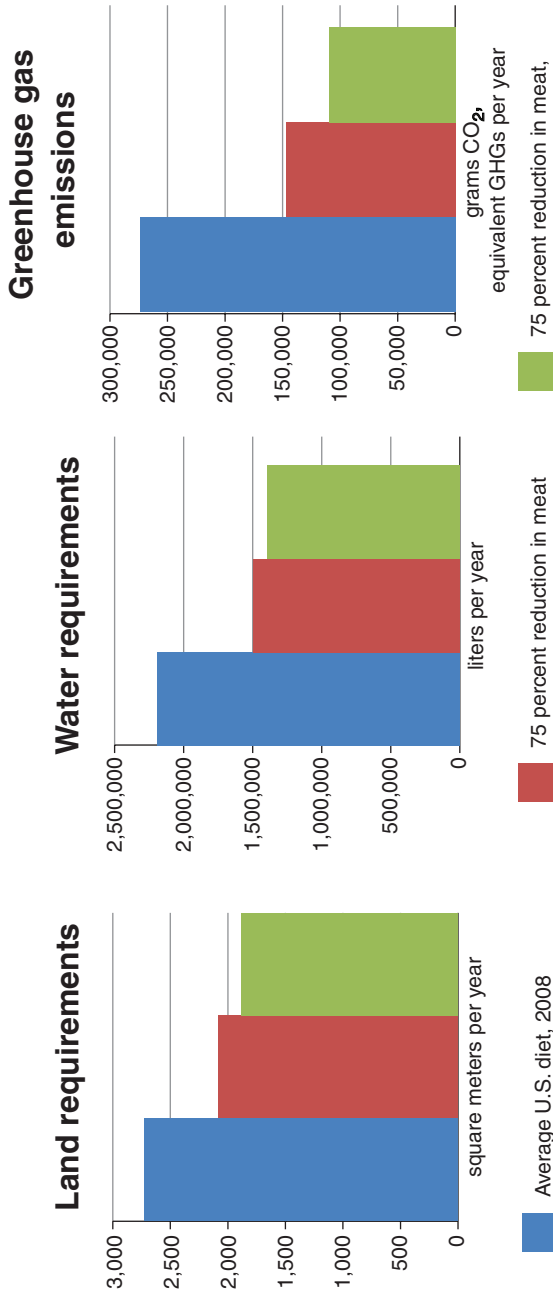



**FIGURE 3-5** How a shift in the U.S. diet from 123 to 30 kilograms of meat per person per year would impact land, water, and greenhouse gas footprints.
SOURCE: Unpublished results from Cassidy.

## LAND USE EFFECTS OF VARIOUS DIET PATTERNS[3]

The USDA ERS has been translating food supply data into consumption data since 1999, with the most recent update in 2008 (USDA, 1999; Wells and Buzby, 2008). The data allow for a comparison between consumption and the U.S. dietary guidelines (e.g., MyPyramid recommendations). The Wells and Buzby (2008) assessment showed that consumption of refined grains and meat/eggs/nuts is above the recommended amount, while consumption of vegetables, dairy, and fruit is below the recommended amount. The data also provide a baseline for how the U.S. diet would need to shift if the U.S. population were to instantaneously start following the dietary guidelines. The ERS has made two attempts to estimate what the land use impact would be if the U.S. population was to make that dietary shift.

First, Buzby et al. (2006) reported adjustments that would need to occur in harvested acreage in order to supply 100 percent of the population with enough food to meet the guidelines, assuming even distribution, during the period 1999-2003. Their results were not particularly surprising, in Peters's opinion, given the disparity between consumption and the dietary guidelines for most food groups. A large increase in acreage, about a doubling, would be expected for fruit, and large but variable increases would be expected for vegetables, depending on the vegetable. Dark green and orange vegetables, as well as legumes, would require large increases in acreage, whereas starchy vegetables, like potatoes, would actually result in decreases. For whole grains, Buzby et al. (2006) analyzed only wheat, projecting a decrease in acreage. They did not examine the land use impacts of meeting the dairy recommendations. Overall, they predicted an increase of about 7.4 million acres. In terms of total land, 7.4 million acres is very small, Peters remarked. For certain food groups, such as for fruit, the change in acreage is substantial. But, overall, it is a small amount, given that harvested acreage in the United States totals about 300 million acres.

In a second study, Young and Kantor (1999) predicted the land use impacts of consumption shifts in other food groups, including sweeteners, meat, and added fat. Aligning sweetener consumption with the U.S. dietary recommendations would require a decrease translating to about a 67 percent reduction in land area for sugar cane, sugar beet, and corn sweetener crops. For meats and added fats, the land use implications of changing the American diet are more complex. The dietary guidelines recommend more lean meat, which would eventually require breeding leaner animals. But, in the short term, a shift to a leaner-meat diet would require more animals because the fattier cuts of meat would be discarded, with land

[3] This section summarizes information presented by Christian J. Peters, Ph.D., Gerald J. and Dorothy R. Friedman School of Nutrition Science and Policy at Tufts University in Boston, Massachusetts.

use implications for both feed grains and oil seeds. The primary oil seed crop in the United States, soybean, is used both as a major livestock feed component and for vegetable oils and salad oils. So, if the demand for lean meat requires more animals, the demand for soybean meal as a livestock feed component would increase. But if the demand for added fat decreases (to meet the recommended dietary fat intake), the demand for soybean oil as a vegetable and salad oil would decrease. The expectation is that trade would resolve the mismatch between the demand for lean meat and less oil, that is, the excess soybean product would be exported, and the changes in soybean use would not necessarily translate into changes in U.S. land use.

The ERS story is not complete, in Peters's opinion. Another way to predict land use change is to examine land use requirements of a complete diet, such as what Peters et al. (2007) did with their two-step process for estimating dietary land requirements for the New York state population. The first step is to estimate agricultural commodity needs (e.g., bushels of wheat, pounds of carcass) for the diet in question, based on the amount of edible food that would be needed to supply the intake, and accounting for losses that occur along the food supply chain. The second step is to estimate land needs, including crops needed for livestock and land required to meet those crop needs. Peters et al. (2007) examined 42 complete 2,300-calorie diets with varying meat and fat content. Meat content ranged from a vegetarian diet to a 381-gram meat diet (the equivalent of 12 cooked ounces of meat), and fat content ranged from 20 percent to 45 percent of total calories. The researchers estimated land requirements per person per year for each diet and concluded that land requirements increase as meat content in the diet increases, but the change in land requirements differs for cultivated crops (e.g., annual crops) versus perennial crops (e.g., hay and pasture) (see Figure 3-6).

According to 2009 food supply data, current consumption of meat (4.67), eggs (0.52), fish (0.46), nuts (0.81), and beans (0.10) totals 6.56 (in meat equivalent ounces[4]), which lies about in the middle of the graph in Figure 3-6. The change in land required per year from where the United States is today with its average diet, that is, mid-way along the x-axis, and a vegetarian diet is more than a twofold difference. Thus, Peters opined, "the assumptions made about what constitutes healthy eating with respect to meat are incredibly important in terms of trying to understand what the impacts will be on land use."

[4] One meat equivalent ounce = 1 ounce of fish; 0.25 cup cooked dry beans, 1 egg, or 0.5 ounce of nuts or seeds.

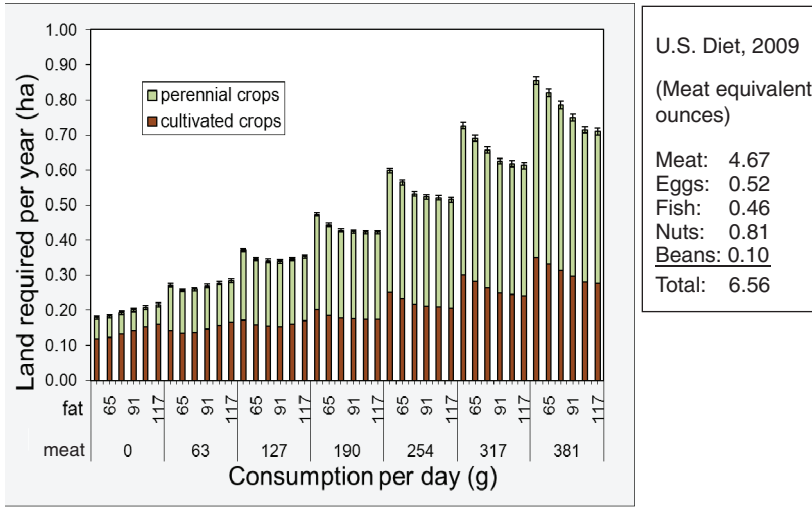



**FIGURE 3-6** Land requirements for 42 different diets, all complete 2,300-calories diets but varying in meat and fat content.
SOURCE: Peters et al., 2007.

### Other Ways to Project Land Use Impacts

Peters identified three other methods to estimate change in land use, all of which are in use today and all of which are evolving to address not just land use but environmental impacts generally. One is economic modeling, with the goal of modeling demand and the potential supply given that demand (Rosegrant and IMPACT Development Team, 2012). An example of this method is the impact model by the International Food Policy Research Institute. A second method is LCA (deVries and deBoer, 2009), with the goal of apportioning the impact, in this case the land use impact, of different dietary patterns based on what has been observed. The third method is biophysical modeling[5] (Wirsenius et al., 2010). Rather than focusing on economic drivers, biophysical modeling focuses on biological and physical factors that constrain and shape what the land requirements of a diet would be. Each method provides a unique perspective. Together, they provide a complete picture.

[5] Biophysical modeling uses methods and theories from physics to study biological systems.

### How Is Land Use Tracked?

Given that it is possible to gain a better understanding of how diet shifts would likely impact land use, how does one actually track the change? In Peters's opinion, there are many good data sources for tracking land use. Temporal trends can be tracked using annual crop production survey data collected by the USDA National Agricultural Statistics Service or 5-year USDA Census of Agriculture data. Spatial patterns can be tracked using the National Land Cover Dataset (from the Multi-Resolution Land Characteristics Consortium[6]), which breaks land use into major categories like forest and agriculture and wetlands, and the Cropland Data Layer data released annually by USDA. Land use change can be tracked using National Resources Inventory data from the USDA Natural Resources Conservation Service,[7] which measures, for example, how much land over time remains cropland as opposed to being converted into some other type of land. All of these various types of data—temporal, spatial, and land use change—can help researchers to understand sustainability impacts.

### How Are Land Use Impacts Evaluated?

Given that it is possible to track land use and how land use is changing at a given point in space and time, how are those changes evaluated? Evaluating land use impacts is a complex task. According to Peters, there is debate in the literature about how to do it, with two contrasting hypotheses: the land-sparing hypothesis (e.g., Ausubel et al., 2013) versus the land-sharing hypothesis (e.g., Perfecto and Vandermeer, 2010). The land sparing hypothesis holds that increased yields spare land from conversion to agriculture, resulting in more undisturbed habitat, presumably greater biodiversity and, in some cases, other ecosystem services such as protection of soil or water recharge. For advocates of the land-sparing hypothesis, reducing land use in agriculture is generally seen as an environmental good. The land-sharing hypothesis, much of which comes from the conservation biology literature, holds that agriculture systems have the potential to both accommodate harvest for food and provide benefits and habitat for wildlife. The focus of land sharing advocates is on the negative social and ecological consequences of intensification. For land-sharing advocates, reducing land use in agriculture may not be an environmental good. In Peters's opinion, the land-sparing hypothesis provides a useful rubric for evaluating land use impacts.

Peters mentioned that a couple of papers in the last few years have

[6] See http://www.mrlc.gov (accessed December 9, 2013).

[7] See http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/nri (accessed December 9, 2013).

made the contention that agriculture should be limited to the current footprint (e.g., Foley et al., 2011; Godfray et al., 2010). He suggested indicators that could be used to help assess whether there is enough land for food security and whether there is room for error if the population were to grow, including land in reserve (e.g., land that is in reserve as part of the conservation reserve program) and the yield gap (i.e., difference between potential and actual yield).

Peters identified several helpful indicators for understanding the environmental impact of land use change, none of which by itself is sufficient for understanding the environmental impact of land use change: GHG emissions (carbon dioxide, methane, nitrous oxide), carbon storage, erosion, losses to air and water (sediment), and biological diversity. As just one example of how land use impacts have been evaluated in the literature, Fargione et al. (2008) predicted the number of years it takes to "pay back" the carbon released when land is changed from one type of ecosystem to another. Fargione et al. concluded that the answer varies a great deal depending on the nature of the change. Starting with marginal cropland or abandoned cropland and changing that land into a cellulosic ethanol system, which is very efficient, creates a payback period of about 1 year. But converting a rainforest into a biodiesel system creates a payback period of 100 or maybe even hundreds of years.

### Balancing Health and Environment

Assuming that enough data exist to understand the context of the environmental impact of land use change, how can environmental benefits versus health benefits be weighed? Peters identified two types of situations: ethical synergy versus ethical dilemma. Ethical synergy occurs when a dietary shift is positive for both health and the environment. For example, eating more legumes would improve health and reduce land use by reducing the reliance on meat as a protein source. As another example, reducing sugar intake would improve health and reduce land use by eliminating excess energy intake. An ethical dilemma occurs when a dietary shift is positive for human health but negative for the environment, or vice versa. For example, increasing fish consumption would have human health benefit but a negative effect on wild stocks. As another example, increasing lean meats would presumably have a health benefit but would also increase land requirements. Ethical dilemmas force a comparison between two competing sets of value systems. With respect to the U.S. dietary guidelines, in Peters's opinion, ethical synergy versus ethical dilemma is an easy way to classify choices.

### Should Availability Influence Dietary Guidelines?

If there is a potential impact of consumption on food availability, should that impact be considered in the dietary guidelines? Peters remarked that it is appropriate to begin to consider it. He referred to an argument made in the late 1990s to think more broadly about agriculture (Welch and Graham, 1999). Welch and Graham (1999) identified three types of agricultural thinking: the production paradigm (with a focus on increasing output and economic efficiency), the sustainability paradigm (with a focus on ecological impact), and the food systems paradigm (with a focus on human health). They advocated for a broader paradigm, one that encompassed production, sustainability, and health. Peters noted that the same argument has been made elsewhere, in different ways. "I think that's an appropriate way to begin looking at the guidelines."

### Summary

Peters summarized his presentation with four concluding points. First, "The jury is still out on the land use impact of diet." Data from ERS suggest that diet changes have a modest impact overall, unless meat consumption changes. Second, researchers have the tools needed to begin both projecting the impacts of dietary change and tracking changes in land use. Third, the evaluation of impacts is complex and requires multiple indicators, although the idea of land sparing provides a useful starting point for thinking about the issue. Fourth, dietary guidelines should consider sustainability, but within the bounds of available evidence and with a key focus on identifying synergies and trade-offs.

## LIFE-CYCLE ASSESSMENT OF DIETARY PATTERNS[8]

"Life-cycle assessment" is a term that has been "thrown around a lot," Martin Heller said. But what exactly is it? In essence, LCA is a methodological framework for tracking the environmental impacts of producing a product, not just during manufacturing but also during the upstream extraction of raw materials, transportation throughout the life-cycle of the product, utilization (e.g., for a car, this would include tailpipe emissions), and disposal at the end of life. In the simplest terms, Heller thinks of it as an environmental accounting tool, one that tags all of these "cradle to grave" impacts together and provides an end result.

The international standards that have been developed to characterize

[8] This section summarizes information presented by Martin Heller, Ph.D., University of Michigan, Ann Arbor, Michigan.

LCA define it as the "compilation and evaluation of the inputs and outputs and the potential environmental impacts of a product system throughout its life cycle" (International Organization for Standardization, 2006, p. 2). The inputs include raw materials (e.g., metals, minerals, water, land) and energy. Outputs include what people normally think of when they think about environmental pollutants: emissions to air, emissions to water, and waste products. When conducting LCA, one also has to consider co-products from systems and their impacts. For example, the production of milk also produces meat as a co-product; thus, the upstream burdens associated with producing those two products need to be allocated between them.

Importantly, LCA is a relative assessment method, which means the end result is relative to some measure, ideally a measure of the function of the system. How that measure, or functional unit, is chosen has significant implications for the end result. The choice of a functional unit is especially important when comparing different systems that provide the same function. Another important feature of LCA to keep in mind, in Hellers's opinion, is that while International Organization for Standardization's standards for LCA have helped to make LCA more consistent from one study to the next, there is still no single method for conducting a LCA. Many of the methodological decisions made in LCA studies depend on the goal of the study and can impact results, meaning comparisons between studies must be done with caution. Also important to keep in mind is that gathering, interconnecting, and managing all of the inputs and outputs can be data-intensive and time-consuming.

The ultimate aim of LCA is to connect all of the inputs and outputs and quantify their environmental significance using impact assessment models. Typical LCAs consider impacts on energy use, global warming potential, eutrophication, acidification, tropospheric ozone, and human toxicity. Other impact categories important to food and agriculture that have been less stressed in typical LCAs include land and water use, biodiversity, and ecotoxicity. According to Heller, developing relevant and meaningful impact assessment models for some of these less-often-used categories is a cutting edge area of current LCA research.

LCA has many uses: identifying hot spots (i.e., places in a system where attention should be re-focused); identifying and evaluating unintended consequences (e.g., production of aluminum to reduce the weight of an automobile and reduce fuel consumption carries a significant environmental burden); identifying and avoiding burden shifting to other life-cycle stages, other environmental impacts, or other geographic regions; comparing alternative products that provide the same service or alternative scenarios within a particular production system; communicating impacts to consumers through standardized product footprints and quantifying Environmental Product Declarations; and informing public policy. LCA has become a large

component of sustainable consumption policy in Europe, according to Heller. In the United States, the Environmental Protection Agency is using LCA to evaluate GHG emissions from renewable fuels under the Energy Independence and Security Act of 2007.

Regardless of its use, Heller reiterated the importance of keeping in mind that LCA is, ultimately, "just a tool." It needs to be considered within its larger context.

### The Use of LCA to Study Food and Agricultural Systems

An examination of the distribution of GHG emissions associated with U.S. milk production serves as a good example of the type of results LCA provides. As shown in Figure 3-7, although it may be possible to squeeze out some efficiency gains during processing, transport/distribution, or at the retail end of the life-cycle, the bulk of GHG emissions from farm milk

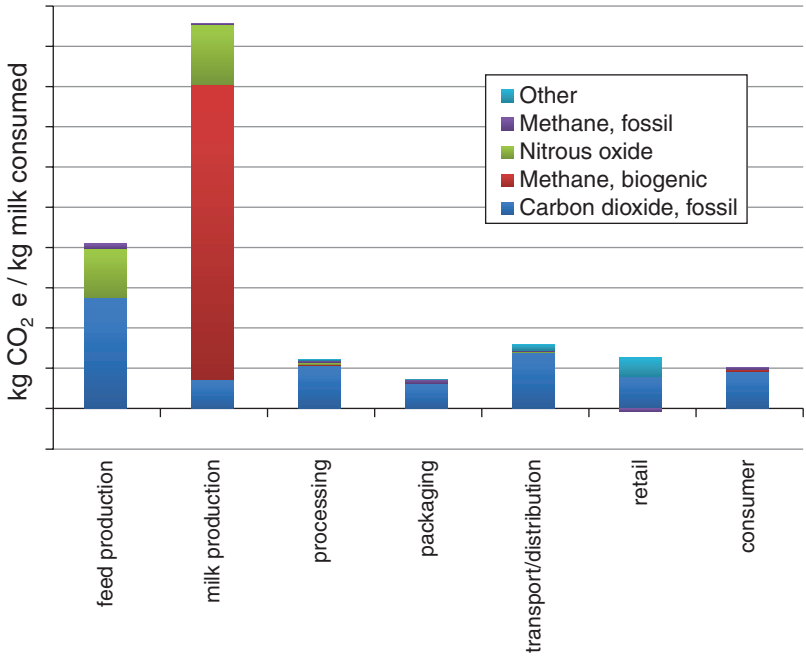



**FIGURE 3-7** An example of life-cycle assessment results: Greenhouse gas emissions associated with U.S. milk production.
SOURCE: Data drawn from personal communication with study author (Thoma et al., 2013).

production in the United States come from enteric fermentation and manure management and, to a lesser extent, feed production (Thoma et al., 2013). The results provide helpful information regarding where to focus greenhouse gas emission reduction efforts.

Heller noted that the data illustrated in Figure 3-7 are per kilograms of milk consumed. That is, GHG emissions are being measured relative to the end user and include losses from retail and consumption, which can be significant, on the order of 30 percent for the U.S. food system in general (Buzby and Hyman, 2012). Because of losses in the milk example, more milk has to be produced for every 1 kilogram of milk actually consumed. Even though the losses occur during the retail and consumption phases of the life-cycle, the impacts of those losses occur throughout the life-cycle. Figure 3-8 reports the same data as Figure 3-7, but with losses shown at the level they are induced. Because those losses—and their impacts—are induced by the consumer and at the retail stage, efforts to reduce impacts associated with loss should target the consumer and retail stages. Food losses are often overlooked as a potential opportunity for reducing environmental

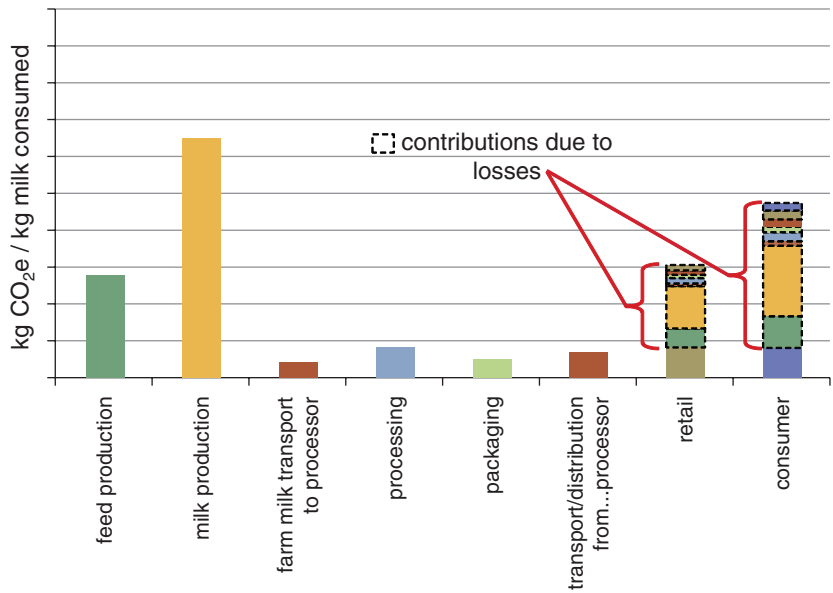



**FIGURE 3-8** An example of life-cycle assessment results: Greenhouse gas emission contributions of food losses during the retail and consumer stages of the milk life-cycle.
SOURCE: Data drawn from personal communication with study author (Thoma et al., 2013).

impacts. A life-cycle perspective can help to highlight the importance of those losses.

Although food and agricultural systems have always been of interest and a challenge to the LCA community, interest has accelerated in recent years, and a body of results has accumulated that allows for comparisons among different types of food (see Table 3-1) (González et al., 2011). Heller reiterated that the results he was sharing were intended to serve as examples only. He cautioned, "Please don't take these numbers home and use them as the end-all answer." Nonetheless, a pattern is beginning to emerge, with animal-based foods at the high end with respect to GHG emissions and plant-based foods at the low end. Notable exceptions include out-of-season vegetable production in heated greenhouses, which have a large impact.

If LCA is going to be used to compare the environmental impacts of different foods, it is pertinent to begin to think about foods in terms of

**TABLE 3-1** A Comparison of Life-Cycle Assessment Results for Greenhouse Gas Emissions Associated with Different Foods

| | Per as-sold weight (kg $CO_2$e/kg) | Per gram of protein (kg $CO_2$e/gram of protein) | Per kcal food energy (kg $CO_2$e/kcal food energy) |
|---|---|---|---|
| Ground beef | 29.29 | 0.120 | 0.0127 |
| Ground lamb | 25.67 | 0.105 | 0.0091 |
| Cheese | 8.60 | 0.035 | 0.0021 |
| Ground pork | 8.20 | 0.032 | 0.0028 |
| Ground chicken | 4.75 | 0.018 | 0.0020 |
| Salmon | 3.27 | 0.015 | 0.0022 |
| Egg | 3.00 | 0.024 | 0.0021 |
| Tuna | 2.60 | 0.010 | 0.0022 |
| Brown rice | 1.20 | 0.014 | 0.003 |
| Skim milk | 1.10 | 0.032 | 0.0032 |
| Whole milk | 1.10 | 0.035 | 0.0018 |
| Dry beans | 1.00 | 0.004 | 0.0003 |
| Strawberries | 0.38 | 0.057 | 0.0012 |
| Broccoli | 0.37 | 0.013 | 0.0011 |
| Orange | 0.33 | 0.035 | 0.0007 |
| Tomatoes, field production | 0.33 | 0.037 | 0.0018 |
| Tomatoes, hothouse production | 5.30 | 0.604 | 0.0296 |
| Apple | 0.28 | 0.109 | 0.0005 |
| Potato | 0.20 | 0.008 | 0.0002 |
| Lettuce | 0.20 | 0.022 | 0.0014 |
| Winter squash | 0.09 | 0.010 | 0.0002 |
| Cucumber, field production | 0.08 | 0.014 | 0.0007 |
| Cucumber, hothouse production | 1.68 | 0.909 | 0.0454 |

SOURCE: González et al., 2011.

some sort of nutritional measure. But how should that nutritional measure be defined? Heller considered some options. As shown in Table 3-1, if milk and dry beans, for example, are compared on the basis of weight, their impact is similar. But if they are compared on the basis of grams of protein delivered, the impact of milk is nearly nine times that of dry beans. Ideally, LCA researchers would like to come up with a functional unit that serves as a measure of comprehensive nutritional quality.

### Diet-Level LCAs

Because people consume foods in combination, with a diversity of foods meeting their dietary needs, Heller suggested that comparing foods, one to another as was done in González et al. (2011), may not be as useful as considering whole dietary patterns. He identified 32 studies to date that have used an LCA approach to evaluate food consumption patterns in terms of either meals or diets (e.g., Macdiarmid et al., 2012; Meier and Christen, 2013; Vieux et al., 2013). The studies vary with respect to scope and goal. Nonetheless, some trends are beginning to emerge. Most diet-level LCA studies (80 percent) are based on process LCAs of individual food items, which are then aggregated into consumption patterns. The remainder is economic input/output LCAs that link data on economic exchanges between sectors with data on sector emissions. Economic input-output LCAs simplify data collection but can be very difficult to interpret because of the sector-level aggregations.

Almost half of the diet-level LCA studies to date have examined only GHG emissions. Researchers recognize the importance of other environmental parameters, but their analyses have been limited by time and data availability. Interestingly, in Heller's opinion, only 40 percent of diet-level LCA studies to date include the consumption phase (e.g., refrigeration, cooking, transportation from retail setting to home). It is known from other LCA estimates that components of that phase can be significant; household storage and preparation contributes 20 to 30 percent of total energy use across the whole food system (Heller and Keoleian, 2003). So, should those components be included in these diet-level LCAs? A shift in diet is probably not going to prompt many consumers to replace their current refrigerators with smaller ones. But when considering long-term policy strategies, one may want to think about broader infrastructure changes that have implications at the consumption stage.

Most diet-level LCA studies are coming out of the European Union. Heller is aware of only one that was conducted in a U.S. context. And only half have attempted to equalize diets on a nutritional basis. Otherwise, comparisons are based only on daily or annual intakes.

Heller observed some broad trends emerging from the diet-level LCAs.

First, typically, the environmental impacts of food life-cycles are dominated by agricultural production. Second, animal-based foods generally have greater impact than plant-based foods across almost all categories (with the exception of hothouse-produced or air-shipped fruits and vegetables). Third, based on the few studies that have examined current average diets versus dietary recommendations in Europe,[9] a shift toward dietary recommendations can decrease GHG emissions by up to 10 percent.

### Challenges and Future Work

Heller identified four major challenges for future food-related LCA work. First, from a life-cycle assessment perspective, finding the link between nutrition and the environment requires establishing an appropriate nutritional basis for a functional unit. Options include diet quality indexes (e.g., the Healthy Eating Index) and nutrient profiling schemes. Heller encouraged an interdisciplinary dialogue to help establish that functional unit.

Second, Heller made a call for more data, with respect to both availability and quality. The USDA census provides good agricultural production data, with the USDA LCA Digital Commons[10] beginning to roll those data into a format that is more useful for LCA, but researchers need more region-specific data. With respect to environmental impact data, environmental impact categories need to be expanded beyond GHG emissions. Also needed is a consistent dataset of food LCA results.

Third, Heller urged consideration of the geospatial specificity of water use impact, land use impact, eutrophication, and other environmental impacts.

Finally, he called for improved ways to weight different environmental impact categories. Making a decision about environmental impact synergies and trade-offs ultimately becomes a value question: which environmental impact is more important? Improving valuation and weighting methods will be very helpful for interpreting future LCA work.

## PANEL DISCUSSION WITH THE AUDIENCE

In the panel discussion with the audience following Heller's presentation, workshop participants asked questions or commented on a range of topics: analyzing the environmental impacts of the full range of U.S. diets, including plant-only diets, processed foods, and functional foods; analyz-

[9] The European Food Safety Authority has provided scientific advice on the establishment of dietary recommendations (see http://www.efsa.europa.eu/en/topics/topic/drv.htm, accessed December 9, 2013).

[10] See http://www.lcacommons.gov (accessed December 9, 2013).

ing the environmental impacts of different animal production systems; variation in land productivity; reliability of data; and the confusing and sometimes incorrect use of certain terms and language.

### Analyzing Environmental Impacts of the Full Range of U.S. Diets, Including Plant-Only Diets, Processed Foods, and Functional Foods

An audience member commented on the fact that most speakers identified plant production as the most sustainable type of food production. She asked the panelists to comment on how they might expand their analyses to include the full range of diets, including plant-only diets. Cassidy replied that, for her, the interesting and important question is: How much meat consumption is sustainable? In Cassidy's opinion, going 100 percent plant-based might be environmentally optimal. However, she commented on the "arduous" task of figuring out which foods to eat, for example, which cereals to mix with which legumes, in order to acquire sufficient amino acids. Heller responded that LCA experts are close to having the methodology and data framework necessary for examining those differences in diet, and there are several examples in the literature of diet-level LCA studies, but quantifying the nutritional quality of different diets remains a challenge. For example, if one were to examine diets with varying levels of meat consumption, how would the nutritional value of those varying levels be quantified? Peters agreed with the audience member that incorporating a wide range of diets into these analyses is desirable, but cautioned that the analyses are limited by methodology.

Another audience member was curious about whether any of the analyses consider processed foods, given that processing can be very energy-intensive. For example, do industry and home-processed foods have different environmental impacts? Heller replied that studying processed foods can be difficult because so much processed food information is privately held. He recalled some examples of LCA studies comparing home and commercially processed foods, such as baking bread in a community artisan bakery versus in a commercial factory (Andersson and Ohlsson, 1999). The differences are far less significant than one might expect.

There was another question about functional foods[11] and whether any of the analyses on environmental impacts consider functional foods. The commenter noted the yogurt industry in upstate New York and the debate on production versus sustainability. Peters responded that his analyses are

[11] The term "functional foods" is defined as whole foods along with fortified, enriched, or enhanced foods that have a potentially beneficial effect on health when consumed as part of a varied diet on a regular basis at effective levels based on significant standards of evidence (Academy of Nutrition and Dietetics, 2013).

focused on the entire diet, not specific foods. That said, he sees functional foods fitting into his analyses and weighing heavily in decisions about sustainability guidelines only if those foods provide something that cannot be provided elsewhere.

### Environmental Impacts of Different Animal Production Systems

Several speakers addressed the environmental impacts of different quantities of meat in the diet or different types of meat in the diet. An audience member questioned whether there have been any analyses of different animal production systems, for example, grass-based animal production versus intensified production systems. Heller did not recall any noteworthy studies[12] on grass-based versus conventional production, but he observed that there has been a wealth of studies on conventional versus organic milk production worldwide. He reiterated what Frank Mitloehner had discussed in a previous session about the direct relationship between production and environmental efficiency.

Peters mentioned a meta-analysis published in 2012 comparing LCAs of different production systems in Europe (Tuomisto et al., 2012). He also commented on the challenge of finding data for alternative production systems. "That's the real stopping point," he said, "because then you get into primary data collection."

### Variation in Land Productivity

An audience member raised a question about variation in land productivity and how analyses of environmental impact account for that variation. For example, land used for meat production is typically unsuitable for crop production. Peters responded that, yes, his second analysis (in which he estimated how many people could be fed off a given land base) accounted for differences in land capacity by classifying land into three categories (land suitable for pasturing, land suitable for perennial production or pasturing, and land suitable for any purpose). He agreed that accounting for land capacity has a big impact on estimating how many people can be fed on a given land base or how many complete diets can be produced from a given land base.

[12] Since the workshop, a study by Lupo et al. (2013) provides a good example of this type of comparison.

### Reliability of Data

A question was raised about the reliability of the datasets being tapped. The commenter mentioned a recent report that data from the USDA database on food wastage was inaccurate. Peters remarked that much of the land use data he uses in his analyses is collected annually. He assumes that data collected from the same locations year after year are relatively good and accurate. He is less certain of the accuracy of data collected from marginal locations, for example, data on specialty crops in areas that are not major production centers and where data are not collected frequently or where less data are available. He added that there is a difference between inaccuracy of data and differences in measurement. A classic example of identifying differences in measurements in land use is in hay crop production. Satellite image data and agricultural census data are very different.

Heller agreed that large datasets can contain significant uncertainty. Estimating that uncertainty is an important part of conducting an LCA. He added that uncertainty in LCAs stems not just from data measurement but also from impact assessment methods, especially the more complex impact assessment methods (e.g., those associated with human health and eco-toxicity). Sometimes, the uncertainty is so great that unless differences are order-of-magnitude differences, they cannot be considered significant.

### Confusing and Sometimes Incorrect Use of Certain Terms and Language

An audience member commented on the sometimes interchangeable use of "organic," "natural," and "grass-fed." In fact, they are very different from each other, in her opinion. Another audience member commented on inconsistent use of the word "sustainability," noting that its inconsistent use is not surprising given that it is a difficult term to define. He referred workshop participants to the National Research Council's 2010 report on agricultural sustainability, *Toward Sustainable Agricultural Systems in the 21st Century* (NRC, 2010), in which sustainability is defined on the basis of four social broad goals in areas of production, protection of natural resources, economic incentive, and community support. The commenter observed that most workshop participants seem to be using the term "sustainable" to refer to only one of those components, but not all four. "It's either sustainable or it's not," he said, "and it's got to have all of those components adequately supported to be sustainable."

## REFERENCES

Academy of Nutrition and Dietetics. 2013. Position of the Academy of Nutrition and Dietetics: Functional foods. *Journal of the Academy of Nutrition and Dietetics* 113:1096-1103.

Andersson, K., and T. Ohlsson. 1999. Life cycle assessment of bread produced on different scales. *International Journal of Life Cycle Assessment* 4(1):25-40.

Ausubel, J. H., I. K. Wernick, and P. E. Waggoner. 2013. Peak farmland and the prospect for land sparing. *Population and Development Review* 38(Suppl):221-242.

Bouwman, A. F., K. W. Van der Hoek, B. Eickhout, and I. Soenario. 2005. Exploring changes in the world ruminant production systems. *Agricultural Systems* 84(2):121-153.

Buzby, J. C., and J. Hyman. 2012. Total and per capita value of food loss in the United States. *Food Policy* 37(5):561-570.

Buzby, J. C., H. F. Wells, and G. Vocke. 2006. *Possible implications for U.S. agriculture from adoption of select dietary guidelines*. Economic Research Report No. 31. Economic Research Service, U.S. Department of Agriculture.

Cassidy, E. S., J. S. Gerber, P. C. West, and J. A. Foley. 2013. Redefining agricultural yields: From tonnes to people nourished per hectare. *Environmental Research Letters* 8:034015.

deVries, M., and I. J. M. deBoer. 2009. Comparing environmental impacts for livestock producers: A review of life cycle assessments. *Livestock Science* 128(1):1-11.

FAO (Food and Agriculture Organization). 1972. *Technical conversion factors for agricultural commodities*. Rome: Food and Agriculture Organization.

FAO. 2013. *Food balance sheets (FBS) FAOSTAT*. http://faostat.fao.org/site/368/default.aspx#ancor (accessed October 15, 2013).

Fargione, J., J. Hill, D. Tilman, S. Polasky, and P. Hawthorne. 2008. Land clearing and the biofuel carbon debt. *Science* 319(5867):1235-1237.

Foley, J. A., N. Ramankutty, K. A. Brauman, E. S. Cassidy, J. S. Gerber, M. Johnston, N. D. Mueller, C. O'Connell, D. K. Ray, P. C. West, C. Balzer, E. M. Bennett, S. R. Carpenter, J. Hill, C. Monfreda, S. Polasky, J. Rockström, J. Sheehan, S. Siebert, D. Tilman, and D. P. M. Zaks. 2011. Solutions for a cultivated planet. *Nature* 478(7369):337-342.

Godfray, H. C., J. R. Beddington, I. R. Crute, L. Haddad, D. Lawrence, J. F. Muir, J. Pretty, S. Robinson, S. M. Thomas, and C. Toulmin. 2010. Food security: The challenge of feeding 9 billion people. *Science* 327(5967):812-818.

González, A. D., B. Frostell, and A. Carlsson-Kanyama. 2011. Protein efficiency per unit energy and per unit greenhouse gas emissions: Potential contribution of diet choices to climate change. *Food Policy* 36(5):562-570.

Heller, M. C., and G. A. Keoleian. 2003. Assessing the sustainability of the US food system: A life cycle perspective. *Agricultural Systems* 76(3):1007-1041.

International Organization for Standardization. 2006. *Environmental management–life cycle assessment—principles and framework*. ISO 14040(E). Geneva: International Organization for Standardization.

IOM (Institute of Medicine). 2006. *Dietary reference intakes: The essential guide to nutrient requirements*. Washington, DC: The National Academies Press.

Lupo, C. D., D. E. Clay, J. L. Benning, and J. J. Stone. 2013. Life-cycle assessment of the beef cattle production system for the northern great plains, USA. *Journal of Environmental Quality* 42(5)1386-1394.

Macdiarmid, J., J. Kyle, G. W. Horgan, J. Loe, C. Fyfe, A. Johnstone, and G. McNeill. 2012. Sustainable diets for the future: Can we contribute to reducing greenhouse gas emissions by eating a healthy diet? *American Journal of Clinical Nutrition* 96(3):632-639.

Meier, T., and O. Christen. 2013. Environmental impacts of dietary recommendations and dietary styles: Germany as an example. *Environmental Science and Technology* 47(2):877-888.

Mekonnen, M. M., and A. Y. Hoekstra. 2012. A global assessment of the water footprint of farm animal products. *Ecosystems* 15:401-415.

Monfreda C., N. Ramankutty, and J. A. Foley. 2008. Farming the planet: 2. Geographic distribution of crop areas, yields, physiological types, and net primary production in the year 2000. *Global Biogeochemical Cycles* 22(1):1-19.

Mueller, N. D., J. S. Gerber, M. Johnston, D. K. Ray, N. Ramankutty, and J. A. Foley. 2012. Closing yield gaps through nutrient and water management. *Nature* 490:254-257.

NRC (National Research Council). 2010. *Toward sustainable agricultural systems in the 21st century*. Washington, DC: The National Academies Press.

Perfecto, I., and J. Vandermeer. 2010. The agroecological matrix as an alternative to the land-sparing/agriculture intensification model. *Proceedings of the National Academy of Sciences of the United States of America* 107(13):5786-5781.

Peters, C. J., J. L. Wilkins, and G. W. Fick. 2007. Testing a complete-diet model for estimating the land resource requirements of food consumption and agricultural carrying capacity: The New York state example. *Renewable Agriculture and Food Systems* 22(2):145-153.

Rosegrant, M. W., and IMPACT Development Team. 2012. *International model for policy analysis of agricultural commodities and trade (IMPACT): Model description*. Washington, DC: International Food Policy Research Institute.

Sturm, R., R. An, D. Segal, and D. Patel. 2013. A cash-back rebate program for healthy food purchases in South Africa. Results from scanner data. *American Journal of Preventive Medicine* 44(6):567-572.

Thoma, G., J. Popp, D. Nutter, D. Shonnard, R. Ulrich, M. Matlock, D. S. Kim, Z. Neiderman, N. Kemper, C. East, and F. Adom. 2013. Greenhouse gas emissions from milk production and consumption in the United States: A cradle-to-grave life cycle assessment circa 2008. *International Dairy Journal* 31(Suppl 1):S3-S14.

Tuomisto, H. L., I. D. Hodge, P. Riordan, and D. W. Macdonald. 2012. Does organic farming reduce environmental impacts?—a meta-analysis of European research. *Journal of Environmental Management* 112:309-320.

USDA (U.S. Department of Agriculture). 1999. *America's eating habits: Changes and consequences*. Agriculture Information Bulletin No. AIB-750. http://www.ers.usda.gov/publications/aib-agricultural-information-bulletin/aib750.aspx#.UggmURaBJz8 (accessed August 14, 2013).

Vermeulen, S. J., B. M. Campbell, and J. S. I. Ingram. 2012. Climate change and food systems. *Annual Review of Environment and Resources* 37:195-222.

Vieux, F., L.-G. Soler, D. Touazi, and N. Darmon. 2013. High nutritional quality is not associated with low greenhouse gas emissions in self-selected diets of French adults. *American Journal of Clinical Nutrition* 97:569-583.

Welch, R. M., and R. D. Graham. 1999. A new paradigm for world agriculture: Meeting human needs. *Field Crops Research* 60(1-2):1-10.

Wells, H. F., and J. C. Buzby. 2008. *Dietary assessment of major trends in U.S. food consumption, 1970-2005*. EIB-33. Washington, DC: U.S. Department of Agriculture, Economic Research Service.

Wirsenius, S., C. Azar, and G. Berndes. 2010. How much land is needed for global food production under scenarios of dietary changes and livestock productivity increases in 2030? *Agricultural Systems* 10(3):621-638.

Young, C. D., and L. S. Kantor. 1999. Moving toward the food guide pyramid: Implications for U.S. agriculture. In *America's eating habits: Changes and consequences*, edited by E. Frazao. AIIB-750. Washington, DC: U.S. Department of Agriculture, Economic Research Service. Pp. 403-413.

# 4

# The Food Price Environment

Although most of the workshop focused on the actual human and environmental benefits and costs of the U.S. food system and dietary guidelines, the session summarized in this chapter revolved around the role of the food price environment and its impact on food and diet decision making. Workshop participants considered the role of weather and climate and the impact on commodity and food prices. Furthermore, participants discussed economic and marketing tools that will help consumers make food and diet choices that are healthier for both themselves and the environment.

Specifically, Richard Volpe, from the Economic Research Service (ERS), discussed the U.S. Department of Agriculture (USDA) food price forecasting, emphasizing that most of the uncertainty of forecasted prices is due to unexpected droughts and other extreme weather events. Recent reversals in a couple of key long-term economic trends, such as the recent increase in commodity prices after decades of decreasing prices, are also likely due, at least in part, to extreme weather events. Still, despite increasing commodity prices, average food prices have been relatively stable and will continue to remain stable in the near future. Although average food prices have remained fairly stable, prices of some major food groups have fluctuated, with healthier foods (e.g., fresh fruits and vegetables) showing more price volatility than less-healthy packaged foods.

Barton Seaver, from Harvard University, encouraged workshop participants to expand their notion of sustainability and think not just about environmental impact but also resource and product use. There is no better

example of the opportunity for improved use of products, in his opinion, than the Peruvian anchoveta fishery. He encouraged a reexamination of U.S. fisheries and a consideration of ways to use some of the many other fish and shellfish in the sea. For example, although cod is a consumer favorite, a cod net yields many other white flaky fish that are just as tasty and as healthy as cod. Seaver described his collaboration with hospitals, in which he asked that they include some of these other white flaky fish on their menus to nudge consumers into broadening their diets. As a result, participating hospitals have reduced their food costs and driven more purchasing dollars into their local economies while providing healthy foods for their consumers.

Like Seaver, rather than putting the burden on the consumer to make changes, Parke Wilde from Tufts University considered other ways to guide consumer decision making. He considered several different types of economic incentives aimed at increasing the healthfulness of consumer choice, such as taxing less-healthful products, and discussed how those incentives compare to incentives aimed at reducing the environmental impacts of consumer choice. In addition to economic incentives, Wilde encouraged workshop participants to consider removing counterproductive agricultural and food policies and developing new public policies that more directly address some of the problems at hand.

**Key Themes of This Chapter**[a]

- Although overall food prices in the United States have remained steady and will likely remain steady into the future, some food groups show more price volatility than others. Healthier food groups (e.g., fresh fruits and vegetables) tend to exhibit more price volatility than less-healthy packaged foods. (Volpe)
- Consumers can be nudged into broadening their diets in ways that benefit health, environment, and economic issues, for example, through creative menuing (e.g., including "other" flaky white fish that are caught in cod nets that are as tasty and healthful as cod). (Seaver)
- There are several different economic incentives and policy approaches to consider as ways to encourage healthful and environmentally conscious consumer food and diet choices. (Wilde)

[a] Key themes identified during discussions, presenter(s) attributed to statement indicated by parenthesis "( )."

## PROJECTED FOOD PRICES: THE IMPACT OF ENVIRONMENTAL CONSTRAINTS[1]

A major function of the ERS, the principal economic arm of USDA, is to forecast retail food prices for major food categories. Volpe explained that the forecasts are updated on the 25th day of each month, with the Consumer Price Index (CPI)[2] serving as a basis for the forecasts, which extend 6-18 months in the future. The forecasts are based on farm and wholesale price projections, fuel and energy prices, labor wages, and structural breaks (points in time where, for various reasons, the direction of food prices suddenly changes), but not climate change or other environmental changes related to weather volatility. Although ERS researchers recognize these factors, the time frame for the food price forecasts is too short to incorporate them. Because these factors cannot be incorporated into the forecasts, they are the single greatest source of uncertainty, with almost all incorrect forecasts due to unexpected extreme weather events. Recent examples are the unusually warm, wet weather in California and western Mexico in 2010-2011, which led to some surprising and strange phenomena with produce crops; the excessive rainfall in South America in 2011-2012 and its impacts on grain and oil seed prices, especially soybean; and the historic Midwest U.S. drought in 2012. Volpe has observed a rise in extreme weather events, even in his 3 short years at ERS.

Volpe highlighted two important long-term economic trends that have reversed in recent years. The first is an increase in the price of commodities since 2002, both globally and in the United States, after many years of the real price of commodities decreasing (which means that, globally, food was becoming cheaper). The second is a slight increase in the share of disposable income spent on food by U.S. households, after having gradually decreased for many years. In Volpe's opinion, one likely explanation for the reversals in both of these long-term trends is increased weather volatility, with increased frequencies of extreme weather events driving up commodity prices and making food more expensive. Another likely contributing factor is that U.S. wages have been stagnant for some time.

Despite the fact that commodity prices, as well as energy prices, have been on the rise and are growing more volatile, food prices in the United States have remained remarkably stable (see Figure 4-1). Prices for what the U.S. Bureau of Labor Statistics defines as "personal services"[3] have also remained stable over time, as they are typically distinct from fuel and

[1] This section summarizes information presented by Richard Volpe, Ph.D., Economic Research Service, Washington, DC.

[2] See http://www.bls.gov/cpi (accessed December 11, 2013).

[3] In the CPI, the U.S. Bureau of Labor statistics describes "other goods and services" as including haircuts and other personal services (U.S. Bureau of Labor Statistics, 2013).

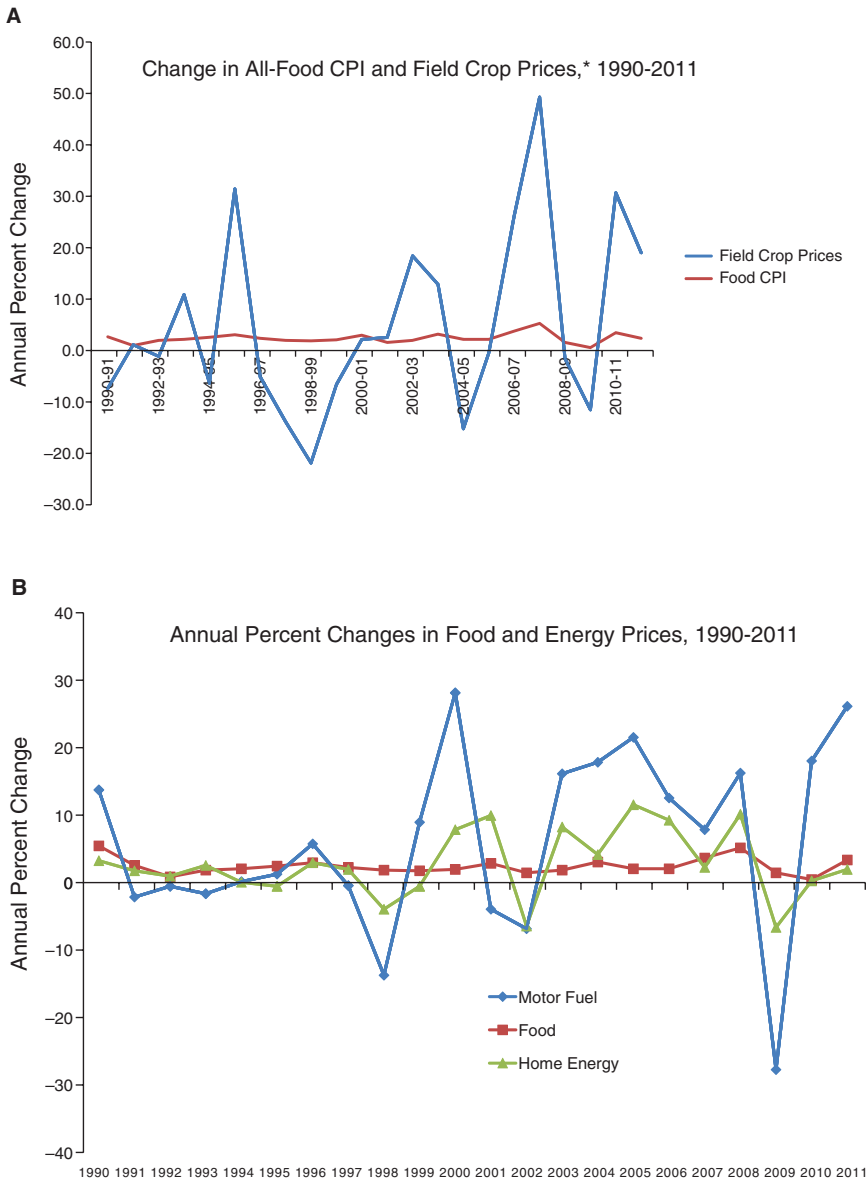



**FIGURE 4-1** (A) Stability of average food prices (and "personal services" prices) over time, compared to (B) fluctuating fuel, home energy, and commodity prices.
NOTE: CPI = Consumer Price Index.
* Production-weighted average farm price of corn, wheat, and soybeans.
SOURCES: ERS, 2012, 2013.

energy prices, and the food CPI bears a closer resemblance to the personal services CPI in terms of volatility. The retail food dollar reflects all of the various industries that contributed to putting that single dollar of food on supermarket shelves, with the farm and agribusiness industry contributing 11.6 percent (commodity prices are reflected in that share), food services 33.7 percent, food processing 18.6 percent, retail trade 13.6 percent, energy and transportation 10.3 percent, finance and insurance 4.4 percent, packaging 4 percent, and advertising, legal, and accounting 3.8 percent (Canning, 2011). Volpe explained that the industry shares are parceled out such that even when energy, transportation, and other costs are associated with the farm and agribusiness sector, they are not included in the farm and agribusiness sector share but rather in their respective energy, transportation, or other sector shares. In what is known as a marketing bill, where the farm share does include those other components, the farm share (and thus the commodity price contribution) is never much larger than about 16 percent. Likewise, when the retail food dollar includes only food at home and not food away from home—again, the farm and agribusiness share is never much larger than about 15-17 percent (Canning, 2011).

Although, on average, food prices have remained stable, with fluctuating commodity prices having little impact, prices for individual food groups have been volatile (see Figure 4-2). Dairy prices have been especially volatile. Fat and oil prices have also been volatile, largely because soybean prices, which comprise a large portion of that food category, have been affected by weather and export events. Fresh fruit and vegetable prices have also been volatile in recent years, again largely due to weather events. Eggs have been by far the most volatile food category in terms of price. By contrast, one of the most stable food categories in terms of price is what the CPI calls "other foods." "Other foods" is the largest major food category and includes processed, packaged, shelf-stable foods, for example, a lot of soups, condiments, and packaged side dishes (e.g., boxes of dried mashed potatoes). Factors contributing to the stability of "other foods" prices include advertising and long-term contracts with big-name manufacturers. In sum, according to Volpe, prices for processed, packaged, shelf-stable foods tend to be more stable than prices for most of the food groups that are considered healthy.

What can be expected for the future? According to Volpe, "We are looking at no significant reduction in food supply and very modest increases in overall food price inflation." The global stocks-to-use ratio[4] is expected to increase slightly in 2013-2014, slowing food price inflation (USDA, 2013b). Even though retail food price inflation is expected to continue to outpace inflation of the overall economy, food prices will still remain rela-

[4] Stocks-to-use ratio is a measure of supply and demand interrelationships of commodities.

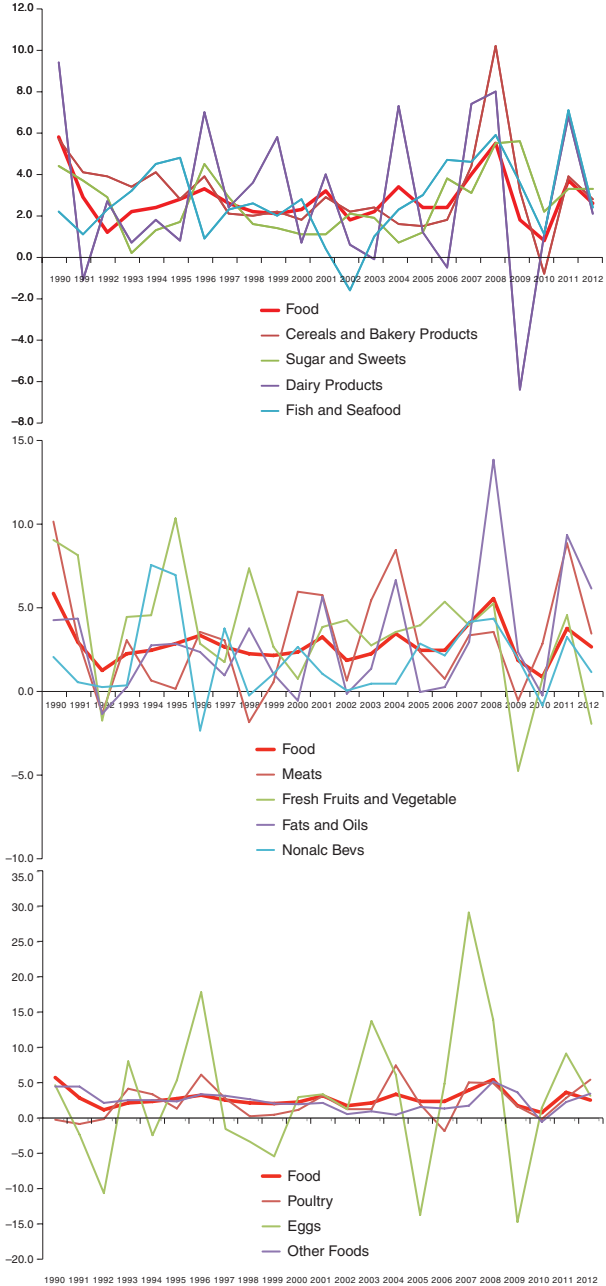



**FIGURE 4-2** Fluctuating food prices for individual major food groups over time. SOURCE: Original analysis by Volpe using data from the Bureau of Labor Statistics.

tively stable through 2022, with an average of 2.4 percent inflation. With respect to climate change, ERS projections for U.S. agricultural production through 2030, based on a range of climate change scenarios, suggest that the impact will be modest even in the harshest scenario, because the U.S. agricultural and food production system has the capacity to respond through geographic shifts (e.g., shifting production away from the West coast) (Malcolm et al., 2012).

## THE EFFECT OF NATURAL RESOURCE SCARCITY ON COMMODITY SOURCING[5]

Seaver began his presentation by saying, "I am thrilled by the conversations that I am hearing … linking environmental sustainability with human health, because I think ultimately they are one and the same." He said he considered "sustainability" to be "somewhat of a limited term" because, for many people, sustainability is based on the assumption that the best that can be done is to sustain the status quo. Thus, sustainability is inherently subject to a cultural or historical baseline. Seaver suggested broadening the discussion to one that revolves around better use, as opposed to sustained use, of products and encouraged workshop participants to think about sustainability as minimizing environmental impacts of products while simultaneously maximizing the impacts of those products on humans. He encouraged workshop participants to consider the notion of sustainable use: look at the resources being used and consider better ways to use those resources.

### Recycling, Organics, and Free Trade: Unintended Consequences

Dissociating solutions to environmental problems from their larger context can lead to a cascade of unintended consequences, in Seaver's opinion. He cited three examples: recycling, organics, and fair trade. Recycling is largely considered to be the most successful environmental campaign of all time—the refrain "reduce, reuse, recycle" has now been legislated into municipalities nationwide and globally. Yet, there has also been increased pace and amount of recyclable goods flowing into the economy. "Reduce, reuse, recycle forgot the first 'R,'" he said, "which was to refuse." If a product cannot be refused, only then should it be used before it can be reduced, reused, and recycled. As another example, Seaver showed an image of American Spirit cigarettes, labeled "Made with 100% organic tobacco."

[5] This section summarizes information presented by Barton Seaver, chef, and Director of the Healthy and Sustainable Food Program, Harvard School of Public Health, Boston, Massachusetts.

The campaign for organic products has led to the creation of what Seaver described as a "fabulous system." But it has also led to the creation of an unhealthy product, cigarettes, made with organic tobacco. Likewise, he said, fair trade is a "brilliant thing." Yet, there are reports coming out of Bolivia and Peru indicating that local populations have sold their entire crops into the global market, mostly to the United States, thus sparking fears of hunger and malnourishment among people who have been subsisting on those crops (i.e., quinoa) for thousands of years. Seaver said, "That is great that they are getting a good price, but it is also exacerbating some other issues."

Seaver emphasized that he does not think there is anything wrong with recycling, organics, or fair trade. He did not use those examples to point out flaws in the systems, which he considered resilient and robust. Rather, the flaw is in what those systems are used for. In his opinion, organic cigarettes are a real abuse of a good system. He said, "We get so caught up in the action that we do not look to the actual consequences."

### Better Use of Products

There is no better example of an opportunity to improve the use of products, in Seaver's opinion, than the Peruvian anchoveta fishery. Seaver described this fishery as the world's largest single-species fishery, accounting for 10 to 15 percent of global catch annually. The fishery boats are so big, carrying 60,000 tons of fish at a time, that they cannot get near shore. Instead, the fish are pumped through pipelines to a facility on shore where most are ground and cooked into fishmeal. About 98 percent of the product never feeds a human being directly. It is used in salmon, pig, and chicken farming and in cosmetics, moisturizers, and other products. Seaver visited a plant that processed 14,000 tons per day and employed 28 people, 12 of whom were security guards. Down the street was a canning facility that processed just 2 tons per day but employed 150 people. "This is what we need to be looking at," Seaver said, "smarter and better usage of the products that we have."

Seaver encouraged a reexamination of fisheries systems. U.S. consumers eat the same 10 species of seafood, more or less. Of the 16 pounds eaten per person every year on average, 8 to 9 pounds is only 3 species: canned tuna, salmon, and shrimp (NOAA, 2013a). This lack of variety is despite hundreds of federally managed fisheries in the United States that import more than 1,700 different species (Warner et al., 2013).

Eating tuna and other large charismatic fish species is environmentally costly. Seaver compared the trophic scale to a diving board. Jumping at the end of the diving board creates a large splash. Jumping at the base creates no splash. He said, "Fisheries are just hammering away at the end of the

diving board. We need to jump a little bit further toward the middle. We need to be eating more clams, mussels, oysters, herring, sardines, mackerel, and anchovy—these things that are biologically meant to be eaten.... We need to take advantage of some of these natural resiliencies." Seaver described the "swirling balls of [these lower trophic level] fish in the ocean" and how they breed with such fecundity that they carry on even as they are being eaten.

Many U.S. fisheries have built what Seaver described as "irrational economies." He pointed to the Reedville, Virginia, seafood landings in 2008 as an example. The Reedville fishery produced 414 million pounds worth $36 million (NOAA, 2011). "That does not end up in a lot of jobs, a lot of houses, a lot of development, a lot of security," he said. The same is true for other landings across North America. Added to these irrational economies being built up around many U.S. fisheries is the problem of bycatch. In the United States, up to 6 pounds of seafood is discarded for every 1 pound of shrimp caught (Seafood Watch, no date). Globally, almost 40 million tons of seafood are discarded annually (WWF, no date). Some of the discarded fish obviously cannot be eaten, like the puffer fish, but many species could make for a "fine dinner," in Seavers opinion. He mentioned guitarfish, croakers, drum, and menhaden. "Come over to my house," he said, "and I will convince you that each of those things is the most delicious thing you have ever had."

Having made cod "king" in New England is a great example of the irrational demands the U.S. fisheries system has created and the way those demands strain fisheries. A cod net yields not just cod, but also pollock, haddock, tusk, ling, wolf, dogfish, monk, skate, ray, eel, shark, and all sorts of what Seaver described as "tasty flaky white flesh fish." In the best-case scenario, pollock earns $2.00 at the dock, and dogfish only 10 cents, while cod, being king, commands $6.00. Yet, all of these fish are equally profitable to the human body, in Seaver's opinion. He asked, "Why are we not setting up a system that is equally profitable to the fisherman?" Why do consumers, when they walk into a store, ask for cod? Why not ask for the best flaky white fish that fits their budgets? By asking for flaky white fish, not cod, consumers would be allowing the ecosystem to provide based on supply, not demand.

Seaver suggested the use of "consumer nudges" to increase sustainable use. He has been involved with some supply-based work with Boston hospitals that wanted to include seafood on their menus more often but were having a difficult time because of expense. The hospitals also wanted to purchase from local fisheries. With Seaver's help, the hospitals are now menuing seafood four times per week and have reduced their menuing of red meat by two times per week. They are also selling more vegetables because seafood tends to be part of a composed plate that includes veg-

etables. By increasing the menuing of local seafood, the hospitals have not only reduced their costs and driven their purchasing dollars into their local economies, but they have also increased the indexes of healthfulness in their products.

In addition to helping the hospitals menu a diversity of fish instead of simply cod, Seaver has helped them to divert their organic waste into compost. Composting organic waste reduces the frequency of waste pick-up, allows for the hiring of people in the community, and generally redirects otherwise misallocated resources back into procuring sustainable and local seafood.

All too often, in Seaver's opinion, sustainability is viewed as a separate entity, with advocates standing on their pedestals and saying "listen to me." The National Geographic Seafood Decision Guide[6] takes a different stance. Rather than providing an answer, it provides information that consumers can use to make their own decisions about what they put inside their bodies.

## CAN ECONOMIC INCENTIVES DRIVE ENVIRONMENTAL SUSTAINABILITY AND HEALTHIER DIETS?[7]

Rather than putting the burden on the consumer to make changes, Wilde underscored the importance of thinking about how resource scarcity and the environmental consequences of production affect food prices and how consumers respond to those prices. Wilde drew on the substantial literature on how economic incentives affect the healthfulness of people's choices, both among the general population and among low-income Americans. He discussed those incentives, compared them to economic incentives for environmental choices, and considered how economic incentives for health and the environment interact.

### Incentives for Healthy Choices

The recommended diet, based on the U.S. federal government's ChooseMyPlate.gov guidance, contains a high fraction of plant foods, such as fruits, vegetables, and grains. A comparison with current consumption reveals that U.S. adults consume less than the recommended amounts of fruit, dairy, beans and peas, and vegetables, and more than the recommended amounts of solid fats, added sugars, and meat (see Figure 4-3).

[6] See http://ocean.nationalgeographic.com/ocean/take-action/seafood-decision-guide (accessed December 11, 2013)

[7] This section summarizes information presented by Parke E. Wilde, Ph.D., Tufts University, Medford, Massachusetts.

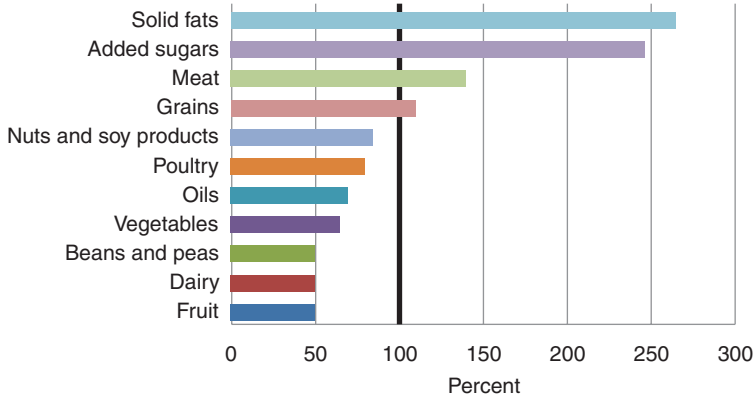



**FIGURE 4-3** Eating pattern comparisons: Usual U.S. intake for adults (adjusted to a 2,000-calorie level) as a percentage of the corresponding recommendation in the ChooseMyPlate.gov recommended amounts.
SOURCE: USDA/HHS, 2010.

Wilde considered whether taxing less-healthful products or incentivizing in other ways would increase consumption of more healthful products.

Economists use elasticity to measure consumer response to taxes. "Own-price elasticity" is the percentage change in the quantity of a good purchased ("good A") in response to a 1 percent change in the price of good A. "Cross-price elasticity" is the percentage change in the quantity of good A in response to a 1 percent change in the price of good B. Whether a big versus small elasticity is good depends on the situation. If something with a large elasticity is taxed, then people will reduce their consumption of the good as it is being taxed. So, if the goal is to use a tax on good A to reduce consumption of good A (e.g., cigarettes), then a large (negative) elasticity is good. But if the goal is to use a tax on good A to generate tax revenue, then a small (negative) elasticity is good.

Elasticity estimates are available through ERS and in the public health literature. Andreyeva et al. (2010) reported the following average elasticity estimates: 0.81 for food away from home, 0.79 for soft drinks, 0.76 for juice, 0.75 for beef, 0.72 for pork, and 0.70 for fruit. Beef's elasticity estimate of 0.75 means that if the price of beef is raised by 10 percent, consumption will fall by 7.5 percent. Although a 7.5 percent decrease is not considered highly responsive, it nonetheless represents a substantial consumer response.

The soft drink estimate is interesting, in Wilde's opinion, because of the literature around price incentives and snack foods. Although the average

elasticity is 0.79, estimates range from 0.33 to 1.24. An elasticity of 1.24 means that if the price of soft drinks is raised by 10 percent, consumption could fall by 12 percent. One of the counter-arguments to using a tax on soft drinks is concern about what people would consume instead. Based on elasticities estimated by Smith et al. (2010), raising the price of caloric sweetened beverages would reduce consumption of such beverages by 1.2-1.3 percent and increase consumption of juices, but only by 0.56 percent, thus only partly offsetting the nutritional gain from reducing consumption of caloric sweetened beverages. Regardless, Wilde expressed skepticism as to whether taxing less-healthful products would actually work in the United States given the unpopularity of proposals to tax less-healthful products.

Aside from taxing less-healthful products, another way to increase healthful food consumption would be to lower market prices of healthful products. However, Wilde cautioned that it is just as important to think about supply response as consumer demand when considering lowering market prices. Lowering market prices of healthful foods signals to farmers that they should be producing fewer fruits and vegetables. A third option would be to have the federal government subsidize the price of comparatively healthful products such as fruits and vegetables. But those would be expensive subsidies, Wilde said. Finally, rather than creating economic incentives, another option would be to create the political space needed to end counterproductive agricultural and food policies.

The challenge of economic incentives for healthy food choices is different for the low-income population. Although food prices cannot be increased to a point where people go hungry, that does not necessarily mean that no food prices can be increased. Wilde explained that suppressing the prices of all goods reduces the ability of prices to send to consumers highly useful signals about what is scarce and help the economy to run in an environmentally sustainable way. When thinking about low-income populations, factors to keep in mind include elasticities (i.e., people with lower incomes may be more price-responsive); concern about hunger and food insecurity (i.e., prices cannot be increased to a point where people go hungry); and the role of nutrition assistance programs. A number of actions are being taken to affect economic incentives for low-income Americans, including the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) voucher for fruit and vegetable consumption; the New York City proposed restrictions on Supplemental Nutrition Assistance Program (SNAP) use for sugar sweetened beverages (which was not approved); and the Healthy Incentives Pilot (HIP) for SNAP (discounts on fruits and vegetables). Wilde noted that some early evaluation results for HIP are available (USDA, 2013a).

### Incentives for Environmental Choices

Given that there are economic incentives to encourage healthful food choices, might similar incentives be implemented to encourage environmental food choices? Wilde observed several distinctive features of environmental incentives. First, the food groups incentivized for environmental reasons may be different than those incentivized for health reasons. Second, price incentives for producers are more central to the discussion of environmental issues compared to the discussion of health incentives. Third, the issues are different because it is physically possible to continually consume unhealthy food and beverages, because there is no feedback loop. The opposite is true of foods and beverages that have a negative impact on the environment. Wilde explained that taxing for health purposes in an effort to reduce consumption of a particular food by 10 percent will not necessarily lead to an actual reduction of 10 percent. Although consumption will fall by some amount, depending on consumer response, there is no guarantee that it will fall by as much as 10 percent. The best that can be done is to forecast the 10 percent and tax appropriately. By contrast, if the issue is environmental, for example, fisheries scarcity, then if the availability of fish falls by 10 percent, market prices will rise by some amount, and purchases will actually fall by a predictable 10 percent. Consumer response is predictable in the latter situation, Wilde explained, because demand cannot be greater than supply.

Scarcity is just one environmental issue, one that comes up when discussing fisheries. Another is externalities, which arise when food production has consequences that are not paid by the food producer. An example is water pollution from animal agricultural production or from excessive nutrients in runoff from grain and soybean production. Incentives for consumers to change the environmental impacts of their food choices are different when the environmental impact is water pollution versus scarcity. With scarcity, the adjustment happens almost automatically: food prices increase when a resource becomes scarcer. The same is not necessarily true of externalities. A third environmental issue of concern is what Wilde referred to as "information failures." Food safety is an example. When consumers do not know the safety of chemicals used in food production, yet a different set of incentives come into play.

### Interactions Between Economic Incentives for Health and the Environment

In Wilde's opinion, when considering the environmental impact of food choices, calories and protein are key. They are the "big environmental sustainability issues," he said. He noted the substantial discussion of meat at the workshop and its associated externalities. Rather than telling people

to eat less meat, Wilde suggested developing public policy that addresses some of those externalities. The fact that meat is overconsumed relative to U.S. dietary recommendations (see Figure 4-3) means that there is "elbow room" to tolerate price increases, and there would be no need to worry about whether people were getting enough protein if prices were raised. Rather than taxing meat in an effort to encourage people to eat less of it, Wilde opined that "we are on much stronger ground" by solving environmental externalities directly and reassuring people that a price increase could be tolerated.

In addition, Wilde encouraged removing what he described as "counterproductive" policies. For example, the U.S. government encourages consumption of particular foods through the checkoff program policy mechanism, whereby the government lends to a producer board the power to use the federal government's power of taxation to tax producers to support advertisements such as "Beef: It's What's for Dinner" and "Pork: The Other White Meat." The goal of checkoff programs is to expand demand. Wilde suggested that now is a good time to reconsider the federal government's role in promotions aimed at increasing meat demand.

Finally, Wilde emphasized the importance of thinking about nutritional assistance programs as a useful part of the toolkit for setting environmentally sound food prices. If there are sound environmental reasons to want higher prices for a particular food group, nutrition assistance programs can help offset the resulting hardship, up to a point. A balance must be reached between sending strong price signals to help the environment and suppressing price signals to protect the poor.

## PANEL DISCUSSION WITH THE AUDIENCE

The presentations on price environment raised several questions about the synergies and trade-offs between health and the environmental for some fruits and vegetables; whether the slightly rising food prices should be of concern, given the stagnancy of U.S. wages; the push in the United States to permit large-scale offshore aquaculture in the Gulf of Mexico; the relationship between food prices and obesity; and the food and agricultural industry response to concerns about future climate change.

### Fruits and Vegetables: Trade-Offs Between Health and the Environment

Not all foods that are good for people are good for the environment, an audience member observed. For example, the carbon footprint for some fruits and vegetables is higher than for starches and sugars. She asked the panelists to consider the challenges of such trade-offs. Wilde replied that he is "more optimistic" and that he views fruit and vegetable production

as a "comparatively resource-efficient" way to obtain food. For fruits and vegetables without much caloric content, like celery, then, yes, considering how many resources are being used to produce 100 calories of celery, celery production does not seem environmentally sound. But no one eats celery for the calories. Many vegetables, like kale and dark leafy greens, are delivery vehicles for micronutrients, not calories. The fruits and vegetables consumed most frequently, including potatoes, tomatoes, apples, and bananas, have less environmental impact per unit of food produced, especially when compared to meat and other animal products.

Seaver observed that much of the environmental impact of fruit and vegetable production comes from transportation. He suggested freezing foods as a way to minimize greenhouse gas emissions. Richard Volpe agreed that transportation is a major concern and observed the rise in local and regional food systems across the United States.

Seaver also noted an important distinction between having an impact and having too much of an impact. Food production will always have an impact, and common foods like celery will always be part of the expected diet. Rather than demonizing carbon in its entirety, he encouraged finding ways to lessen the impact.

### Rising Food Prices, Stagnant Wages

A participant commented on the slow but significant rise in food prices, especially given the stagnancy of U.S. wages. The participant asked the panelists to address this "slow but significant squeeze" and the fact that the food industry is among the lowest-wage-paying sectors. Volpe agreed that median wages across the economy have been fairly stagnant for a long time, while retail food prices have been increasing at about 2.5 to 3 percent annually during the last 20 years or so. That said, the rate of inflation for food prices has actually been slower than the rate of inflation overall. Only since around 2006-2007 has that trend shifted and a squeeze been observed (i.e., a greater proportion of income being spent on food). If the proportion of income spent on food continues to increase in the future, then there will be some real concerns.

With respect to the food industry being among the lowest-wage-paying sectors, Volpe agreed that, at the farm level, there is increasing concern that the farm share of the U.S. dollar is decreasing. However, there are policies in place to provide a safety net for U.S. food supply producers. In his opinion, the fact that the recent Midwest drought did not hit farm incomes as much as originally forecasted demonstrates the success of those policies.

Another participant asked whether panelists had any policy recommendations for making food more affordable for people who cannot afford it. Wilde pointed out the role of nutrition assistance programs. SNAP includes

an automatic inflation updater, with benefits being increased in proportion to the previous year's inflation-adjusted price estimates. But he also encouraged food system advocates to think beyond nutrition assistance programs. He mentioned the 1990s bipartisan agenda for economic improvement and anti-poverty progress. Although one side of the aisle emphasized moving people into the workforce and the other side emphasized anti-poverty programs, there was a sense from both sides that Americans ought to be making economic progress. He said, "I hear [an emphasis on poverty reduction] from few people in recent years that have any political influence." Moderator Deborah Atwood, executive director of AGree, noted that, according to recent findings, about one in four people eligible for SNAP does not participate in the program and wondered about the implications of this lack of participation for the need to find bipartisan answers (Food Research and Action Center, 2013).

Volpe added that the WIC program is another very large food assistance program in the United States that provides purchasing power to low-income Americans to buy healthy foods (e.g., infant formula, milk, bread, cereal). WIC is not an entitlement-based program. Funding comes entirely from annual appropriations from Congress. The extent to which women, infants, and children are able to be served by the program depends on cost-efficiencies of the program. In Volpe's opinion, it is becoming increasingly clear that WIC faces a structural problem in terms of cost containment. However, he has observed much more concerted focus in the last couple of years to maintain or even increase overall participation capabilities of the program.

### Aquaculture Versus Wild Fisheries

An audience member representing the Johns Hopkins Center for a Livable Future asked Seaver about the push in the United States to permit large-scale offshore aquaculture in the Gulf of Mexico. Seaver replied that aquaculture accounts for about 50 percent of global consumption of seafood (NOAA, 2013b). The United States is the third largest consumer of aquaculture products, yet produces only about 1 percent of the global total (FAO, 2012)—a discrepancy that Seaver described as a "total failure." He said, "We really should be farming more fish." Aquaculture has received a "bad rap," but rightly so, in his opinion. However, it is a very young, very dynamic, and well-capitalized industry. Technological advances are occurring rapidly, even within the lowest grades of aquaculture, and Seaver predicts that many of the environmental problems that have been associated with common aquaculture practices will disappear within the next 3 to 5 years. For example, farmers are using selective breeding to develop strains of salmon and other fish that are inherently more sustainable. These

salmon are able to create long-chain fatty acids out of plant-based products, diminishing the need to use fish meal in their feed and thus reducing their negative impact.

Moreover, in Seaver's opinion, some aquaculture products, like cultured oysters, are more than sustainable. They are restorative. Planting oyster beds not only helps to replenish native oyster populations, but also performs a vital ecosystem service. Oysters feed on the algae blooms that result from the excessive nutrients being discharged into the ocean; by allowing sunlight to penetrate further through the photic zone, they also create substrate and habitat for other species, thereby increasing total biomass and biodiversity of the marine ecosystem.

Seaver views aquaculture as a way to create new products, not replace old products. Moreover, an aquaculture program that complements the U.S. wild fisheries program would not only create new products, it also would create new jobs. He pointed out that more of America is underwater than above water and that the U.S. economic zone is much larger than its terrestrial territory. In his opinion, it is time to take greater advantage of that underwater economic zone.

### Food Prices and Obesity

Based on the trends reported by Volpe, an audience member observed an apparent correlation between falling food prices and rising obesity rates. A recent study in the *British Medical Journal* described a coupling between food and fuel shortages in Cuba in the 1990s and a subsequent decrease in obesity and type 2 diabetes rates among Cubans; after food prices stabilized, the obesity and type 2 diabetes rates rebounded (Franco et al., 2013). The audience member asked the panelists to comment on the relationship between food price and health. Volpe mentioned a long history of data dating back to medieval times showing an indirect relationship between the price of food and health problems related to obesity and overweight. However, he does not view food prices in the United States as a major driver of obesity or diabetes. He views the growing number of nontraditional store formats (e.g., food marketing in super centers and in dollar stores) as the more important driver. In his opinion, where consumers shop matters. Whether a consumer purchases his or her food at a super center, club store, dollar store, convenience store, or elsewhere has health implications. Volpe expressed concern that the issue is being oversimplified as a food price-health relationship. Food at these nontraditional stores tends to be cheaper, whether measured on a per-serving or per-calorie basis. The more relevant issues, in his opinion, are food availability, product menu, private label ingredient (or store-developed ingredients/products), and other ways

that nontraditional store formats are evolving to meet and shape consumer demand.

Seaver clarified that the 1990s period of food scarcity in Cuba was a "nasty chapter" in the history of Cuba, not a celebration of the reduction of disease. Moreover, he warned that obesity is too often construed as a symptom of food. In his opinion, it is not. It is a social construct. Health itself is a social construct. He views obesity as the product of a system that is not set up to sustain humans. He noted the way houses are built around televisions, cities are eviscerated by freeways, and people lack access to parks. Although food is certainly a vehicle to obesity, obesity is also part of a much broader societal construct of quality of life.

Wilde emphasized the importance of recognizing the wide variety of plausible explanations for obesity and said that the decline in cost of food per person, relative to income, is a sign of prosperity. Prosperity is, in his opinion, a "good thing."

### Climate Change and Agribusiness

An audience member asked Volpe if there is any evidence that agribusiness is responding to the climate change patterns being observed in the United States (e.g., shifts in precipitation, temperatures, growing season patterns). Volpe responded that he has not observed any clear trends. He expects that the initial response will be at the production stage, in farming, and that the response will then filter down through wholesale and so on. But he suggested that other experts within the ERS would probably be better suited to answering the question.

Another member of the audience added that PepsiCo and other companies have been working with agricultural economists and climatologists to predict the likely future consequences of climate change. They are taking very seriously the likelihood that some crops will be in the middle of a desert, while others will be in the middle of a flood zone, and they are planning commodity changes based on those likely scenarios. Also, the World Economic Forum, a grouping of major agricultural and food companies, has been examining this same issue and making plans that extend 50 years into the future, not just about respect to what to plant but also about how to plant. The audience member suggested that the sense of "urgency and awareness" is greater in industry than in government.

## REFERENCES

Andreyeva, T., M. W. Long, and K. D. Brownell. 2010. The impact of food prices on consumption: A systematic review of research on the price elasticity of demand for food. *American Journal of Public Health* 100(2):216-222.

Canning, P. 2011. *A revised and expanded food dollar series*. ERR-114. Washington, DC: U.S. Department of Agriculture, Economic Research Service.

ERS (Economic Research Service). 2012. *Food prices less volatile than fuel prices*. http://www.ers.usda.gov/data-products/charts-of-note.aspx (accessed October 18, 2013).

ERS. 2013. *Food price outlook. Charts*. http://www.ers.usda.gov/data-products/food-price-outlook/charts.aspx#.UmF-9nDkuSo (accessed October 18, 2013).

FAO (Food and Agriculture Organization). 2012. *State of the world fisheries and aquaculture, 2012*. Rome: FAO.

Food Research and Action Center. 2013. *SNAP/food stamp participation*. http://frac.org/reports-and-resources/snapfood-stamp-monthly-participation-data (accessed September 6, 2013).

Franco, M., U. Bilal, P. Orduñez, M. Benet, A. Alain Morejón, B. Caballero, J. F. Kennelly, and R. S. Cooper. 2013. Population-wide weight loss and regain in relation to diabetes burden and cardiovascular mortality in Cuba 1980-2010: Repeated cross sectional surveys and ecological comparison of secular trends. *British Medical Journal* 346:f1515.

Malcolm, S., E. Marshall, M. Aillery, P. Heisey, M. Livingston, and K. Day-Rubenstein. 2012. *Agricultural adaptation to a changing climate: Economic and environmental implications vary by U.S. region*. ERR-136. Washington, DC: U.S. Department of Agriculture, Economic Research Service.

NOAA (National Oceanic and Atmospheric Administration). 2011. *Fisheries of the United States, 2011*. http://www.nmfs.noaa.gov/stories/2012/09/docs/fus_2011_fact_sheet_final92012.pdf (accessed September 9, 2013).

NOAA. 2013a. *Seafood and human health*. http://www.nmfs.noaa.gov/aquaculture/faqs/faq_seafood_health.html#6how (accessed September 9, 2013).

NOAA. 2013b. *What is aquaculture?* http://www.fishwatch.gov/farmed_seafood/what_is_aquaculture.htm (accessed October 7, 2013).

Seafood Watch. No date. *Wild seafood issue: Bycatch*. http://www.montereybayaquarium.org/cr/cr_seafoodwatch/issues/wildseafood_bycatch.aspx (accessed October 29, 2013).

Smith, T. A., B.-H. Lin, and J.-Y. Lee. 2010. *Taxing caloric sweetened beverages: Potential effects on beverage consumption, calorie intake, and obesity*. ERR-100. Washington, DC: U.S Department of Agriculture, Economic Research Service.

U.S. Bureau of Labor Statistics. 2013. *Frequently asked questions (FAQs)*. http://www.bls.gov/cpi/cpifaq.htm (accessed October 10, 2013).

USDA (U.S. Department of Agriculture). 2013a. *Healthy incentives pilot (HIP). Interim report*. http://www.fns.usda.gov/ORA/menu/Published/SNAP/FILES/ProgramDesign/HIP_Interim.pdf (accessed October 18, 2013).

USDA. 2013b. *USDA agriculture outlook forum. Grains and seeds outlook*. http://www.usda.gov/oce/forum/presentations/GrainsOilseedsOutlook.pdf (October 18, 2013).

USDA/HHS (U.S. Department of Health and Human Services). 2010. *Dietary guidelines for Americans*. 7th Edition. Washington, DC: U.S. Government Printing Office.

Warner, K., W. Timme, B. Lowell, and M. Hirshfield. 2013. *Oceana study reveals seafood fraud nationwide*. http://oceana.org/sites/default/files/reports/National_Seafood_Fraud_Testing_Results_FINAL.pdf (accessed October 7, 2013).

WWF (World Wildlife Fund). No date. *Fact sheet: Bycatch*. http://awsassets.panda.org/downloads/bycatch_factsheet.pdf (accessed October 7, 2013).

# 5

# Options and Approaches to Enable Sustainable Food Choices

As the workshop progressed, the focus of discussion shifted from the synergies and trade-offs associated with healthy eating to options and approaches for managing those synergies and trade-offs in ways that simultaneously improve human health, the environment, and economic issues. The intention was to consider not just policy approaches but also economic, educational, and research approaches. This chapter summarizes the presentations and discussion, during which participants explored some of those options and approaches.

The first speaker, Tim Lang from the City University London, provided an overview of how the European Union (EU) and the efforts of several EU countries are approaching the issues. He described the various policy efforts under way by nongovernmental organizations (NGOs), the sciences and other professions, governments, and industry. In his opinion, different policy approaches are still "jostling" for position, with no "take-off" yet. Next, Katherine Clancy, a food systems consultant, discussed key lessons learned from the EU experience, including the need for a changed consciousness among U.S. policy makers and regulators and a willingness to act on that consciousness. She emphasized the importance of cross-silo collaboration when developing new sustainable diet policy and identified specific policy targets in the United States, a key one being the U.S. dietary guidelines. Finally, Jennifer Wilkins, from Cornell University, explored available evidence on linkages between dietary guidance, human health, and environmental protection. Although nutritionists have a long history of studying the connection between dietary guidance and human health, they

are only just beginning to explore the connection between dietary guidance and environmental protection.

Before the presenters spoke, moderator Gail Feenstra, from the University of California, Davis, encouraged workshop participants to keep three key challenges in mind as they considered the various options put forth. First, she encouraged workshop participants to adopt a systems thinking approach to examining the issues at hand. That is, rather than thinking about situations in terms of "either/or," think in terms of "both/and." Feenstra observed that the field of nutrition has come a long way toward systems-level thinking in the past 25 years. When she first started practicing, in the 1970s and 1980s, most nutritionists and dieticians were confident in their roles promoting health through improved diets. Although this often remains their primary role today, more and more nutritionists approach their roles in promoting health from a larger perspective. In 1986, in an article titled "Dietary Guidelines for Sustainability," in the *Journal of Nutrition Education*, Joan Gussow and Kate Clancy proposed building diets on environmental as well as nutritional criteria and coined the term "sustainable diet" (Gussow and Clancy, 1986). That article and the thinking behind it changed the face of the nutrition field, in Feenstra's opinion. No longer was nutrition education just about human health it also included concern for the environment.

The second challenge Feenstra posed to workshop participants was to be mindful of how the workshop discussions included, or excluded, racial, ethnic, or income classes not represented and which have historically not had much voice in critiquing or designing sustainable diets. For her, sustainability encompasses not just the present and future health of our food economies and our environment, but also social justice for all populations engaged with the food system, especially given that disenfranchised populations are often hardest hit by environmental resource limits.

Finally, Feenstra challenged workshop participants to consider that many options exist for addressing the complexity of sustainable food choices. She encouraged participants to take note of what other countries and regions are doing to address the many food, environmental, and social justice challenges ahead.

**Key Themes of This Chapter[a]**

- Several different sectors of European Union (EU) society have been involved in developing sustainable diet policy, including the very active nongovernmental organization world, scientific and other professional groups, both EU and national governments, and the private sector. (Lang)
- There are several lessons to be learned from the EU experience, including the need for a changed consciousness among policy makers of the linkages between food choices and environmental integrity and a willingness to act on that consciousness. (Clancy, Lang)
- Many workshop participants agreed that basing U.S. dietary guidelines on environmental as well as nutritional criteria should be the first specific policy target aimed at reducing the environmental impacts of the U.S. food system. (Clancy, Lang, Wilkins)
- Nutritionists have been studying the connection between dietary guidance and human health for decades and the connection between human health and environmental protection for years. However, they have only recently focused their attention to the connection between dietary guidance and environmental protection, leaving many unanswered questions. (Wilkins)

[a] Key themes identified during discussions, presenter(s) attributed to statement indicated by parenthesis "( )."

## LESSONS FROM ACROSS THE ATLANTIC: POLICY FAULTINESS AND POLICY POSSIBILITIES ON SUSTAINABLE DIETS[1]

The European Union, with 27 countries, is not just a large region, but also has complex systems of food governance, Tim Lang suggested. His intention was to provide workshop participants with the flavor of sustainable diet policy activities across Europe, with an emphasis on policy activities aimed at resolving some of the tensions being discussed during this workshop. The "big picture," in Lang's view, is that the food system is in trouble. Although huge advances have been made during the past century, with more food being produced, more people being fed, and people living longer lives, those advances have come at a cost. The effort to resolve hunger by producing more food has led to what Lang described as a "weird world" in which more people are obese or overweight than are hungry and where under-, mal-, and over-consumption exist simultaneously and nega-

[1] This section summarizes information presented by Tim Lang, Ph.D., Centre for Food Policy, City University London, United Kingdom.

tive impacts on the environment and health are pressing. Although Europe is not suffering hunger seen in various other regions across the world, it does exemplify many trends and problems that must be addressed in the 21st century, which is why efforts to embed notions of sustainability, not least in diet, are rising up in the policy agenda.

The notion of a "sustainable diet" is not a new idea, in Lang's opinion. He agreed that the Gussow and Clancy (1986) paper was a seminal event, but he observed that the many themes in the notion of "sustainable diets" can be traced back to the Malthus debate about environmental limits and what makes for a good food system.

Although Lang's talk was organized around the four major categories of "actors in the system," specifically, civil society (e.g., NGOs), the sciences and other professions, government (both EU and national governments), and industry, in his opinion the bigger story is how complexity is being addressed and how progress is being redefined. He described what is happening in Europe with respect to sustainable diet policy as a rethinking of the food system, a process that started in the 1940s but with no "lift-off" yet. He described current activity as different policy approaches "jostling for position."

## Civil Society

The European Union is home to some very powerful NGOs that are well organized and cover sectoral interests familiar to the United States, including environmental, human health, consumer, and animal welfare lobbies. NGOs across these sectors are beginning to be aware of and address the unsustainability of the food system.

The United Kingdom (UK) hosts many NGOs whose rising influence has been partly a legacy of political efforts to reduce the role of the state from the era of Prime Minister Margaret Thatcher. For example, Sustain,[2] a UK alliance on food, health, and environment, which Lang used to chair, has more than 100 member organizations, from the very small to some of the largest NGOs in Europe. For 30 years, member NGOs have been learning from each other and cross-fertilizing each other's issues. Together, they are significant sources of pressure to address food and sustainability.

Eight years ago, for example, in collaboration with a large UK food company, Sustain explored whether campaigning for food labels to include multiple sustainability features would be feasible and useful. They concluded that, while possible, food labels should use colors and shapes to include sustainability features (Sustain, 2013), but its real value lay more in encouraging companies to lower their carbon or other impacts. In Lang's

[2] See http://www.sustainweb.org.uk (accessed December 11, 2013).

view, there is currently not much pressure for a sustainability element to European food labeling, although that might emerge, given the European Commission's predilection for common labels and information systems to aid the free flow of goods. Instead, the sharing of consumer information through social media networks is "really taking off," Lang said, not just in the European Union, but also in the United States.

Across Europe, Lang noted that there is currently considerable NGO interest in developing sustainability indicators and in pushing for tougher impact reduction targets. An example is the Zero Carbon Britain project,[3] which is using life-cycle analysis (LCA) to benchmark what a diet based on zero carbon emissions would look like. Lang also noted the "very interesting think tank work" from *Which?* (formerly the Consumers Association), the UK equivalent of the American Consumers Union, showing that the more consumers learn about the complexity of environment, health, and social justice issues, the more concerned they become (Which, 2013). EU consumer groups are increasingly aware of the gap between what consumers eat and what is desirable for both health and environment. As a result, coalitions and campaigns are emerging. In the United Kingdom, for example, about 30 organizations have formed the *Eating Better*[4] coalition to promote sustainable diets to meet environmental, human health, social justice, and animal welfare concerns.

Lang summarized NGO policy activity evolving in the European Union around sustainable diets as a process of "bubbling democratic experimentalism," a mixture of championing the integrated approach to sustainable food and diets and challenging policy makers, industry, and the public itself. A key tension emerging from all work is whether policy should be based on consumer choice (assuming consumers are in control of their food and the food system) or on choice editing (in which producers or retailers frame the choices by reducing impacts before the consumer can even choose). Lang noted that while in the United States the policy rhetoric is of consumer choice, most large EU companies are taking the choice editing route, saying "trust us, we'll do it." Privately, however, many companies and commercial researchers express concerns about how far they can pursue choice editing before consumers will have to be engaged more openly in a shift to sustainable diets.

### The Professions/Sciences

Although the field of nutrition has not been engaged in the past in discussions of sustainable diets or sustainable foods, today its engagement

[3] See http://www.zerocarbonbritain.org (accessed December 11, 2013).
[4] See http://www.eating-better.org (accessed December 11, 2013).

is growing rapidly. The UK Nutrition Society held a meeting in 2012 and the Belgian, French, and UK Nutrition Societies co-hosted a conference in 2013.[5] Lang mentioned academic work emerging from, for example, a Barilla-funded academic center at Bocconi University, Milan, Italy, and at various universities, for example, in France via the French National Institute for Agricultural Research, in the Netherlands at Wageningen, and in the United Kingdom at Universities of Aberdeen, Cardiff, City, and Oxford.

Amid this development, agricultural science appears to be caught in what Lang described as a "clash between two policy narratives": productivity (i.e., should the goal be to try to decarbonize productivity gains and rally around the notion of sustainable intensification?) versus social change (i.e., should the goal be to consider how to change society and the consumer differently?) (Lang and Barling, 2012).

Engineers are also becoming engaged in the sustainable diet/food dialogue, bringing a heavy focus on technological solutions, for example, to waste (Institution of Mechanical Engineers, 2013). Likewise, Lang noted, social science interest is rising as analysts realize that behavior change requires shifts in consciousness. Texco, the largest retailer in Great Britain and the third largest retailer in the world, awarded a £25 million grant a few years ago to social scientists at the University of Manchester, England, to found a Sustainable Consumption Institute.[6] Lang noted that there is some tension between different schools of thought in social science about around how to change behavior: "nudge individualism" versus "shove control" (e.g., see Centre for Climate Change Economics and Policy recent seminar series[7]).

In sum, Lang observed that although the sciences are engaged in the sustainable diet/food dialogue, "they are pretty nervous about it." They remain confined by their disciplinary silos. They follow their research funding, which comes mostly from the European Union, but also national governments, companies, and some foundations. So far, most thinking around sustainable foods is through the lens of "low-carbon and healthy." There is no sustainable diet equivalent of the Eurodiet—a set of common guidelines about population health. Eurodiet was created through a 3-year effort to coalesce all member states' dietary guidelines. In Lang's opinion, a similar effort is needed to develop a sustainable diet equivalent. Although the Eurodiet is not yet formally supported by the Europan commission,

[5] See http://fensnutrition.eu/docs/news/ProgramSustainableDietLille.pdf (accessed December 11, 2013).

[6] See http://www.sci.manchester.ac.uk (accessed December 11, 2013).

[7] See http://www.cccep.ac.uk/Events/Past/2012/January/corporate-action-climate-change.aspx (accessed December 11, 2013).

Lang noted that discussion has been taking place in Brussels and beyond about its desirability.

### Commerce

Although many food and drink companies currently focus on LCAs as the methodology of choice for measuring product impact, in fact companies and commercial research bodies are doing much more than that, according to Lang. In 2002, for example, a group of multinationals launched the Sustainable Agriculture Initiative,[8] and in 2009 another group of top companies, called B20, launched its position on food security and food sustainability (B20, no date). To date, most EU companies are taking a product-specific approach to sustainability, that is, they are decarbonizing (or reducing carbon emissions of) specific products. Lang referred workshop participants to a 2012 FoodDrinkEurope report, *Environmental Sustainability Vision Towards 2030* (FoodDrinkEurope, 2012). The report represents a convergence in thinking between the commercial sector and the European Union's Knowledge-Based Bio-Economy research framework. The Barilla Center's double pyramid also contributes to that shift in thinking (see Figure 2-2).

As summarized by Lang, although there is no sustainable diet commercial framework, serious engagement with aspects of sustainability is now advanced in EU food sectors. The European Commission provides some important guidance through its Sustainable Consumption and Production framework, which focuses on resource efficiency. Some uncertainties remain with regard to the business model. Commerce seems divided on whether the priority is cost cutting or a genuine ecological commitment.

### Government: The European Union

We need to remember that "Europe is not Europe," Lang said. "It is 27 member states with different arguments, different traditions, and very different players." According to Lang, the contemporary EU approach toward sustainable diet and food can be traced back to agreements reached at the 1992 United Nations Conference on Environment and Development, Rio de Janeiro, Brazil, and then again in Johannesburg in 2002 and at the 2012 Rio+20 Conference, and with the resulting 10-year framework of programs, called the Marrakech Process.[9]

Lang identified two phases in the EU general approach to sustainable diets. Phase 1 (2008-2013) focused on sustainable consumption and pro-

[8] See http://www.saiplatform.org (accessed December 11, 2013).
[9] See http://esa.un.org/marrakechprocess (accessed December 11, 2013).

duction (SCP), following the 1992 Rio and 2002 Johannesburg summits. Phase 1 developments included a study on eco-labeling that resulted in the eco-label extension to sustainability being dropped (Oakdene Hollins Research and Consulting, 2011). Lang's opinion was that this study was a missed opportunity, having started with trying to see whether the organic food label could be expanded to include other sustainability criteria. He wouldn't have started with that label, he said. Also during phase 1, the European Food Sustainable Consumption Production Roundtable[10] was created, a much more important and powerfully backed policy framework.

Phase 2 of the EU general approach to sustainable food policy is more recent. Its focus is a specific effort to reduce carbon emissions and waste. He highlighted one document in particular *Roadmap to a Resource Efficient Europe* (European Commission, 2011). This report called for systems-level change thinking, not just product LCA and paved the ground for new pan-European thinking summarized in the 2013 Sustainable Food consultation (European Commission, 2013). This is a step toward what might become an EU formal directive (law/regulation). Another document of importance Lang noted that summarizes much scientific input to EU policy processes is the 2011 3rd Scientific Advisory Committee on Agricultural Research report (Freibauer et al., 2011).

Although the sustainability challenge is beginning to emerge in EU food policy, Lang noted that the "elephant in the policy room" remains the Common Agricultural Policy (CAP). In the past 10 years, CAP has shifted from paying farmers for commodity production to paying them for environmental and public goods. (CAP still dominates EU budgets, accounting for about 40 percent of total European Commission budgets.) Although the environment now plays a significant role in EU farm policy, Lang noted that health does not. There is an EU Platform for Action on Diet, Physical Activity, and Health,[11] but this is a voluntary platform and so far has not injected public health goals into CAP, although it may create some progress toward incorporating sustainability issues. More significant is the commitment to waste, for example, the Integrated Product Policy.[12] Overall, the pursuit of sustainable diet as integrating environment, health, and social goals remains distant, Lang judged.

He observed the importance of the shift from the SCP platform to a LCA approach. Policy makers and commerce appear comfortable with LCA because it provides metrics for measuring carbon and water, but an overreliance on LCA has dangers, Lang thinks. Cultural and social issues of

[10] See http://www.food-scp.eu (accessed December 11, 2013).

[11] See http://ec.europa.eu/health/nutrition_physical_activity/platform/index_en.htm (accessed December 11, 2013).

[12] See http://ec.europa.eu/environment/ipp/integratedpp.htm (accessed December 11, 2013).

sustainability are not measurable in LCA terms, which define sustainability precisely but too narrowly and materially.

### Government: Member States

Among EU member states, Sweden was the initial leader in policy development on sustainable diets. Lang encouraged workshop participants to read the Swedish report *The National Food Administration's Environmentally Effective Food Choices* (Livsmedelsverket, 2009), which he described as the "best attempt anywhere on the planet to produce sustainable dietary guidelines." The report considered the best environmentally conscious ways to proceed, given key foods that Swedes eat, and recommended eating seasonally. It used an integrated knowledge framework covering public health nutrition, environment, and sociocultural mores. The report was sent to the European Food Safety Authority for approval at the EU level in 2009 but later withdrawn. Lang said some deemed it too threatening, others claimed that it infringed the European Union's single-market commitments (by recommending local and seasonal foods). Whatever the reason, the report has been withdrawn, but it still represents the high point in formal evidence-based governmental advice among EU member states.

Many other, particularly northern, European countries have begun to develop positions on sustainable food, if not diet, per se. These various efforts deserve examination. Lang mentioned The Netherlands' advisory report *Guidelines for Health Eating: An Ecological Perspective* as being especially interesting because it has not been withdrawn (Health Council of the Netherlands, 2011).

Debates in the United Kingdom around sustainable diets started with two 2008 documents. The first, *Food: An Analysis of the Issues* (Cabinet Office, 2008a), provided the first review of British food policies since World War II. The second, *Food Matters: Towards a Strategy for the 21st Century* (Cabinet Office, 2008b), argued for a new, low-carbon and healthy framework for British business. These reports were followed by a series of additional policy reports and the 2008 Climate Change Act, which aims at reducing greenhouse gas emissions by 80 percent by 2050 (UK Government, 2008). The 80 percent reduction in greenhouse gas emissions targeted by the Climate Change Act requires that the food system be addressed. Lang said, "You cannot deal with 80 percent carbon reduction in any country unless you are dealing with the food system." The act served as a lever for action and led to a rapid explosion in activity within the government, including *Setting the Table* (Sustainable Development Commission, 2009) and culminating in *Food 2030* (DEFRA, 2010). Lang considered *Food 2030* to be the most ambitious national report linking health and environmental issues.

Lang observed that although much of this UK government-level activity ceased with the 2010 election, the commercial sector is still pushing the broad framework forward and recently pressured the government to initiate the Green Food Project (2011-2012).[13] Many of the old arguments still exist, Lang said, but in different forms. Lang also noted interesting policy activities in Wales and Scotland, e.g., *Toward Healthier and More Environmentally Sustainable Food and Drink in Scotland* (Scottish Government, 2011).

## Moving Forward

Although progress in refining what is meant by "sustainable diets" and "sustainable food" has occurred, Lang cautioned that there is opposition. This is true not just in the European Union, but also in the United States. In Lang's opinion, it is important to pay attention to those arguments. "We've got to address the critics," he said.

The case for sustainable dietary guidelines deserves support, Lang opined. Most importantly, sustainable dietary guidelines bridge the gap between the noncommunicable diseases and $CO_2$ emission discourses. They also help reset moral drivers. For example, what is a "good" food system? Is it one that allows you to go into a grocery store and choose from 35,000 items? Or is it one that assures you that your great, great grandchildren will be able to eat, too? Above all, sustainable dietary guidelines would provide a new basis for public advice and supply chain goals with respect to what to eat, how to consume, and how food is produced.

There are a number of options for moving forward, including public policy (government-led), professions-led, commercially-led, and civil society-led routes. Possible government-led routes include a World Health Organization/Food and Agriculture Organization (FAO)/United Nations Environmental Programme joint high-level report and creation of an intergovernmental panel on sustainable diets, like the International Panel on Climate Change. Possible science-led routes include formation of an interdisciplinary working group or foundations-led work (e.g., the Gates Foundation). Possible commercial-led routes include, as Lang said, "leaving it to the Barillas of this world." Finally, possible civil society-led routes include engaging the World Wildlife Fund and its One Planet Diet. It is unclear, Lang opined, which of these routes the sustainable dietary guideline movement will take.

If given 5 minutes with the President of the United States, this is what Lang would say: "Don't be frightened of this. It's evidence-led.… You

[13] See https://www.gov.uk/government/publications/green-food-project-conclusions (accessed December 11, 2013).

can organize changes better than enforce change.... Embryonic shifts are already under way. You're not going to have to force companies to do it. They're beginning to do it." Lang emphasized what he called the "garbage can theory." Even if today's thinking about sustainability is not delivered today, a future president will be able to reach down into the garbage can and pull out previously developed ideas and policy proposals and apply or use them.

The scientific task at hand is to conduct more interdisciplinary research, which currently is poorly funded, and to move on from Malthus (i.e., notion that environment determines capacity). Lang referred to the 1943 Hot Springs, Arkansas conference, which he said set today's global United Nations food policy framework. "We need a new Hot Springs," Lang said, to set "the framework for the future." Some of his own thinking is laid out in work for the UK Sustainable Development Commission (2011) and in various academic papers (see Lang and Rayner, 2012, and Lang and Barling, 2012, 2013).

## POLICY IMPLICATIONS[14]

> It is clear that sustainable diets, even if widely adopted, will not lead automatically to a sustainable agriculture. What is required for widespread adoption of the latter is a farm policy that rewards agricultural practices conserving of natural resources, and an overall policy (domestic and foreign) that promotes regional self-reliance in food both here and abroad. (Gussow and Clancy, 1986, p. 1986)

Kate Clancy observed that although some progress has been made since she and co-author Joan Dye Gussow concluded that sustainable diets require both a farm policy and an overall food policy as described in the above quote, both policy goals are still quite far away. She considered lessons that can be learned from the EU sustainable diet policy experience, new policy approaches under way in the United States, and specific U.S. policy targets.

### What Can Be Learned from Europe?

The first key lesson from Europe, in Clancy's opinion, is a great need in the United States for a changed consciousness among policy makers and regulators of the linkages between food choices and environmental integrity and a willingness to act on that consciousness and knowledge. This

[14] This section summarizes information presented by Kate Clancy, Ph.D., Food Systems Consultant, University Park, Maryland.

would include, at minimum, recognition of the food system as a complex system containing multiple feedback loops that cannot be addressed successfully by addressing only their constituent parts and acknowledgment that sustainable diets are an appropriate policy and public health goal in the United States. Clancy observed that a portion of the food industry and of many civil society organizations (e.g., people advocating for sustainable food systems) is far ahead of most policy makers working on this topic. Although there is still a great distance to go, these "pioneers" in industry and in the NGOs world make very good private-sector partners for governmental work.

A second key lesson learned from Europe is the need for good planning. Clancy observed that although the Department for Environment, Food, and Rural Affairs' work in Great Britain has been suspended, as Lang noted during his presentation, a 2011-2012 evidence plan can still be found on the department's website (DEFRA, 2011). Clancy described the evidence plan as extensive, incorporating myriad components and six themes. Another European example of good planning is the 2010 FAO *Biodiversity in Sustainable Diets* report (FAO, 2010), which was the result of a coordination of multiple efforts and institutions worldwide. Clancy contrasted these efforts with the U.S. situation, where she is aware of no attention by agencies developing federal dietary guidance to the environmental implications of food choices. Nor does the United States have a food policy framework that would provide a starting point for working across agricultural and food sectors rather than continuing down the same siloed pathways. Clancy noted that the lack of a food system policy framework was eloquently discussed many times in the early 1980s, with an important report issued by the Government Accountability Office (GAO) (1982).

A third key lesson pertains to the status of evidence-based research across Europe. There is already quite a lot of evidence on the environmental consequences of food production, especially of animal products, processing, and delivery. Clancy referred to the many workshop presentations covering some of that evidence base. But there are many gaps in the evidence base as well, "far too many gaps," in Clancy's opinion. Many recommendations put forth for sustainable dietary guidelines are qualitative, not quantitative, due to a lack of research attention and statistical uncertainties around greenhouse gas emissions and other phenomena (Health Council of the Netherlands, 2011).

A key theme across all of these lessons is that although there are differences between the EU and U.S. situations, many thoughtful and useful data analyses, logic models, and plans that were developed in Europe are available for use and could provide the United States with a head start on addressing some of the complicated issues at hand.

### New Policy Approaches

Clancy identified two different but related new policy approaches, transformative and interconnected (i.e., interconnected across departments and administrations), emphasizing that even transformative policy work should be carried out by departments, agencies, and administrations that are willing to work together. What is surprising, even concerning, for Clancy is that although the idea of systems science, cross-disciplinary research, and related concepts has existed for decades in multiple academic disciplines and organizations across the United States, little of what has become second nature to many food policy analysts seems to have made its way into government projects.

That said, the National Research Council report *Toward Sustainable Agricultural Systems in the 21st Century* (NRC, 2010), provides what Clancy described as a "rich, detailed, articulate rationale for increasing the attention and resources" directed toward interdisciplinary and transdisciplinary systems research. She believes very strongly that the same argument put forth in that report can apply to policy work on sustainable diets. Specifically, she emphasized the need for appropriate price signals or incentives to farmers to adopt more resource-conserving production practices; the need for farm and food policies to be redrafted so that they are less likely to produce unintended consequences that result in less conservation of water, land, and other resources; and the need for more policy tools that are politically viable and effective at a landscape level. Except for some policy that relates to watersheds, most sustainable agriculture policy is still directed toward individual farms, which doesn't elicit any systems thinking and is too incremental.

In addition, the groundbreaking 1982 GAO report stated that GAO's emphasis, from then on, would be on cross-issue analyses and requested that agencies dealing with food-related issues consider the same. The 2011 Foresight report on global foods states strongly that interconnected policy making is critically important to solving those problems (Foresight, 2011).

Clancy also noted the many good policy ideas put forth by workshop speakers, all of which could be compiled into a policy research agenda for building sustainable diets that could be disseminated both inside and outside government.

Multiple agencies need to be looking across food supply chains to comprehensively delineate and share information on energy use, climate change, greenhouse gasses, water pollution, soil erosion, and other environmental consequences. Clancy pointed to some excellent internal work being conducted at the U.S. Department of Agriculture (USDA), with people from different agencies within the USDA collaborating on the Know Your Farmer, Know Your Food initiative (USDA, 2013). But that's an internal model for

collaboration. There is also some cross-agency collaborative work on sustainable communities planning grants being conducted by the U.S. Department of Housing and Urban Development, the Environmental Protection Agency, the Department of Transportation, and USDA (USDHUD, 2013; USDOT, 2012). Clancy called for more models of successful collaborations not just across government agencies, but also between government and NGOs.

### Specific Policy Targets

With respect to specific policy targets, Clancy identified first and foremost the U.S. dietary guidelines and described several components of what would be a much more complex process for the dietary guidelines committee to consider (USDA/HHS, 2010). First, would be to add committee members with knowledge of sustainable diets, that is, with expertise on how diet and food choices interact with agricultural and environmental resources. Second, would be to develop a working definition of a sustainable diet specifically for the purpose of dietary guidance. Clancy considers the FAO and Biodiversity International definition[15] to be a wonderful long-term goal, but not necessarily the right starting point because it includes so many elements. Third, would be to review all available evidence related to diet/environmental linkages. Fourth, would be to take a step-wise approach, that is, to start by examining and including one or more components and then adding others as more research is conducted.

Dietary guidance is an important policy target partly because of its multifunctional nature. Not only can it be used to educate the public about food choices, it can also be used to effect change in food choices. Although its effect on changing food choices has a mixed history, there have been some successes. If environmental concerns become incorporated into dietary guidance, dietary guidance can also be used to educate the public about the entire food system and, in Clancy's words, "its utter dependence on ecological health." In addition to being a tool, dietary guidance is also a signal that the government recognizes its role in providing the best food and dietary advice to the public in order to protect public health and understand the links between health, environment, and food security. In Clancy's opinion, it is impossible to talk about food security without recognizing that the intersection of health and the environment is essential to national

[15] "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" (Burlingame and Dernini, 2012, p. 7). (See the summary of Barbara Burlingame's presentation for background information on this definition.)

food security. Dietary guidance is also a signal that the public has a role in conserving natural resources through its food choices and that citizens are not bystanders. Although people have been saying this for "many decades," Clancy said, incorporating environmental concerns into dietary guidance would signal its importance.

A second specific policy target is research. Clancy called for an acceleration of progress in research that will help to inform sustainable dietary guidance and for more government funding for research. Reports issued in the past few years from a range of sources, such as the American Enterprise Institute (Alston and Pardey, 2011) and the President's Council of Advisors on Science and Technology (2012), have stated that the federal government needs to fund more agricultural research because of the low commercial value of many environmental improvements to agricultural production. Clancy also called for more research, both basic and applied, encompassing the multiple dimensions of sustainability and resiliency and conducted by multi- and transdisciplinary teams (ideally across agencies). Finally, she called for more research on systems properties (e.g., emergent properties of food systems).

## OPTIONS AND APPROACHES TO ENABLE SUSTAINABLE FOOD CHOICES: RESEARCH PRIORITIES[16]

Has research been successful in connecting dietary guidance, human health, and environmental protection? If success is defined as having a dietary guidance tool to promote sustainability, then, according to Wilkins, the quick answer is "no." But, for Wilkins, further examination of the question revealed three embedded connections: connections between dietary guidance and environmental protection, connections between environmental protection and human health, and connections between human health and dietary guidance. Wilkins examined the evidence base available for understanding each of these connections.

### Dietary Guidance and Human Health

The field of nutrition has a long history of researchers accumulating evidence of the connection between diet and health. That evidence is reviewed every 5 years by an advisory committee who makes recommendations for improving the dietary guidelines (USDA/HHS, 2010). Food guides (e.g., MyPlate.gov) are also updated, but less frequently. Most of the evidence that informs the dietary guidelines and recommendations on

[16] This section summarizes information presented by Jennifer Wilkins, Ph.D., R.D., Cornell University, Ithaca, New York.

food intake comes from single-nutrient studies. Although single-nutrient studies have been very informative with regard to how nutrients and food components affect health and the risk of chronic disease, they have also led to the realization that it is important to look at whole foods and entire diets. There is a fair amount of evidence that non-nutrient components in food are very protective against chronic diseases. Wilkins mentioned the discontinued single-nutrient beta-carotene retinol efficacy trial (known as CARET) conducted back in the 1990s. The trial was designed to test the effect of daily doses of beta-carotene and retinyl palmitate supplement on incidence of lung and other cancers and death among more than 18,000 participants. It was discontinued when researchers found that participants receiving the supplement showed a 28 percent increase in incidence of lung cancer and a 17 percent increase in death (Omenn et al., 1996).

Wilkins categorized evidence on diet–health connections into three groups: (1) consistent evidence, that is, evidence that remains the same when research is replicated; (2) emerging evidence; and (3) contested evidence. Nutritional evidence about the healthfulness of fruits and vegetables and whole grains in the diet is based on consistent evidence. Recommendations regarding types of fat and quantity of fat in the diet are based on emerging evidence; it is still not clear what kind of fat or how much fat is healthy. That same is true for certain components in foods, like phytochemicals. Calcium requirements, including how much calcium is needed from dairy foods, are an example of nutritional advice based on contested evidence and are a "real hot button" right now in the nutrition community, according to Wilkins. The vitamin D requirement is similarly contentious, as well as benefits derived from iron from meat versus iron from other sources.

### Human Health and Environmental Protection

The environmental movement as a whole stemmed, at least in part, from concern about exposures that can be harmful to public health. The assumption, in Wilkins's opinion, is that protection of and resilience of natural resources (water, air, soil, biodiversity) is a necessary condition for people to be healthy. Researchers are beginning to explore that connection as it relates to food choices. Again, the evidence can be categorized as confirmatory, emerging, or contested.

Water is an essential nutrient and comprises 70 percent of our body weight. Although humans can survive without food for weeks, they cannot survive more than a few days without water. Years of research have shown how agriculture impacts water quality in ground water, streams, rivers, and aquifers. The impacts of nonrenewable fossil fuel-based inputs, such as fertilizers and pesticides, on ground water, streams, and rivers are especially

well documented. The U.S. Geological Survey reported nearly two-thirds of domestic and public drinking water wells sampled to be contaminated with at least one volatile organic compound, pesticide, or nitrate from human sources (Toccalino and Hopple, 2010). Impacts of intensive food animal production on water quality are also well documented, with many studies concluding that the amount of manure generated yearly is too much for the land to absorb, leading to nitrogen and phosphorous runoff into streams and shallow aquifers and turning what could be a rich resource into a pollutant (Hooda et al., 2000; Smith et al., 2013). In addition, animal waste often has other elements in it, including antibiotic-resistant bacteria and other pathogens, arsenic, dioxin and other persistent organic pollutants, and complex mixtures of volatile organic compounds. In Wilkins's opinion, comparing different kinds of animal production systems should be a research priority. She also urged comparing animal production systems to systems built around plant-based sources of protein.

Research on air quality has detailed significant impacts from industrial food animal production as well; air is contaminated with ammonia, hydrogen sulfide, carbon dioxide particulates, and microorganisms (Heederik et al., 2007; Viegas et al., 2013). Research has also shown substantially elevated rates of respiratory conditions among workers and community members living near the facilities (Mirabelli et al., 2006; Schinasi et al., 2011). In Wilkins's opinion, air quality issues raise social justice issues as well, as often the damage and negative health effects from the food system are experienced by people without much voice. Pesticides are another air quality issue.

The nutrition community is, in Wilkins's words, "really waking up to" the link between soil quality and human health. She recalled earlier issues of various journals, such as the *American Journal of Alternative Agriculture* (now called *Renewable Agriculture and Food Systems*), calling for a broader consideration of soil quality beyond productivity. Researchers were urged to also consider environmental quality, human and animal health, and food safety and quality. Soil quality is an area Wilkins thinks deserves more attention. Food is the most obvious ecosystem service that soil provides, but soil also can improve water and air quality, help mitigate greenhouse gas emissions, and enhance biodiversity.

With respect to biodiversity, Wilkins referred workshop participants to Barbara Burlingame's presentation (see Chapter 2) and reiterated that the global food supply depends on very few species. Only 12 plant species account for 75 percent of the global food supply, and only 15 mammal and bird species account for 90 percent of animal agriculture (FAO, 1998, 2007).

### Environmental Protection and Dietary Guidance

The connection between environmental protection and dietary guidance has not been a central issue for most nutritionists, Wilkins opined. It is not a central topic for her department at Cornell University, nor has it been a central message from the major nutrition professional organizations, such as the Academy of Nutrition and Dietetics and the Society for Nutrition Education and Behavior. However, within both of those organizations and others, like the American Public Health Association, small but growing communities of nutrition professionals are addressing the issues. One of Wilkins's roles at Cornell is to serve as community coordinator for her department's dietetic internship program. She remarked that it has been interesting to observe the changing interests among applicants in the past few years. A growing number want environment protection–dietary guidance connection issues to be part of their dietetic training. Wilkins also sits on a national committee that is advising the Academy of Nutrition and Dietetics on developing standards of practice and professional performance in the area of sustainable and resilient food and water systems. "The fact that they formed this committee and want this information I think is very encouraging," Wilkins said.

Wilkins highlighted several key research needs to help understand the connection between environmental protection and dietary guidance. First are questions related to diet composition, especially the different roles of plant versus animal protein in a sustainable food system. How much meat should we eat? What other ecosystem services do we want agricultural animals to provide? How would those services be translated into ounces of meat or kinds of meat consumed daily or weekly? How do intensive animal production systems compare with pasture-based multi-species systems in terms of their impact on the natural environment and their ability to feed and meet consumer demand?

Understanding seasonal variation is another key research need. For example, does varying diet by seasonal availability alter the nutritional content of one's diet? What are the nutrition, food-planning, and meal-cooking implications of varying the form of food being used (e.g., fresh fruits and vegetables in season compared to stored fruits and vegetables in the off season)? What are the environmental impacts of canning, freezing, and other off-season storage processes?

Variety is yet another research issue to consider. In Wilkins's opinion, a varied diet is the cornerstone of nutrition advice. Yet, the U.S. national diet is not a varied diet, with half of vegetable intake comprised of potatoes and tomatoes. Wilkins suggested that much could be done to vary the vegetables, as well as fruits, being consumed. She mentioned local and regional food systems and efforts by Ian Merwin, a pomologist at Cornell University,

who grows about 30 different varieties of apples on his farm, some ripening in July, others in November. His work is based on the premise that greater variety satisfies the market for fresh apples for a longer period of time.

Finally, Wilkins identified processing as the "elephant in the room." She encouraged workshop participants to read Carlos Monteiro's invited commentary "Nutrition and Health: The Issue Is Not Food, Nor Nutrients, So Much as Processing," in *Public Health Nutrition* (Monteiro, 2009). The commentary categorizes foods into three processing groups: (1) minimally processed foods are foods that are recognizable after they have had something done to them (i.e., after they have been washed or trimmed); (2) substances extracted from whole foods include oils, flours, and other food substances often used to enhance foods in the first category; and (3) ultra-processed foods are shelf-stable, subsidized ingredients that are generally profitable (for the food industry) but not healthful. Processing itself is not the problem, Wilkins remarked. Rather, the problem is the quality and type of processing and whether any inherent nutrients remain in the product after it has been processed. In addition to being "nutrient-sucking," as Wilkins said, a lot of processing is energy- and resource-intensive.

### How Can Food Systems Research Support Sustainable Diets?

Wilkins identified several gaps in food systems research. First, is the lack of information about food systems embedded in food products. She mentioned how eye-opening it is for her students to evaluate food products in terms of the food systems represented by those products. Second, is a need for more evaluations of the types of healthy-food-access intervention activities that are under way and how they are working. Third, is a need for more work on the relationship between food skills and waste. Fourth, is a need for comparisons between highly concentrated food systems and local and regional food systems. Fifth, is an evaluation of the social costs of food systems (i.e., the social costs of what is grown, how it is grown, and where it is grown).

### Dietary Guidelines: The Need for a New Framework

The dietary guidelines are intended to promote health and reduce chronic disease (USDA/HHS, 2010). They also provide nutrition standards for food assistance programs (e.g., school meal programs; the Special Supplemental Nutrition Program for Women, Infants, and Children; the Child and Adult Care Food Program; Supplemental Nutrition Assistance Program Education). Finally, they may affect sustainability of the food system, but in untapped ways. The process for developing dietary guidelines needs to be reinvigorated, in Wilkins's opinion, such that the guidelines not only

promote health and reduce chronic disease but also increase sustainability and resiliency.

Wilkins also urged broadening the food guide definition. The current definition (from Welsh et al., 1992, p. 12) reads: "A food guide translates recommendations on nutrient intake into recommendations for food intake. It provides a conceptual framework for selecting the kinds and amounts of foods of various types which together provide a nutritionally satisfactory diet." In the end, the goal is to encourage food choices that do two things: promote not just optimal health and disease but also sustainable regional food systems. A new framework, or conceptual model, for developing new dietary guidelines and food guides should be based not only on what is known about the relationship between diet and health, but also on lessons from communication and behavior change research and theory and on seasonality and other regional food system sustainability criteria. Although the food choices people make can be steered by dietary guidelines and food guides, they are also moderated by all sorts of individual factors (e.g., individual preferences, food histories) and environmental factors (e.g., availability at the local store).

The Northeast Regional Food Guide, which was developed in the mid-1990s and was based on the 1992 food guide pyramid, illustrates how geographic context can be embedded into a food guide (see Figure 5-1).

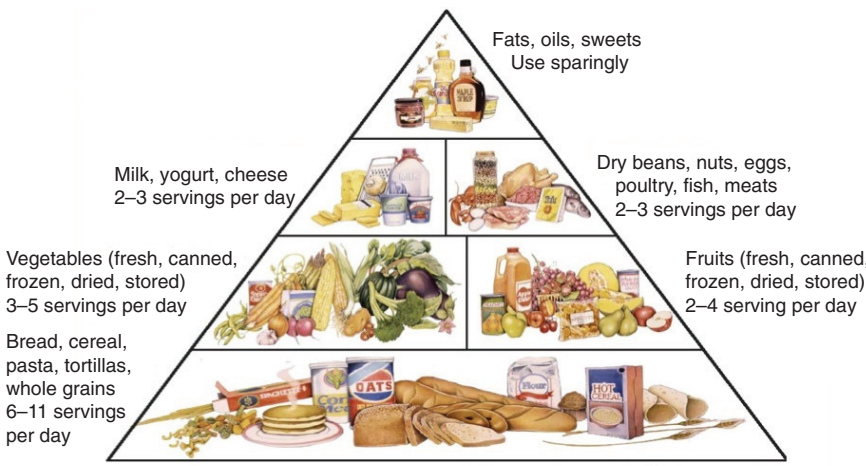



**FIGURE 5-1** Northeast Regional Food Guide developed in the mid-1990s and based on the 1992 U.S. Food Guide Pyramid.
SOURCE: Cornell Cooperative Extension, 1996.

Instead of oranges and bananas in the fruits section, regional fruits are represented. Also, instead of symbols for fats and sugars in the fats, oils, and sweets section, actual regional agricultural products are represented (e.g., syrup, butter, canola oil, jams and jellies). Wilkins suggested that a guide like this one might foster more regionally based sustainable food systems.

## PANEL DISCUSSION WITH THE AUDIENCE

Following Wilkins's presentation, panelists welcomed questions and comments from the audience. Topics included dietary guideline revisions; how panelists' past experiences in other places or sectors shaped their thinking about sustainable diets; and what panelists would choose to request if given a chance to influence an important policy maker with respect to the issues being discussed at the workshop.

### Dietary Guideline Revisions

An audience member noted that the revision process for the next edition of the dietary guidelines (2015) is just getting started. The revision committee was announced in May 2013 (after the workshop), and a public comments database is available at www.dietaryguidelines.gov. The audience member encouraged workshop participants to submit comments.

Another audience member remarked that the U.S. dietary guidelines do not actually seem to be doing what they are intended to do, that is, prevent chronic disease. She noted the rapid rise in obesity and diabetes after the dietary guidelines were created in the late 1970s. She said, "Either they're not working because people aren't following them, or they aren't working because people are following them. But either way, they aren't working." She suggested examining the decade before the U.S. dietary guidelines were created, when Americans were actually eating less food and farmers were making more money. Immediately after the guidelines were created, when people were told to start eating foods that required more processing (e.g., breads, cereals, pasta, grains) and less food requiring less processing (e.g., whole milk, meat, eggs), caloric intake increased and farm profits declined. The commenter opined that eggs are a great example of a cheap renewable source of protein, but the dietary guidelines recommend eating no more than one per day. That recommendation, she said, is based on outdated science on dietary and serum cholesterol and on egg intake and heart disease. She asked the panelists to address the reality that some dietary recommendations "get in the way of sustainability."

Wilkins agreed that the dietary guidelines need improvement, especially if sustainability it going to be principled into them. She suggested that more work be directed toward how to communicate good choices within

the guidelines. The guidelines do not receive as much attention as other voices encouraging certain kinds of consumption. Efforts to market foods of minimal nutritional value far outweigh the promotion of wholesome food consumption.

Lang agreed with the commenter that dietary guidelines do not change diets. However, they do provide a benchmark for policy makers and companies to measure progress, and for NGOs and academics to conduct public interest reviews. Lang reiterated the significant role of the 1943 Hot Springs conference in creating not just FAO, but a way to think about food and agricultural policy as something that could transform human health and begin harnessing science, technology, and capital to increase production, support farming, and deliver more affordable foods. The creation of FAO was, in a sense, recognition that the legacy of the previous 100 years of industrialization and uneven supply could be tackled. The food system could be managed in a different way to address unmet need and prevent 1930s-type agricultural booms and slumps. The modern "productionist" food policy paradigm became dominant in the 1940s. Policy makers finally accepted the scientific and practical farming evidence that had been accumulating in the 1920 and 1930s. Today, once again, the dominant paradigm is in trouble. Lang said, "We're in exactly the same situation, where we've got masses of evidence without an adequate policy response." But we also have split proposals, some wanting a further round of intensification, others calling for realignment on ecological principles. Food companies are beginning to listen. Much depends on public reaction. But, in Lang's opinion, it is the politicians who are not listening. Lang encouraged workshop participants to make the U.S. 2015 dietary guideline revision an opportunity to inject environmental thinking. He mentioned the "bitter fight" to do this in the recent Australian dietary guidelines, finalized in 2013 (Australian Government, 2013). Although mention of the environment in those guidelines appears only in the appendix, at least it appears.

### Panelist's Lessons from Past Experience in Other Places and Sectors

An audience member commented on the "primacy of synergy" in transdisciplinary thinking and innovation and asked Wilkins whether any of the innovative approaches from the University of Gastronomic Sciences, Italy, might be applied in the United States. Wilkins described the "stages," or tours, of the University of Gastronomic Sciences curriculum. Each stage is focused on a particular food (e.g., pasta, cheese, salami, honey, other typical Italian foods). Students travel to different places, even different countries, to learn about the product and the food systems behind that product. For example, they might first visit Barilla and then visit a small artisanal manufacturer to learn about different scales of pasta production. The stage

concept is something that Wilkins opined could be embedded in food and nutrition programs in the United States.

The same commenter asked Lang how his farming experience has informed his work. Lang replied, "It changed everything." He learned about the challenge of climate and temperature and soil, how difficult animals are, how messy nature is. One thing to which he is acutely sensitive after his farming experience is how farmers receive almost no money. The money is made "off the land," i.e., after food leaves the farm and begins to route to processing, retailing, and catering or home. This is true even for very big farmers, in Lang's opinion. He noted that there had been little discussion at the workshop about the implications of a transition to sustainable diets for food actors "off the land," which he thought was a mistake. Very interesting alliances can emerge when and if the pursuit of sustainability is shared by interests beyond "just agriculture."

### If You Could Wave a Magic Wand and Ask a Policy Maker to Make One Change…

Erik Olson, from the Natural Resources Defense Council, asked the panelists what he called a "magic wand question." If they had a magic wand and could influence an important policy maker, what would they request?

Clancy would ask for a consciousness and commitment to the idea that dietary guidance and sustainable food systems are a legitimate political and policy issue. There are myriad changes that need to be made, she said. So, rather than asking for any single change, she would ask for that conscious commitment, regardless of whether the issue is commodity subsidies or the Environmental Protection Agency budget or something else. Without that commitment and an integration of that thinking, she said "we can't get anywhere."

Lang would request at least two environmental scientists on the dietary guidelines revision committee; that the terms of reference for the revision committee include the need to address environmental considerations; and that the Institute of Medicine, professional societies, and others set up "watchdog" dietary guidelines monitoring committees representing a diversity of disciplines.

Finally, Wilkins identified a systems-level change in economics and where profits are made as the single most important change that she would like to see. Specifically, she would like to see margins in grocery stores being highest for healthful foods and lowest for ultra-processed foods (see the summary of Wilkins's presentation for a description of "ultra-processed" foods).

## REFERENCES


Alston, J., and P. Pardey. 2011. For want of a nail: The case for increased agricultural research and development spending. *AEI Online*, July 12. http://www.aei.org/paper/economics/fiscal-policy/federal-budget/for-want-of-a-nail-the-case-for-increased-agricultural-rd-spending (accessed October 7, 2013).

Australian Government. 2013. *Australian dietary guidelines*. Canberra: Australian Government, National Health and Medical Research Council.

B20. No date. *B20 task force recommendations on food security*. http://www.fao.org/fsnforum/post2015/sites/post2015/files/resources/Food%20Security%20B20%20Recommendations_final%20doc_0.pdf (accessed October 7, 2013).

Burlingame, B., and S. Dernini, Eds. 2012. *Sustainable diets and biodiversity: Directions and solutions for policy, research, and action*. Rome: FAO and Bioversity International.

Cabinet Office (UK Government). 2008a. *Food: An analysis of the issues. A strategy unit paper.* London: Crown.

Cabinet Office (UK Government). 2008b. *Food matters: Towards a strategy for the 21st century. A strategy unit paper.* London: Crown.

Cornell Cooperative Extension. 1996. *Northeast regional food guide*. http://www.human.cornell.edu/dns/extension/upload/Northeast-20Regional-20Food-20Guide.pdf (accessed October 7, 2013).

DEFRA (Department of Environment, Food, and Rural Affairs). 2010. *Food 2030*. London: Crown.

DEFRA. 2011. *Sustainable, secure, and healthy food supply evidence plan 2011/12*. London: Crown.

European Commission. 2011. *Roadmap to a resource efficient Europe*. COM 2011(571). http://ec.europa.eu/environment/resource_efficiency/pdf/com2011_571.pdf (accessed August 14, 2013).

European Commission. 2013. *Sustainable food.* http://ec.europa.eu/environment/eussd/food.htm (accessed October 8, 2013).

FAO (Food and Agriculture Organization). 1998. *Women: Users, preservers, and managers of agro-biodiversity*. Rome: FAO.

FAO. 2007. *The state of the world's animal genetic resources for food and agriculture*. Rome: FAO.

FAO. 2010. *Technical workshop. Biodiversity in sustainable diets*. Rome: FAO.

FoodDrinkEurope. 2012. *Environmental sustainability vision towards 2030*. Brussels, Belgium: FoodDrinkEurope.

Foresight. 2011. *The future of food and farming*. London: The Government Office of Science.

Freibauer, A., E. Mathijs, G. Brunori, Z. Damianova, E. Faroult, I. Girona, J. Gomis, L. O'Brien, and S. Treyer. 2011. *Sustainable food consumption and production in a resource-constrained world*. European Commission Standing Committee on Agricultural Research (SCAR) Report. Brussels, Belgium: European Commission.

GAO (U.S. Government Accountability Office). 1982. *Food, agriculture, and nutrition issues for planning.* CED-82-27. Washington, DC: GAO.

Gussow, J. D., and K. Clancy. 1986. Dietary guidelines for sustainability. *Journal of Nutrition Education and Behavior* 18(1):1-4.

Health Council of the Netherlands. 2011. *Guidelines for a healthy diet: The ecological perspective*. Publication No. 2011/08E. The Hague, The Netherlands: Health Council of the Netherlands.

Heederik, D., T. Sigsgaard, P. S. Thorne, J. N. Kline, R. Avery, J. H. Bonlokke, E. A. Chrischilles, J. A. Dosman, C. Duchaine, S. R. Kirkhorn, K. Kulhankova, and J. A. Merchant. 2007. Health effects of airborne exposures from concentrated animal feeding operations. *Environmental Health Perspectives* 115(2):298-302.

Hooda, P. S., A. C. Edwards, H. A. Anderson, and A. Miller. 2000. A review of water quality concerns in livestock farming areas. *Science of the Total Environment* 250(1-3):143-167.

Institution of Mechanical Engineers. 2013. *Global food: Waste not, want not*. London: Institution of Mechanical Engineers.

Lang, T., and D. Barling. 2012. Food security and food sustainability: Reformulating the debate. *Geographical Journal* 178(4):313-326.

Lang, T., and D. Barling. 2013. Nutrition and sustainability: An emerging food policy discourse. *Proceedings of the Nutrition Society* 72(1):1-12.

Lang, T., and G. Rayner. 2012. Ecological public health: The 21st century big idea? *British Medical Journal* 345:e546.

Livsmedelsverket (National Food Administration, Sweden). 2009. *The national food administration's environmentally effective food choices. Proposal notified to the EU*. http://www.slv.se/upload/dokument/miljo/environmentally_effective_food_choices_proposal_eu_2009.pdf (accessed August 14, 2013).

Mirabelli, M. C., S. Wing, S. W. Marshall, and T. C. Wilcosky. 2006. Asthma symptoms among adolescents who attend public schools that are located near confined swine feeding operations. *Pediatrics* 118(1):e66-e75.

Monteiro, C. A. 2009. Nutrition and health: The issue is not food, nor nutrients, so much as processing. *Public Health Nutrition* 12(5):729-731.

NRC (National Research Council). 2010. *Toward sustainable agricultural systems in the 21st century*. Washington, DC: The National Academies Press.

Oakdene Hollins Research and Consulting. 2011. *EU ecolabel for food and feed products—feasibility study* (ENV.C.1/ETU/2010/0025). A report for Environment Directorate-General and European Commission. Aylesbury, UK: Oakdene Hollins Research and Consulting.

Omenn, G. S., G. E. Goodman, M. D. Thornquist, J. Balmes, M. R. Cullen, A. Glass, J. P. Keogh, F. L. Meyskens, B. Valanis, J. H. Williams, S. Barnhart, and S. Hammar. 1996. Effects of a combination of beta carotene and vitamin A on lung cancer and cardiovascular disease. *New England Journal of Medicine* 334(18):1150-1155.

President's Council of Advisors on Science and Technology. 2012. *2012 report to the president on agricultural preparedness and the agriculture research enterprise*. Washington, DC: President's Council of Advisors on Science and Technology.

Schinasi, L., R. A. Horton, V. T. Guidry, S. Wing, S. W. Marshall, and K. B. Morland. 2011. Air pollution, lung function, and physical symptoms in communities near concentrated swine feeding operations. *Epidemiology* 22(2):208-215.

Scottish Government. 2011. *Towards healthier and more environmentally sustainable food and drink in Scotland: Background report on developing a draft framework for joining up decision making*. Edinburgh, Scotland: Scottish Government.

Smith, A. P., A. W. Western, and M. C. Hannah. 2013. Linking water quality trends with land use intensification in dairy farming catchments. *Journal of Hydrology* 476(7):1-12.

Sustain. 2013. *Labeling for sustainability*. http://www.sustainweb.org/labelling (accessed October 7, 2013).

Sustainable Development Commission. 2009. *Setting the table: Advice to government on priority elements of sustainable diets*. London: Sustainable Development Commission.

Sustainable Development Commission. 2011. *Looking back, looking forward: Sustainability and UK food policy 2000–2011*. London: Sustainable Development Commission.

Toccalino, P. L., and J. A. Hopple. 2010. *The quality of our nation's waters—quality of water from public-supply wells in the United States, 1993-2007—overview of major findings*. U.S. Geological Survey Circular 1346.

UK Government. 2008. *Climate change act 2008*. http://www.legislation.gov.uk/ukpga/2008/27/contents (accessed August 21, 2013).

USDA (U.S. Department of Agriculture). 2013. *Know your farmer know your food initiative*. http://www.usda.gov/wps/portal/usda/knowyourfarmer?navid=KNOWYOURFARMER (accessed October 18, 2013).

USDA/HHS (U.S. Department of Health and Human Services). 2010. *Dietary guidelines for Americans*. 7th Edition, Washington, DC: U.S. Government Printing Office.

USDHUD (U.S. Department of Housing and Urban Development). 2013. *Sustainable communities regional planning grants*. http://portal.hud.gov/hudportal/HUD?src=/program_offices/sustainable_housing_communities (accessed October 7, 2013).

USDOT (U.S. Department of Transportation). 2012. *Supporting sustainable rural communities*. http://www.fhwa.dot.gov/planning/publications/sustainable_rural_communities/page05.cfm (accessed October 7, 2013).

Viegas, S., V. M. Faisca, H. Dias, A. Clerigo, E. Carolino, and C. Viegas. 2013. Occupational exposure to poultry dust and effects on the respiratory system in workers. *Journal of Toxicology and Environmental Health Part A* 76(4-5):230-239.

Welsh, S., C. David, and A. Shaw. 1992. Development of the food guide pyramid. *Nutrition Today* 27(6):12-23.

Which? 2013. *The future of food. Giving consumers a say.* Consumer report, April 2013. London: Which?

# 6

# Moving Forward

Although much of the discussion about moving forward revolved around policy, one of the most important points in the sustainable diet debate, in Derek Yach's opinion (from the Vitality Group®), is "the reality that none of the changes happen unless individuals at the point of purchase make a decision that can in fact have a big impact on their lives and their health and on the environment." This raises the question: how can people at the point of purchase be coaxed into making decisions that support sustainable diets? This chapter begins with a summary of George Loewenstein's (from Carnegie Mellon University and University of Pennsylvania) exploration of this question. Loewenstein discussed how behavioral economics can contribute to a greater understanding of the food environment and the choices that consumers make and how that understanding is providing policy makers with new approaches to managing the obesity epidemic. He discussed a variety of approaches to improving diet inspired by behavioral economics that have been successful to varying degrees, but concluded by expressing concern that many of the interventions that could be most beneficial, like taxing unhealthy foods, are unlikely to be implemented. Instead, he fears that "easier" behavioral economics solutions, which will have only a limited aggregate impact will substitute for real action.

The remainder of this chapter summarizes reflections by the workshop's organizing committee chair, Erik Olson, moderator Derek Yach, and invited discussant Lisa Eakman (from The Chicago Council on Global Affairs) on major themes of the workshop presentations and discussions.

To reiterate, the goal of the workshop was not to reach consensus on

any issues or make any recommendations for future action. As is true of this entire workshop summary, any conclusions or suggestions for action put forth this chapter reflect the opinions of individual workshop participants.

**Key Themes of This Chapter[a]**

- Behavioral economics provides a helpful framework for considering ways to increase the human health and environmental impact of consumer choice at the point of purchase. (Loewenstein)
- A shared vision between the traditionally siloed nutrition and environmental resource research communities appears to be emerging around the notion of a sustainable diet. (Olson)
- Plant-based protein sources are worth considering as an alternative to animal-based protein sources as a way to improve human, environmental, and economic health. (Eakman, Yach)
- There are many opportunities for the public sector in the United States to become more active in sustainable diet policy development and research. (Eakman, Yach)

[a] Key themes identified during discussions, presenter(s) attributed to statement indicated by parenthesis "( )."

## BEHAVIORAL ECONOMICS: IMPLICATIONS FOR THE FOOD ENVIRONMENT AND CHOICES[1]

While in town for a meeting in Orlando, Florida, Loewenstein took a jog and rewarded himself afterward with an ice cream. As he was walking into the ice cream store, he notices a couple exiting with monstrously large ice cream sundaes with whipped cream and cherries. He looked at the couple and thought, "These are not people who should be eating these large ice cream sundaes." When he saw the menu board, he understood why they had probably chosen the large-sized option: $4.29 for a small cone, $5.29 for a regular cone, $6.29 for a large cone, and $6.99 for a large sundae. "If you like getting a bargain," Loewenstein said, "you're going to end up getting the large sundae." Lower-income consumers, in his opinion, will probably be even more likely to get the large sundae because of their greater sensitivity to "getting a good deal." That is behavioral economics: people like good deals. More generally, behavioral economics is the application

[1] This section summarizes information presented by George Loewenstein, Ph.D., Carnegie Mellon University, Pittsburgh, Pennsylvania.

of insights and research findings from psychology, economics, and related fields. Loewenstein explored the implications of behavioral economics for the food environment and the choices consumers make, with a focus on obesity.

### What Is Responsible for the Obesity Epidemic?

The obesity epidemic is a new epidemic. "For a long time, we were a reasonably thin nation," Loewenstein said. But in the 1980s, obesity rates suddenly accelerated (Finkelstein et al., 2005). Why? One of the reasons the obesity epidemic is so difficult to address is its many causes. In a speech at the Grocery Manufacturers Association Conference in March 2010, First Lady Michelle Obama discussed these multiple causes.

The first is sedentary lifestyle. As Ms. Obama said, "Back when many of us were growing up, we tended to be able to lead lives that kept us at a pretty healthy weight. Most of us walked to and from school every day, and then we ran around all day at recess … and for hours after school before dinner.… Our kids today lead a very different kind of life. Those walks to and from school have been replaced by car and bus rides" (Obama, 2010). According to Loewenstein, the evidence supports Ms. Obama's claim. From 1950 to 2000, average daily television viewing increased from less than 5 hours per day to more than 7 hours per day (Brownson et al., 2005), and today recreational Internet use is close to equaling television viewing. Lack of physical recreation is much more severe for minorities, which probably explains, in part, why minorities have greater health problems (CDC, 2004). These increases in sedentary behavior have serious consequences for population health. Hu et al. (2003) showed that, for women, every 2-hour-per-day increment in television viewing is associated with a 23 percent increase in obesity and a 14 percent increase in risk of diabetes. On the other hand, 1 hour per day of brisk walking is associated with a 24 percent reduction in obesity and a 34 percent reduction in risk of diabetes.

A second contributing factor to the obesity epidemic is portion size. In her 2010 speech, Ms. Obama said, "Portion sizes have exploded. Food portions are two to five times bigger than they used to be. And beverage portions have grown as well" (Obama, 2010). Loewenstein explained that 20 years ago, a typical bagel measured 3 inches in diameter and contained 140 calories. Today, a typical bagel measures 6 inches in diameter and contains 350 calories. Twenty years ago, a typical cheeseburger contained 333 calories, compared to 590 today. Twenty years ago, a typical serving of french fries weighed 2.4 ounces and contained 210 calories, compared to 6.9 ounces and 610 calories today (personal communication, The NPD

Group, September 6, 2013[2]; see also Nielsen and Popkin, 2003; Young and Nestle, 2002).

Snacking also feeds into the obesity epidemic. Ms. Obama said, "Today, snacking between meals has become more the norm rather than the exception. While kids 30 years ago ate just one snack a day, we're now trending toward three—so our kids are taking in an additional 200 calories a day just from snacks alone. And one in five school-age kids has up to six snacks a day" (Obama, 2010). Loewenstein commented on how his own daughter comes home and wants to take a walk. But where does she walk? She walks to the convenience store and comes home with a bag of chips. "As a parent," he said, "it's incredibly difficult to regulate that even if you are conscious of it." One study in the *Journal of Economic Perspectives* argued that higher snack calories are responsible for the entire rise in energy intake among females between 1977 and 1978 and 1994 and 1996 and for 90 percent of the increase among males during that same time period (Cutler et al., 2003). Nielsen and Popkin (2003) found that 76 percent of the growth in calories between the same two time periods resulted from increased snacking.

A fourth contributing factor is time pressure. Ms. Obama said, "It wasn't long ago that I was a working mom dashing from meetings and phone calls, ballet and soccer and whatever else. I felt like it was a miracle just to get through the day and get everybody where they were supposed to be. So the last thing I had time to do was to stand in a grocery store aisle squinting at ingredients that I couldn't pronounce to figure out whether something was healthy or not" (Obama, 2010). Families are much more pressed for time today. Families today have what Loewenstein described as "an incredible shortage of time," which discourages cooking and puts a premium on processed foods.

In Loewenstein's opinion, prices are also important. The price of food relative to other goods rose about 1 percent during the period when obesity rates were constant (1960s-1970s) (Finkelstein et al., 2005). However, between 1980 and 2000—when the obesity epidemic went into full swing—the relative price of food fell about 14 percent, with the relative prices of processed foods dropping disproportionately. In fact, almost the entire decrease in food prices resulted from a decrease in the price of processed foods; fresh foods actually increased in price during that period (Finkelstein et al., 2005). According to Loewenstein, several economic analyses (e.g., Cutler et al., 2003; Finkelstein et al., 2005) attribute most of the increase in obesity to increases in calorie intake that resulted, in turn, from changes

[2] National Eating Trends (NET), Spring 1995 Release, The NPD Group. NET is a proprietary, syndicated data base made available courtesy of The NPD Group.

in relative prices, including those resulting from the reduced time-cost of processed foods for time-pressed families.

Finally, Loewenstein observed that changing social norms are also contributing to the obesity epidemic. When behavior changes, social norms change, and those new social norms, in turn, affect behavior. It becomes very difficult to break the cycle. As an example of changing social norms, according to consumer surveys conducted by The NPD Group,[3] in 1985, 55 percent of homemakers surveyed completely agreed with the statement, "People who are thin look a lot more attractive." In 2009 only 23 percent of homemakers surveyed completely agreed. As another example of changing social norms, other NPD Group data show that the percent of adults on any diet has been decreasing over time for both men and women. In 1991, more than 35 percent of women and more than 25 percent of men surveyed reported being on a diet. In 2009, 25 percent of women and fewer than 20 percent of men surveyed reported being on a diet.

### What Can Behavioral Economics Contribute to the Discussion on Obesity?

Behavioral economics can lead to a better understanding of the underlying psychological mechanisms that explain many of these patterns. In addition to the desire to get a good deal, other behavioral mechanisms to consider include present-biased preferences, which is the human tendency to put a huge weight on immediate costs and benefits and to "discount" delayed costs and benefits; and the "drop-in-the-bucket effect," which is the idea that a "drop" of food, such as a single potato chip, does not have any perceptible effect on weight; and lack of knowledge (see Rick and Loewenstein, 2008).

In addition to leading to a better understanding of the underlying psychology of many of the behaviors that contribute to obesity, behavioral economics can also help to develop new approaches to policy. Loewenstein highlighted three policy approaches informed by behavioral economics: (1) better ways to provide information, such that people will understand and respond to the information; (2) nudges, or "choice architecture," which involve changing the environment to encourage people to eat better or less food (Thaler and Sunstein, 2008); and (3) better ways to deliver incentives.

[3] National Eating Trends (NET), Spring 1995 Release, The NPD Group. Data from NET, a proprietary, syndicated database made available courtesy of The NPD Group (personal communication, September 6, 2013).

*Better Ways to Provide Information*

In 1994, the Nutrition Labeling and Education Act (NLEA) led to ubiquitous food labeling on packaged foods, but most research has shown that the labels have had very little impact on people's diets. Using consumer survey data provided by The NPD Group, Loewenstein and colleague Mark Patterson have been tracking various attitudinal, behavior, and health variables over time. Loewenstein described some preliminary findings of this study. Introduction of the labels had an impact on one survey item: people's responses to the statement "I check labels." People reported checking labels more often after the labels were introduced in 1994. Loewenstein remarked that given that labeling was much more limited prior to the NLEA, if the survey did not show this impact, we would have little trust in the data. However, it was pointed out that the research shows that the NLEA had few other significant effects on attitudes or behaviors. Loewenstein points out that research also supports the conclusion that the NLEA did not lead to a reduction in fat or cholesterol, two attributes listed prominently on the new labels. For example, Variyam (2007) reported that the labels led to increased consumption of iron and fiber, but had very little impact on total fat, saturated fat, or cholesterol. Moreover, Variyam's research suggests that the NLEA had very little impact on obesity, except among white females who used the labels. In Loewenstein's opinion decreased obesity among women who use the labels is not very informative, as those women might very well have lost the weight even without the labels.

Calorie posting was supposed to be introduced into New York City (NYC) in 2007. But the food industry fought it, so it was not introduced until 2008. "I think if the food industry had realized how little the impact was," Loewenstein said, "they wouldn't have bothered to fight it." The NYC calorie posting policy was motivated by what Loewenstein described as a "flawed" study: Bassett et al. (2008) found that people who reported looking at calorie information posted in Subway restaurants ate 50 fewer calories on average compared to people who did not look at calorie information. Lowenstein again pointed out that those who look at nutritional information are likely to be different from those who do not, including in regard to their motivation to lose weight. Subsequent research has confirmed suspicions that calorie posting has little if any impact (Dumanovsky et al., 2011; Elbel et al., 2009, 2011; Finkelstein et al., 2011). Elbel et al. (2009), for example, reported that people consumed 825 calories on average at 14 quick-service NYC restaurants before labeling, compared to 846 after labeling.

Loewenstein wondered if labeling could be effective if it were implemented in a more innovative fashion. For example, would traffic light labeling be more effective? The evidence is mixed. Levy et al. (2012) showed

a reduction in purchase of red-light items and an increase in purchase of green-light items, especially beverages, in a hospital cafeteria in Boston. Ellison et al. (2013) showed a reduction in calorie intake among patrons at a sit-down restaurant. But Sacks et al. (2009) showed no effects of traffic light labeling on increased purchases of healthy "ready meals" and sandwiches in the United Kingdom. Furthermore, Sacks et al. (2011) showed no effects from traffic light labels on the relative healthiness of products purchased online in Australia.

Loewenstein and colleagues have done some preliminary research on traffic light labeling. Loewenstein found the effects from two of his studies "surprising." In one of the studies, he and his colleagues gave some people entering a McDonald's restaurant a menu with traffic light labels, while others received labels with calorie information or no nutritional information. People using the traffic light menus ordered more green items, but they ordered so many green items that they ended up ordering more total calories. Also, people ordering yellow items tended to order the most highly caloric yellow items, and the same was true for the red items. The effects are "perverse," Loewenstein said. "It's really a cautionary note. Traffic light labeling seems like a no-brainer, but you can't assume that things that are no-brainers will work. You have to test things (obvious policies) before you roll them out."

Based on the notion that posting calorie information does not work because people do not know how to interpret and use the information, NYC regulators in launched an educational campaign publicizing daily calorie recommendations. In the second study Loewenstein found "surprising" he and his colleagues assessed whether providing people with calorie recommendations makes a difference (Downs et al., 2013). The researchers stood outside two McDonald's restaurants in NYC, both before and after calorie posting was introduced in 2008, and gave people either a "day" recommendation (the number of calories they should eat per day), a "meal" recommendation (the number of calories they should eat per meal), or no recommendation. The researchers expected the meal recommendation to be the most effective in terms of reducing calorie intake; consumers would be handed information on how many calories they should eat and then, inside the McDonald's, they would see the posted calorie information and make a decision. Unexpectedly, the researchers found no effect from providing a calorie reference either before or after the calorie posting went into effect. In fact, the researchers observed what Loewenstein described as some "strange" effects, with calorie posting actually leading to an increased calorie intake among people who were overweight or obese. That finding might be explained by the way some people use labels; rather than using labels to limit calories, some people may use them to maximize calories per dollar.

*Nudges or "Choice Architecture"*

Behavioral economists have analyzed different choice architecture approaches. Schwartz et al. (2012) reported that 14 to 33 percent of customers at Chinese fast-food restaurants voluntarily accepted a half-portion of a steamed or fried rice side dish and consumed 100 fewer calories as a result. Loewenstein opined that many people want smaller portion sizes, but they are not provided with that option. Hanks et al. (2012) found that displaying healthier foods in a cafeteria lunch line led to an increase in healthy food consumption (from 33 to 36 percent of total consumption). Just and Wansink (2009) found that giving children a choice between carrots and celery increased both sales and consumption of carrots compared to providing just carrots. "People like choices," Loewenstein said. Just and Wansink (2009) also found that moving the salad bar to a more central location led to a sustained increase in salad sales. By contrast, they found that trayless cafeterias, where children take only a plate and therefore cannot load everything onto a tray, led to 26 percent fewer salads taken but only 8 percent fewer bowls of ice cream; and those trayless cafeterias also produce more waste.

*Incentives*

Traditional economics is based on the assumption that incentives matter. But behavioral economics research shows that, in fact, how incentives are delivered also matters. The same incentives can be extraordinarily effective when delivered in some ways, but completely ineffective when delivered in other ways. Loewenstein mentioned a study that he and his colleagues conducted in collaboration with a company in Pittsburgh that wanted to increase its Health Risk Assessment completion rates (Haisley et al., 2012). The company was already paying employees $25 for completing the assessment. Loewenstein's team either increased the payment to $50 or increased it to $50 with a behavioral economics incentive and found that simply doubling the payment had no effect but that doubling the payment and adding a behavioral economics incentive led to a substantially increased completion rate.

In what Loewenstein described as a "very encouraging" study of 15 elementary school cafeterias, Just and Price (2011) introduced various incentives to eat fruits and veggies. Children received either 25 cents immediately, 5 cents immediately, a prize immediately (a raffle ticket), money at the end of the month, or a prize at the end of the month. All of the incentives were effective. Thus, for even a small amount of money, children can be incentivized to eat more fruits and vegetables. Loewenstein remarked that, although he considered the results impressive, he has some discomfort with

the approach. He said, "I'm not convinced that the right way to get kids to eat healthy foods is to pay them.… My guess is that it would be a lot better to try to make healthy foods more attractive to them."

Loewenstein himself has been testing various behavioral economics incentives to encourage weight loss. In a randomized controlled trial on financial incentives and weight loss, he and colleagues tested two incentive conditions: lottery and deposit contract (Volpp et al., 2008). All of the study participants were obese veterans, with body mass indexes between 30 and 40. At the beginning of the study, all subjects were given a 1-hour consultation with a dietician, a scale to take home, and the goal of losing 4 pounds per month for 4 months. In both conditions, subjects phoned in their daily weight and were sent daily text messages if they were achieving their goal to let them know how much they won that day in incentives.

Subjects in the lottery condition were enrolled in a daily lottery, with a 1 in 5 chance of winning $5 and a 1 in 100 chance of winning $100. They were entered into the lottery every day, but were paid only if they called in and their weight was below their target. So, even if they won, they would not get paid if they called in and were above their target or if they did not call in. The lottery condition was designed to play on people's love of lotteries. According to Loewenstein, more than half of the U.S. population plays the lottery, with lower-income people spending a disproportionate amount of their income on it.

Loewenstein summarized the study methodology. Subjects in the deposit contract condition were allowed to put money down at the beginning of each month, from 1¢ to $3 per day. For every day that they met their weight loss goal, they kept their money and received a one-to-one match. So, if they put $3 down, they got their $3 back and received an additional $3 for staying below the line. If they went above the line, they lost their $3. The deposit contract condition played on loss aversion. People hate losing their own money, Lowenstein opinioned. He observed that the study also played on over-optimism. People are generally overly optimistic about things, especially about their likelihood of exerting self-control in the future, including their ability to lose weight. The intention was to create a "self-fulfilling optimism," with subjects initially driven by optimism to put a lot of money down and then driven by loss aversion to lose weight in order to keep their money.

Subjects in both groups were asked to return to the lab at the end of each month for a weigh-in. They received their money at the end of the month if the study scale corroborated their self-reported weights.

The incentives proved to be very successful, with subjects in the two incentive conditions losing 13 and 14 pounds respectively during the 4-month study period. Interestingly, in Loewenstein's opinion, successful weight loss was correlated with exercise, not diet, a finding he has observed in a num-

ber of other studies as well. An unfortunate result of the study, however, was that, by the 7-month follow-up, most participants had regained most of the weight they had lost.

Loewenstein and colleagues conducted a second study to see if a longer incentive period 8 months instead of 4 months, would help participants develop a habit that would lead to extended weight loss (John et al., 2011). But although participants were able to keep weight off for 8 months while the incentives were in place, at the 17-month follow-up, most participants had regained their lost weight. Loewenstein and colleagues are continuing to study different type of incentives, for example social incentives, to help people not just lose weight but also keep the weight off.

### What Would It Take to Reverse the Obesity Epidemic?

Piecemeal actions are not a solution. As First Lady Obama said to the Grocery Manufacturers Association, "We need you not to just tweak around the edges but entirely rethink the products you are offering, the information that you provide about these products, and how you market those products to our children" (Obama, 2010). Loewenstein cautioned, however, that the food industry answers to its shareholders, not its customers. Neither the food industry nor the schools, movie theaters, or other stakeholders directly bear the huge costs to society of the health consequences of unhealthy food. Real change is going to require realigning incentives by taxing the production and sale of unhealthy foods, subsidizing the production and sale of healthy foods, mandating proportionate pricing of junk food (e.g., ending super-sizing), and providing incentives to improve patrons' diets. Realigning incentives will drive the food industry to devote its creativity to selling healthy foods and will encourage consumers, including low-income parents, to buy healthy foods because they are cheaper.

Loewenstein expressed concern that many interventions that could be most beneficial, such as taxing unhealthy foods, are unlikely to be implemented. Instead he is worried that some of the behavioral economics "easy solutions" will substitute for the steps that need to be taken to realign incentives. Not only might those "easy solutions" not add up to much, but also, as in the case of traffic light labels, they might have unintended consequences. He ended by noting that mid-level solutions, such as "Meatless Weekdays" (eating meat only on weekends) or spending more money on school lunches, might be the best approach.

## REFLECTIONS OF DEREK YACH

At several different times during the workshop discussion, Yach offered some reflections on key topics. This section summarizes his remarks.

### Reducing Obesity: Doable Steps

In Yach's opinion, the size of the energy gap that needs to be reduced in order to re-establish the population's energy balance "is not huge." Although calorie shifts per person per day would be substantially higher for individuals with high body mass indexes, shifts could be accomplished at a population level by applying some of the incentives mentioned by Loewenstein. Yach noted that interventions like "Meatless Mondays" have already been proposed and emphasized simple incentives can be very powerful. He recalled how pharmaceutical companies used to deliver pizzas to hospitals in the evening, which had a favorable impact on profitability. Even though the actual monetary value of the pizzas was small, the deliveries were so perfectly timed that physicians on the floor were willing to accept them and to support the companies that provided the pizzas. The cozy relationships that were established translated into billions of dollars of profitability for the pharmaceutical companies. Yach described that particular example as one with a "perverse" long-term effect, but other incentives could be aligned with common goals around sustainable diets. He encouraged full engagement of industry and government leaders and emphasized the role of government in setting broad policy frameworks and removing structural impediments that are either wasteful or driving systems in perverse ways.

### The Need for a Broader Coalition

Similar debates on the human health and environmental synergies and trade-offs associated with food have been under way for some time now in the World Economic Forum's sustainable agriculture groups. Yach observed that the broader investor community, including insurers, is taking the issue very seriously because of the long-term risks of climate change, mass famine, and hunger and encouraged the engagement of corporations that are not directly linked to particular products. He called for a broader coalition to move forward. By reaching out, he said, "we would find a lot more synergy than we suspect."

### Think Globally

Yach also called for a global perspective. No single country can do it alone. He expressed concern that local initiatives will not solve long-term needs, in particular, long-term water needs. He said that he gets "terribly fearful" when he hears that Sweden is beginning to develop its own self-sufficiency food program. "That would be a disaster for the planet," he said. "It would be the height of selfishness.… Sweden is blessed with some of the best water resources now and for the next 50 years. Their responsibil-

ity is not just to become sufficient, but to become a net exporter for food that is going to be required around the world as the water crisis gets worse [in many developing countries in Asia, Africa, and the Middle East]." (See the summary in Chapter 5 of Tim Lang's discussion on various efforts in the European Union to develop sustainable diet public policy.)

### Non-Meat Sources of Protein

Yach remarked that, although he found the workshop discussions on fish important, there was very little mention during the workshop of aquatic plants. He viewed aquatic plants as a serious potential source of long-term food and pointed to work under way in Saudi Arabia, in its Red Sea initiatives and partnerships with Eritrea and elsewhere, as an example of efforts to understand that potential. He also wondered whether there might be a future role for laboratory-generated amino acid that could be supplied in the "unthinkable" event that the human population runs out of enough land, water, and energy for animal protein production. He mentioned that start-ups in Boston were already exploring this possibility. (See the summaries in Chapter 2 and 4, respectively, of Cynthia Jones's and Barton Seaver's presentations on fish.)

### Economic Incentives to Move from a Quantity-Based to Quality-Based Diet

In Yach's opinion, tackling obesity in the long term will require thinking about financing as well as messaging and labeling. He asked what the right economic arguments and incentives would be to move from a quantity-based diet to a quality-based diet. Yach said that the clothes detergent business serves as an example. Tide has cornered a huge proportion of the detergent market with a product that uses less stuff; the entire detergent industry has followed suit by offering tiny packets of detergent that consumers can simply throw into their dishwashers. As a result, less detergent is being used and less environmental damage is being done. Yach highlighted the Tide story as an example of when the choice to sell less stuff can actually be tremendously profitable. He asked what the equivalent would be for obesity.

A workshop participant responded that the key is protein, because protein regulates appetite. Rather than talking about calories, the participant encouraged a greater focus on protein requirements. She opined that it is likely that people who eat cheap foods are eating a lot more of those foods because they are trying to acquire the protein that they need, but they are not getting it. Although the highest-quality sources of essential amino acids are animal foods, these sources are also the most expensive and most environmentally impactful.

When Yach asked the participant whether laboratory-generated amino acids might provide a solution, the participant suggested instead considering ways to incorporate more plant-based protein into the diet. She mentioned the "thriving" aquatic plant-based food industry in Southeast Asia and the many ethnic stores across North America selling those aquatic plant products. The participant implied that it would also be worth considering the many fermented functional beverages being used in traditional cultures worldwide. Many of those beverages are combinations of different plants that have tremendous potential to be incorporated into a healthy U.S. diet.

### What Is Food in the Public Policy Forum?

What should be classified as food in the public policy forum? Yach mentioned the many debates about whether coffee, tea, cocoa, and certain other products should be classified as food. The public sector and many development agencies are investing significantly in coffee, tea, and cocoa production as if those products are equivalent to nutritionally rich foods (e.g., federal dollars are being used for U.S. aid programs to support cocoa farmers in other parts of the world). Meanwhile, there has been very little discussion of palm oil, which Yach described as the "nexus of bads." Palm oil production has enormously destructive effects on the environment. Yach expressed skepticism about claims that palm oil production is sustainable. He stated that the same companies and groups supporting sustainable palm oil production in parts of Asia are rapidly expanding and destroying rainforests across West Africa. Not only does palm oil have destructive effects on the environment, it also impacts human health. Specifically, it has a long-term impact on cardiovascular disease. In Yach's opinion, palm oil should be reduced and ideally removed from the human diet. The Institute of Medicine, the World Health Organization, and others have made it very clear over the years that there are a range of healthier oils, although there is debate about the environmental consequences of those oils as well. Yet, again, there has been very little discussion of oil consumption in the public policy forum. So what constitutes food in the public policy forum?

## REFLECTIONS OF ERIK OLSON[4]

The challenge at hand is that there are both nutritional issues that need to be addressed, including malnutrition and obesity at both the domestic

[4] Workshop organizing committee chair Erik D. Olson, J.D., identified several common themes among the presentations and discussions that took place on the first day of the workshop, that is, the information presented in Chapters 1-4 of this report. This section summarizes his remarks. They should not be interpreted to be the views of his employer or any other person.

and global levels, and some very real environmental constraints. Olson was inspired by the seeming convergence between the nutrition and environment "silos" on several issues and the shared vision that is emerging. He identified five components of that shared vision:

(1) *Healthy food*. Healthy food is needed to supply a U.S. Department of Agriculture MyPlate diet and to ensure that omega-3 fatty acid and other micronutrient needs are being met.
(2) *Economic return for U.S. farmers*. Olson referred to keynote speaker Kathleen Merrigan's "eloquent plea" to consider the economic needs of struggling small and medium-sized domestic farmers. (See Chapter 1 for a summary of Merrigan's keynote presentation.)
(3) *Access to healthy foods, especially for lower income consumers*. Olson noted several ways to encourage access encouraged by workshop participants, including through existing programs (e.g., Supplemental Nutrition Assistance Program [SNAP] and the Special Supplemental Nutrition Program for Women, Infants, and Children) and via new incentives that could be created.
(4) *Environmentally sustainable food supply*. Olson called for clear agreement around how to move forward with respect to building an environmentally stable food supply, not just with respect to climate change and greenhouse gas emissions but also with respect to land protection and resource overuse. Olson noted that aquaculture might help solve overfishing problems and that improved approaches to domestic animal agricultural production might help to increase production efficiencies. In addition, he noted that different types of meat have enormously different efficiencies and profoundly different impacts on the environment. "So, you can have meat in your diet without necessarily having the same impact, depending on what your selections are," he said. He also noted the clear need to embed crop biodiversity in the vision and referred to Barbara Burlingame's descriptions of the varying nutritional values among different varieties of the same plant species. (See Chapter 2 for a summary of Burlingame's presentation.)
(5) *Foods that people actually eat*. What can be done to ensure that people are actually eating and not throwing away healthy food? Olson noted that several speakers had suggested ways to educate and encourage people to try new foods. For example, Kathleen Merrigan (see Chapter 1) discussed the Farm to School and SNAP Education programs, and Barton Seaver (see Chapter 4) described a program that introduced into the diet new types of fish that

consumers otherwise might not eat. (See Chapters 1 and 4 for a summary of Merrigan's and Seaver's presentations, respectively.)

This vision and its five components were supported by some interesting undergirding themes, in Olson's view. In particular, he was struck by the notion that some situations are characterized by what Christian Peters (see Chapter 3) described as ethical synergy, where the opportunity exists to improve both improve human and environmental impact. Examples are eating more legumes and eating less sugar. But other situations create ethical dilemmas. Examples are the recommendations put forth by some nutritionists to eat more fish and to increase lean meat consumption. Realizing the shared vision will require answering a key question—how can those ethical dilemma recommendations be managed given the environmental challenges associated with them?

## LISA EAKMAN'S TAKE-HOME MESSAGES[5]

On the topics of human and environmental synergies and trade-offs, methods for quantifying those synergies and trade-offs, and the economic context of those synergies and trade-offs (information summarized in Chapters 1-4 of this report), Eakman identified several take-home messages:

- *There is growing evidence of the nexus between the nutrition and environmental sectors*. Eakman predicted that the nexus will become an increasingly important area of study over time. The demand for food is expected to grow by 60 percent by 2050 (Alexandratos and Bruinsma, 2012). Yet, already almost 870 million people worldwide are hungry (FAO, 2013). Not only are undernourishment rates expected to increase, so too are obesity rates as low- and middle-income economies go through nutrition transitions.
- *Many panelists placed a high value on policy-relevant data*. As just one example, Martin Heller discussed gaps in data that need to be filled in order to use life-cycle analysis as a policy tool. Policy-relevant data will enable a more evidence-based discussion on the optimal way forward for human health and the environment. (See Chapter 3 for a summary of Heller's presentation.)
- *Diet has an impact on the environment*. There was a great deal of discussion on meat, beef in particular, and its impacts on land, water, and greenhouse gas emissions. Eakman cited what she referred to as

[5] Twice during the workshop, Lisa Eakman, M.A., The Chicago Council on Global Affairs, Illinois, was invited to offer her reflections on the overall workshop discussion. This section summarizes her remarks.

Emily Cassidy's "powerful" statistics, including the finding that 36 percent of all calories produced by agriculture are for animal feed and 44 percent of land used for agriculture is used for meat production. She reiterated, however, Frank Mitloehner's concern that the environmental impacts of food production, especially those associated with livestock, vary depending on geography. Compared to its impact in the United States, livestock production has much greater environmental consequences in other parts of the world, especially in middle- and low-income countries. (See Chapters 2 and 3, respectively, for summaries of and references supporting Mitloehner's and Cassidy's presentations.)

- *The link between nutrition and the environment is bidirectional.* Although most presenters focused on the impact that diet has on the environment, early on during the workshop Burlingame made a strong case that environmental biodiversity plays an important role in nutrition, with different varieties of crops carrying different nutritional values. (See Chapter 2 for a summary of Burlingame's presentation.)
- *Many presenters and members of the audience touched on the impact of waste on the environment.* Globally, as much as 30 to 40 percent of food is wasted. Waste could be used in a much more sustainable manner.
- *Shifting to the U.S. recommended dietary guidelines will have environmental impacts.* Several speakers described the impacts. Cynthia Jones elaborated on the reality that there are literally not enough fish in the sea for people to consume the recommended portion of protein. This is true of both domestic and global fish consumption. Christian Peters described how meeting the U.S. recommended fruit and vegetable guidelines would require roughly doubling the amount of land currently being used to produce fruits and vegetables. Still, given how little land is currently used for that purpose, the impact would be minimal. Cassidy described how a decrease in U.S. meat consumption would yield significant savings in land and water and greenhouse gas emissions. Although most of the workshop discussion focused on the U.S. agricultural production system, Eakman suggested that it would be useful to consider the relationship between the U.S. system and the international agricultural production system. In addition, Eakman reiterated the need for more policy-relevant data to enable more evidence-based conversations. (See Chapters 2 and 3 for summaries of Jones's, Peters's, and Cassidy's presentations.)
- *There was much discussion of decision making about what foods are produced and why consumers buy what they buy.* Richard Volpe

reported that even though commodity prices have risen, food prices have remained relatively stable. But some food groups, such as fruits, vegetables, and eggs, are more volatile than others. Seaver argued that consumer familiarity with a product, largely as a result of marketing, may limit food choices. (See Chapters 3 and 4, respectively, for summaries of Seaver's and Volpe's presentations.)

- *There was a great deal of discussion around different types of policy approaches.* Keynote speaker Kathleen Merrigan argued that connecting communities to food producers through farmers' markets, school gardening programs, and other avenues could increase consumption of fruits and vegetables. She also argued for the use of creative solutions, such as mobile food trucks, to increase the purchase of fruits and vegetables in food deserts. Cassidy discussed work under way in South Africa, where discounts on healthy food have been shown to incentivize people to increase consumption of fruits and vegetables and decrease consumption of less-nutritious foods. Eakman mentioned some concern about the practicality in the United States of taxing less healthful foods and recalled Parke Wilde's discussion of policy considerations that should be made when thinking about how to incentivize the purchase of healthful food or when thinking about the impact of food on the environment. Eakman encouraged more consideration and discussion of non-policy solutions to solving problems in the growing nexus between human health and the environment. (See Chapters 1, 3, and 4, respectively, for summaries of Merrigan's, Cassidy's, and Wilde's presentations.)

## Moving Forward

At the conclusion of the workshop, Eakman identified four major take-home messages from the Day Two workshop discussion on available options and approaches for developing a sustainable U.S. diet (i.e., information presented and discussed on Day Two of the workshop and summarized in Chapter 5 and in this chapter):

(1) *Further research on links between nutrition guidelines and environmental constraints must include social and economic dimensions.* The nutrition guidelines–environment relationship is complicated and complex and cannot be examined without also considering those other dimensions.
(2) *Incentives to spur behavior change should be tested before being implemented.* Eakman encouraged holistic thinking about the dif-

ferent types of prompts being considered and their accompanying implications. Will their combined effect be more than the sum of the parts? Or will the sum of the parts not be great enough to get us to where we need to be?

(3) *The public sector in the United States could play a significant role*. However, public-sector action needs to be more collaborative across agencies, encompass a wider set of perspectives, and consider the full range of issues. Eakman referred to Katherine Clancy's call for a greater consciousness about the priority of sustainable diets being a legitimate policy issue and Tim Lang's suggestion to be more intentional about incorporating other perspectives when developing dietary guidelines.

Given that consumers are not using the information being provided to them, whether it be through labeling or other means, Eakman suggested that there might be new ways to present information so that people are better incentivized to change their behavior. In addition, she suggested that there might be some ways to incentivize farmers to better align their production with the goals of sustainable eating, for example through the Conservation Stewardship Program.

The public sector could also help to fill research gaps. Not only is there a need for more U.S. investment in agricultural and food research, there is also a need for a different kind of research than what has been done in the past. Specifically, Eakman echoed other workshop participants' calls for more multidisciplinary research. Along with the U.S. Department of Agriculture, Eakman suggested that the National Science Foundation, the National Institutes of Health, the Department of Energy, and the Environmental Protection Agency become involved. By engaging all of these agencies, the health–environment nexus could be examined through the lens of economic and social constraints as well.

(4) *Although "we absolutely need this public voice," Eakman said, other nongovernmental actors can help to engender change*. Eakman referred to Lang's suggestion that the United Nations could play a role by issuing a joint World Health Organization/Food and Agriculture Organization/United Nations Environmental Programme report or by establishing an intergovernmental panel on sustainable diets with the same stature as the Intergovernmental Panel on Climate Change. Lang also suggested establishing watchdog groups to monitor the implementation and impact of the dietary guidelines and serve as an information resource for policy makers. Private companies could also take action. For example, Derek Yach mentioned The World Economic Forum's New Vision

for Agriculture group—there might be an opportunity to leverage that group. Finally, given the economic impact of sustainability, these may be issues to address in G8 or G20 forums.

## REFERENCES

Alexandratos, N., and J. Bruinsma. 2012. *World agriculture towards 2030/2050: The 2012 revision*. Rome: Food and Agriculture Organization.

Bassett, M. T., T. Dumanovsky, C. Huang, L. D. Silver, C. Young, C. Nonas, T. D. Matte, S. Chideya, and T. R. Frieden. 2008. Purchasing behavior and calorie information at fast-food chains in New York City, 2007. *American Journal of Public Health* 98(80): 1457-1459.

Brownson, R. C., T. K. Boehmer, and D. A. Luke. 2005. Declining rates of physical activity in the United States: What are the contributors? *Annual Review of Public Health* 26:421-443.

CDC (U.S. Centers for Disease Control and Prevention). 2004. Health disparities experienced by racial/ethnic minority populations. *Morbidity and Mortality Weekly Reports* 53(33):755-756.

Cutler, D. M., E. L. Glaeser, and J. M. Shapiro. 2003. Why have Americans become more obese? *Journal of Economic Perspectives* 17(3):93-118.

Downs, J. S., J. Wisdom, B. Wansink, and G. Loewenstein. 2013. Supplementing menu labeling with calorie recommendations to test for facilitation effects. *American Journal of Public Health* 103(9):1604-1609.

Dumanovsky, T., C. Y. Huang, C. A. Nonas, T. D. Matte, M. T. Bassett, and L. D. Silver. 2011. Changes in energy content of lunchtime purchases from fast food restaurants after introduction of calorie labelling: Cross sectional customer surveys. *British Medical Journal* 343:d4464.

Elbel, B., R. Kersh, V. L. Brescoll, and L. B. Dixon. 2009. Calorie labeling and food choices: A first look at the effects of low-income people in New York City. *Health Affairs* 28(6):w1110-w1121.

Elbel, B., J. Gyamfi, and R. Kersh. 2011. Child and adolescent fast-food choice and the influence of calorie labeling: A natural experiment. *International Journal of Obesity* 35(4):493-500.

Ellison, B., J. L. Lusk, and D. Davis. 2013. Looking at the label and beyond: The effects of calorie labels, health consciousness, and demographics on caloric intake in restaurants. *International Journal of Behavioral Nutrition and Physical Activity* 10:21.

FAO (Food and Agriculture Organization). 2013. *The state of food insecurity in the world, 2013. The multiple dimensions of food security*. Rome: FAO.

Finkelstein, E. A., C. J. Ruhm, and K. M. Kosa. 2005. Economic causes and consequences of obesity. *Annual Review of Public Health* 26:239-257.

Finkelstein, E. A., K. L. Strombotne, N. L. Chan, and J. Krieger. 2011. Mandatory menu labeling in one fast-food chain in King County, Washington. *American Journal of Preventive Medicine* 40(2):122-127.

Haisley, E., K. G. Volpp, T. Pellathy, and G. Lowenstein. 2012. The impact of alternative incentive schemes on completion of health risk assessments. *American Journal of Health Promotion* 26(3):184-188.

Hanks, A. S., D. R. Just, L. E. Smith, and B. Wansink. 2012. Healthy convenience: Nudging students toward healthier choices in the lunchroom. *Journal of Public Health* 34(3): 370-376.

Hu, F. B., T. Y. Li, G. A. Colditz, W. C. Willett, and J. E. Manson. 2003. Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. *Journal of the American Medical Association* 289(14):1785-1791.

John, L., G. Loewenstein, A. Troxel, L. Norton, J. Fassbender, and K. Volpp. 2011. Financial incentives for extended weight loss: A randomized, controlled trial. *Journal of General Internal Medicine* 26(6):621-626.

Just, D., and J. Price. 2011. *Using incentives to encourage healthy eating in children*. http://byuresearch.org/home/downloads/justandprice2011.pdf (accessed October 8, 2013).

Just, D. R., and B. Wansink. 2009. Smarter lunchrooms: Using behavioral economics to improve meal selection. *Choices* 24(3):1-7.

Levy, D. E., J. Riis, L. M. Sonnenberg, S. J. Barraclough, and A. N. Thorndike. 2012. Food choices of minority and low-income employees: A cafeteria intervention. *American Journal of Preventive Medicine* 43(3):240-248.

Nielsen, S. J., and B. M. Popkin. 2003. Patterns and trends in food portion sizes, 1977-1998. *Journal of the American Medical Association* 289(4):450-453.

Obama, M. 2010. *Remarks at Grocery Manufacturers Association conference*, March 16. http://www.whitehouse.gov/the-press-office/remarks-first-lady-a-grocery-manufacturers-association-conference (accessed September 30, 2013).

Rick, S., and G. Loewenstein. 2008. Intangibility in intertemporal choice. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences* 363(1511):3813-3824.

Sacks, G., M. Rayner, and B. Swinburn. 2009. Impact of front-of-pack "traffic light" nutrition labeling on consumer food purchases in the UK. *Health Promotion International* 24(4):344-352.

Sacks, G., K. Tikellis, L. Millar, and B. Swinburn. 2011. Impact of "traffic-light" nutrition information on online food purchases in Australia. *Australian and New Zealand Journal of Public Health* 35(2):122-126.

Schwartz, J., J. Riis, B. Elbel, and D. Ariely. 2012. Inviting consumers to downsize fast-food portions significantly reduces calorie consumption. *Health Affairs* 31(2):399-407.

Thaler, R. H., and C. R. Sunstein. 2008. *Nudge. Improving decisions about health, wealth, and happiness*. New Haven, CT: Yale University Press.

Variyam, J. N. 2007. Do nutrition labels improve dietary outcomes? *Health Economics* 17(6):695-708.

Volpp, K. G., L. K. John, A. B. Troxel, L. Norton, J. Fassbender, and G. Loewenstein. 2008. Financial incentive-based approaches for weight loss: A randomized trial. *Journal of the American Medical Association* 300(22):2631-2637.

Young, L. R., and M. Nestle, 2002. The contribution of expanding portion sizes to the US obesity epidemic. *American Journal of Public Health* 97(2):246-249.

# A

# Abbreviations and Acronyms

| | |
|---|---|
| CAFO | concentrated animal feeding operation |
| CAP | Common Agricultural Policy |
| CARET | single-nutrient beta-carotene retinol efficacy trial |
| CBD | Convention on Biological Diversity |
| CDC | U.S. Centers for Disease Control and Prevention |
| COP | Conference of Parties |
| CPI | Consumer Price Index |
| DOT | U.S. Department of Transportation |
| EBT | Electronic Benefit Transfer |
| EPA | U.S. Environmental Protection Agency |
| ERS | Economic Research Service |
| EU | European Union |
| FAO | Food and Agriculture Organization |
| GAO | U.S. Government Accountability Office |
| GHG | greenhouse gas |
| HHS | U.S. Department of Health and Human Services |
| HIP | Healthy Incentives Pilot |
| IOM | Institute of Medicine |

| | |
|---|---|
| LCA | life-cycle assessment (or analysis) |
| NET | National Eating Trends (database) |
| NGO | nongovernmental organization |
| NLEA | Nutrition Labeling and Education Act |
| NOAA | National Oceanic and Atmospheric Administration |
| NRC | National Research Council |
| SCP | sustainable consumption and production |
| SNAP | Supplemental Nutrition Assistance Program |
| SNAP-Ed | Supplemental Nutrition Assistance Program Education |
| UK | United Kingdom |
| UN | United Nations |
| USDA | U.S. Department of Agriculture |
| WHO | World Health Organization |
| WIC | Special Supplemental Nutrition Program for Women, Infants, and Children |

# B

# Workshop Agenda

Sustainable Diets:
Food for Healthy People and a Healthy Planet
May 7-8, 2013

National Academy of Sciences Building
2101 Constitution Ave., NW
Washington, DC
Auditorium

*Day 1: May 7, 2013*

8:15 am **Registration**

8:45 **Welcome and Introductions**
Erik Olson, *Workshop Planning Committee Chair, Natural Resources Defense Council*

9:00 **Keynote and Discussion**
Kathleen Merrigan, *Former Deputy Secretary of Agriculture, U.S. Department of Agriculture*

**SESSION 1—DEFINING RELATIONSHIPS BETWEEN EATING PATTERNS AND ENVIRONMENTAL HEALTH: TRADE-OFFS BETWEEN HUMAN AND ENVIRONMENTAL HEALTH**

9:35 **Session 1 Introduction**
Moderator: Robert Burns, *Grocery Manufacturers Association*

9:40 **Priority Agriculture–Environmental–Nutrition Linkages for Sustainable Diets**
Barbara Burlingame, *Food and Agriculture Organization of the United Nations*

10:00 **Trade-Offs Between Human and Environmental Health: Fish**
Cynthia Jones, *Old Dominion University*

10:20 **Trade-Offs Between Human and Environmental Health: Meat**
Frank Mitloehner, *University of California, Davis*

10:40 **Panel and Audience Discussion with Session 1 Speakers**

11:10 **Break**

**SESSION 2—QUANTIFYING TRADE-OFFS BETWEEN HUMAN AND ENVIRONMENTAL HEALTH: MOVING FROM CONCEPTUAL LINKS TO EMPIRICAL DATA**

11:25 **Session 2 Introduction**
Moderator: Allen Levine, *University of Minnesota*

11:30 **Quantifying Environmental Impacts of Dietary Guidance Policy**
Emily Cassidy, *University of Minnesota*

11:50 **Land Use Effects of Various Dietary Patterns**
Christian Peters, *Tufts University*

12:10 pm **Life-Cycle Analysis**
Martin Heller, *University of Michigan*

12:30 **Panel and Audience Discussion with Session 2 Speakers**

1:00 **Lunch**

**SESSION 3—SUSTAINABLE COMMODITY SOURCING AND THE FOOD PRICE ENVIRONMENT**

2:00 **Session 3 Introduction**
Moderator: Deborah Atwood, *AGree*

2:05 **Projected Food Prices: The Impact of Environmental Constraints**
Richard Volpe, *Economic Research Service*

2:25 **The Effect of Natural Resource Scarcity on Commodity Sourcing**
Barton Seaver, *Harvard University*

2:45 **Can Economic Incentives Drive Environmental Sustainability and Healthier Diets: Consumer Responsiveness to Price Incentives**
Parke Wilde, *Tufts University*

3:15 **Panel and Audience Discussion with Session 3 Speakers**

3:45 **Break**

**SESSION 4—DAY 1 SUMMARY PANEL**

4:00 **Review and Discussion About Day 1**
Moderator: Derek Yach, *The Vitality Group*

4:30 **Summary of Key Ideas**
Discussant: Lisa Eakman, *The Chicago Council on Global Affairs*

5:00 **Adjourn**

*Day 2: May 8, 2013*

8:00 am **Registration**

8:15 **Welcome and Recap of Day 1**
Erik Olson, *Natural Resources Defense Council*

**SESSION 5—OPTIONS AND APPROACHES TO ENABLE SUSTAINABLE FOOD CHOICES**

8:30 **Session 5 Introduction**
Moderator: Gail Feenstra, *University of California, Davis*

8:35 **Lessons from Across the Atlantic**
Tim Lang, *City University London*

9:10 **Policy Implications: Dietary Guidelines for Americans**
Katherine Clancy, *Johns Hopkins Bloomberg School of Public Health*

9:35 **Research Priorities**
Jennifer Wilkins, *Cornell University*

10:00 **Panel and Audience Discussion with Session 5 Speakers**

**SESSION 6—FUTURE DIRECTIONS AND SUMMARY**

10:30 **Session 6 Introduction**
Moderator: Derek Yach, *The Vitality Group*

10:35 **Behavioral Economics and Implications for the Food Environment and Choices**
George Loewenstein, *Carnegie Mellon University*

11:30 **Reflections and Discussion About Day 2**
Discussant: Lisa Eakman, *The Chicago Council on Global Affairs*

12:00 pm **Adjourn**

# C

# Speaker Biographical Sketches

**Deborah Atwood** serves as executive director of Meridian's AGree: Transforming Food and Agriculture Policy. She has more than 30 years of experience in policy and legislative matters regarding food, agriculture, the environment, research, and risk management, including extensive experience working with executives in the private sector, federal government, and nonprofit organizations. Ms. Atwood is a marine resource scientist by training.

**Barbara Burlingame, Ph.D.,** is a nutrition scientist and deputy director at the Food and Agriculture Organization of the United Nations (UN), where she has worked since 1998. Her expertise includes food composition, human nutrient requirements, dietary assessment, and the thematic areas of biodiversity for food and nutrition and sustainable diets. She is a member of several scientific advisory boards and international nutrition committees; the author of many scientific papers and UN publications, and several book chapters and reference books; and has served in the role of editor and editorial board member of several food and nutrition journals during the past 25 years, including 12 years as the editor-in-chief of Elsevier's *Journal of Food Composition and Analysis*. She obtained her undergraduate degrees from University of California, Davis, in nutrition science and environmental toxicology, and her Ph.D. from Massey University in New Zealand.

**Robert Burns, Ph.D.,** is vice president, health and nutrition policy, at the Grocery Manufacturers Association. In 1982, Dr. Burns joined Mead

Johnson Nutritionals, where he conducted research on nutrient bioavailability and established standards for the content and communication of nutrient aspects of infant formulas, toddler foods, and adult nutritional products. He joined Cadbury Schweppes in 2005, assuming global responsibility for nutrition and scientific issues relating to the beverage, chocolate, candy, and gum product portfolios. In 2011, he joined Grocery Manufacturers Association, where he is responsible for the application of balanced science to health and nutrition policy. His primary interest is the development of sound scientific bases for impactful public health policy. Dr. Burns is actively involved and has held leadership roles in professional societies including the American Society for Nutrition and Institute of Food Technologists. He received a B.S. in biochemistry and a Ph.D. in nutritional biochemistry, both from Queen's University, Belfast, Northern Ireland.

**Emily Cassidy,** is a graduate research assistant at the University of Minnesota's Institute on the Environment. Ms. Cassidy is working with Vitality Group® to quantify the environmental impacts of the HealthyFood benefit subsidy program. Her research has focused on the global environmental impact of dietary preferences. Specifically, Ms. Cassidy's interests lie in studying the feed and land requirements for meat and dairy production, and how this will change with an increasingly affluent global population. She is co-author on a 2011 *Nature* publication titled "Solutions for a Cultivated Planet." She has a B.S. in environmental science and is currently finishing up a M.S. at the University of Minnesota.

**Kate Clancy, Ph.D.,** is currently a food systems consultant, visiting scholar at the Center for a Livable Future, Johns Hopkins Bloomberg School of Public Health, adjunct professor at Tufts University, and senior fellow at the Minnesota Institute for Sustainable Agriculture, University of Minnesota (she resides in University Park, Maryland). Her resume includes positions at several universities (Cornell, Syracuse, and the Center for Integrated Agricultural Systems at the University of Wisconsin); the federal government (nutritionist and policy adviser at the Federal Trade Commission); and nonprofits (director of the Wallace Center for Agricultural and Environmental Policy, senior scientist at the Union of Concerned Scientists, and fellow at the National Center for Food and Agricultural Policy). Dr. Clancy has served on numerous boards (the Society for Nutrition Education, Bread for the World, Wallace Institute for Alternative Agriculture, Consortium for Sustainable Agriculture Research and Education, Michael Fields Agricultural Institute, and the Agriculture Food and Human Values Society, among others). She developed a graduate course on food systems in 1982 and since then has published, taught, spoken, and consulted widely on sustain-

able agriculture and food systems with government agencies, universities, and nonprofits around the country. Dr. Clancy's present interests are the research and policy facets of Agriculture of the Middle, the development of regional food systems, food supply chain analyses, the connections between community food security and regional food security, and the research needed to advance sustainable agriculture and food systems policy. Her B.S. and Ph.D. in nutrition sciences are from the University of Washington and the University of California, Berkeley, respectively.

**Lisa Eakman, M.A.,** serves as the executive director for The Chicago Council on Global Affairs' global agriculture and food projects. Prior to joining the Council in 2007, she worked with the Department of the Air Force's General Counsel Dispute Resolution division and Center for Strategic and International Studies in Washington, DC. She holds an M.A. in security policy studies from George Washington University and a B.A. in international studies, political science, and Spanish from Bradley University.

**Gail Feenstra, Ed.D., R.D.,** is the food systems coordinator at the Agricultural Sustainability Institute and University of California Sustainable Agriculture Research and Education Program (SAREP). SAREP's Food Systems Program encourages the development of regional food systems that link farmers, consumers and communities. Dr. Feenstra's research and outreach includes farm-to-school evaluation, regional food system distribution, food access/food security for low-income populations, food system assessments, and local food policy. Her professional background is in nutrition. She is a registered dietitian and has worked in low-income communities in Boston and New York City as a Special Supplemental Nutrition Program of Women, Infants, and Children/community nutritionist. Dr. Feenstra has a doctorate in nutrition education from Teachers College, Columbia University, with an emphasis in public health.

**Martin Heller, Ph.D.,** is a research specialist with the Center for Sustainable Systems at University of Michigan. His most recent research interest involves integrating nutritional information into environmental impact assessments of food and diet. Dr. Heller has conducted life-cycle assessment studies of short-rotation woody biomass energy crops (upstate New York Department of Energy willow demonstration project), a large-scale vertically integrated U.S. organic dairy (Aurora Organic Dairy), and, as part of an international team, a comprehensive, spatially explicit study of U.S. dairy production for the Dairy Research Institute. He also developed the seminal report on *Life Cycle-Based Sustainability Indicators for Assessment of the U.S. Food System*. As a researcher at the C.S. Mott Group for Sustainable Food Systems at Michigan State University (MSU), Dr. Heller investigated

the ecological services provided by pasture-based and confinement-based dairies, and developed a "community food profile" intended to frame for a general audience the opportunities of a community-based food system. He received a B.S. in chemical engineering from MSU and a Ph.D., also in chemical engineering, from the University of Colorado at Boulder. He has spent much of the past 10 years growing organic vegetables and starting and managing market farms/community-supported agriculture. Through a local nonprofit, he is currently developing a Farmer Residency program to assist new farmers in gaining farm management experience.

**Cynthia M. Jones, Ph.D.,** is the Annye L. Morgan Professor of Sciences, professor of ocean, earth, and atmospheric sciences, eminent scholar, and the director of the Center for Quantitative Fisheries Ecology at Old Dominion University. She studies marine fisheries and the quantitative ecology of fish. She is a fellow of the American Association for the Advancement of Science and has been recognized numerous times for faculty excellence. Dr. Jones received a Ph.D. in oceanography from the University of Rhode Island.

**Tim Lang, Ph.D.,** is professor of food policy at the Centre for Food Policy, City University London, since 2002. He has been advisor to four Parliamentary Select Committee Inquiries and to government groups such as the Expert Group on Obesity (2008-2010). He was formerly chair and a founding member of Sustain, the nongovernmental alliance responsible for national initiatives such as Sustainable Fish City and the Children's Food Campaign. In 2006-2011, Dr. Lang was Natural Resources and Land Use Commissioner on the UK government's Sustainable Development Commission. In 2005-2008, he was a member of the Royal Institute of International Affairs (Chatham House) Food Supply in the 21st Century team. Dr. Lang's interest is how policy both addresses and responds to the environment, health, social justice, and citizens. He is the author/co-author of 100 journal articles, 46 book chapters, 10 books, and 57 reports. Dr. Lang has written a monthly column in *The Grocer* since 2000. After receiving his Ph.D. at Leeds University in social psychology, he became a hill farmer in the 1970s, which shifted his academic attention to food policy, where it has been ever since.

**Allen S. Levine, Ph.D.,** is professor and director of the Minnesota Obesity Center at the University of Minnesota. The National Institutes of Health–funded obesity center has more than 70 federal grantees from the university, the Mayo Clinic, the Minneapolis VA Medical Center, HealthPartners, and Hennepin County Medical Center. The center's grant is now in its 18th year. For more than 30 years, Dr. Levine and his colleagues have explored the neural regulation of food intake, particularly related to the opioid

peptides, oxytocin, and Neuropeptide Y. Dr. Levine has published more than 290 scientific papers and more than 100 review articles, editorials, and book reviews. He is a professor in the departments of food science and nutrition, psychiatry, neuroscience, and surgery, and is a member of the nutrition, food science, and neuroscience graduate faculties at the University of Minnesota. Dr. Levine is a fellow in the American Association for the Advancement of Science, the American Psychological Association, the Obesity Society, and Sigma Xi. He is a past president of the Society for the Study of Ingestive Behavior (2010-2011). Dr. Levine has been a member of a variety of editorial boards, including *Pharmacology, Biology, and Behavior* (1990-present), the *American Journal of Clinical Nutrition*, and the *Journal of Nutrition*. He has served on advisory groups for various food and pharmaceutical corporations, including the Dannon Institute, Best Foods, and the International Life Sciences Institute. He has received two awards for his work on food intake regulation: the Mead Johnson Award from the American Institute of Nutrition and the Grace A. Goldsmith Award from the American College of Nutrition.

**George Loewenstein, Ph.D.,** is the Herbert A. Simon University Professor of Economics and Psychology at Carnegie Mellon University and the director of behavioral economics at the Center for Health Incentives at the Leonard Davis Institute of the University of Pennsylvania. Dr. Loewenstein's research focuses on applications of psychology to economics, and his specific interests include decision making over time, bargaining and negotiations, psychology and health, law and economics, the psychology of adaptation, the role of emotion in decision making, the psychology of curiosity, conflict of interest, and "out-of-control" behaviors such as impulsive violent crime and drug addiction. He is one of the early proponents of a new approach to public policy called, variously, "asymmetric" or "libertarian" paternalism, and his most recent research focuses on applications of behavioral economics to public policy, with special emphasis on health. He received his Ph.D. in economics from Yale University.

**Kathleen A. Merrigan, Ph.D.,** is former Deputy Secretary of the U.S. Department of Agriculture (USDA). Dr. Merrigan brought a wealth of knowledge to USDA from a decades-long career in policy, legislation, and research related to the many missions of USDA. She has managed the Know Your Farmer, Know Your Food effort to highlight the critical connection between farmers and consumers and support local and regional food systems that increase economic opportunity in rural America. In November 2009, she made history as the first woman to chair the Ministerial Conference of the Food and Agriculture Organization of the United Nations. Recognizing the history and scope of her work, *Time* magazine named Dr. Merrigan among

the "100 Most Influential People in the World" in 2010. Before becoming Deputy Secretary, Dr. Merrigan served for 8 years as assistant professor and director of the agriculture, food, and environment graduate program at the Friedman School of Nutrition Science and Policy at Tufts University, Boston, Massachusetts. Under an appointment by President Bill Clinton, Dr. Merrigan was administrator of the USDA Agricultural Marketing Service from 1999 to 2001. She served for 6 years as a senior staff member of the U.S. Senate Committee on Agriculture, Nutrition, and Forestry, working for Senator Patrick Leahy. She holds a Ph.D. in environmental planning and policy from the Massachusetts Institute of Technology, a master of public affairs from the University of Texas, and a B.A. from Williams College.

**Frank Mitloehner, Ph.D.,** is professor and air quality specialist in the department of animal science at the University of California, Davis. He is an expert for agricultural air quality, animal–environmental interactions, and agricultural engineering. Dr. Mitloehner is principal investigator of a broad range of studies and has authored 73 publications in refereed journals. He was recently elected chairman of the global United Nations Food and Agriculture Organization project titled LEAP to benchmark environmental footprint of livestock production. He serves as a workgroup member on the President's Council of Advisors on Science and Technology and as member on the Institute of Medicine committee on "A Framework for Assessing the Health, Environmental, and Social Effects of the Food System." Dr. Mitloehner received his M.S. degree in animal science and agricultural engineering from the University of Leipzig, Germany, in 1996 and his Ph.D. degree in animal science from Texas Tech University in 2000.

**Erik D. Olson, J.D.,** has 30 years of experience in public policy and consumer advocacy. He currently is senior strategic director for Health & Food at the Natural Resources Defense Council (NRDC), which he rejoined in December 2013. He is helping to manage and expand NRDC's food and environmental health work (including toxic chemicals, air toxics, pesticides, chemicals in food, agriculture, climate change and health, and other issues), and is working with NRDC's executive director and senior management on developing new strategic directions and approaches for its wide array of work. Previously, Mr. Olson served as senior director of Food Programs at The Pew Charitable Trusts where he oversaw Pew's food-related work including campaigns on food safety, food additives, school foods, and antibiotics and animal agriculture. He helped lead the coalition effort to enact the first major overhaul of the Food and Drug Administration's food safety law in over 70 years, signed into law in January 2011. Before joining Pew, Mr. Olson was deputy staff director and general counsel for the U.S. Senate Committee on Environment and Public Works. Prior to his Senate tenure,

he worked for 15 years at NRDC as advocacy center director, public health program director and senior attorney. Mr. Olson previously served for five years as counsel for the National Wildlife Federation's environmental quality program, and was an attorney in U.S. Environmental Protection Agency's Office of General Counsel. During this public interest career, he helped to lead several successful national legislative campaigns, and litigated environmental cases ranging from the Exxon Valdez litigation to major cases involving natural resource damages, drinking water, food safety, and other issues. Mr. Olson graduated from the University of Virginia School of Law, where he was inducted into the Order of the Coif legal honor society and served as an editor of the environmental law journal, and from Columbia College of Columbia University. Mr. Olson is a member of the Institute of Medicine's Food Forum. The views he expressed in the workshop are his alone and should not be imputed to his current or former employer.

**Christian J. Peters, Ph.D.,** is an assistant professor in the Friedman School of Nutrition Science and Policy at Tufts University. Dr. Peters joined the faculty of the Friedman School in 2010 and teaches primarily in the agriculture, food, and environment program. His research interests lie in the developing field of sustainability science, within the thematic area of food systems. Dr. Peters focuses on three major topics: (1) land requirements of the human diet, (2) capacity for local and regional food systems, and (3) feed needs of livestock systems. He is perhaps most well known for his spatial analysis of potential local foodsheds of New York State, providing a concrete example of a term that has resonated with the local and regional food movements. Dr. Peters received his B.S. in environmental sciences from Rutgers University, and his M.S. and Ph.D. degrees in soil and crop sciences from Cornell University.

**Barton Seaver** is working to restore our relationship with the ocean, the land, and with each other—through dinner. As the director of the Healthy and Sustainable Food Program at the Center for Health and the Global Environment, Harvard School of Public Health, his work is unified by the belief that food is a crucial way for us to connect with the ecosystems, people, and cultures of our world. His projects aim to highlight the important connection between environmental resiliency and human health while ensuring the profitability of local food producers. Complementary to his role at Harvard, the New England Aquarium named Mr. Seaver its first Sustainability Fellow in Residence to help relate the aquarium's conservation messages to our dinner plates. As a National Geographic Fellow, Mr. Seaver has worked with National Geographic's Ocean Initiative to create the Seafood Decision Guide. The guide compiles sustainability, omega-3, and mercury data in an interactive manner to help consumers make seafood choices

that are best for both personal and environmental health. Mr. Seaver is also helping the State Department with its diplomacy abroad as a member of the American Chef Corps. Mr. Seaver's second cookbook, *Where There's Smoke*, was released in April 2013.

**Richard (Ricky) Volpe, Ph.D.,** is a research economist in the food markets branch of the food economics division in the U.S. Department of Agriculture's Economic Research Service. His research focuses on the food retail sector, particularly the economic behavior and performance of supermarkets and other store formats. In addition, Dr. Volpe provides monthly retail food price forecasts based on Consumer Price Index (CPI) data from the Bureau of Labor Statistics and updates the Food CPI and Expenditures Briefing Room. He holds an M.S. from the University of Massachusetts, Amherst, and a Ph.D. from the University of California, Davis.

**Parke E. Wilde, Ph.D.,** is an associate professor in the Friedman School of Nutrition Science and Policy at Tufts University. His research addresses food security and hunger measurement, the economics of food assistance programs, and federal dietary guidance policy. Prior to his position at Tufts, Dr. Wilde worked for the U.S. Department of Agriculture's Economic Research Service. He is a member of the Institute of Medicine's Food Forum. Dr. Wilde has published numerous articles in leading nutrition science and agricultural economics peer-reviewed journals and is author of *Food Policy in the United States: An Introduction* (Routledge/Earthscan). Dr. Wilde received his Ph.D. in agricultural economics from Cornell University.

**Jennifer Wilkins, Ph.D., R.D.,** is lecturer and senior extension associate at Cornell University's Division of Nutritional Sciences. For more than 20 years, her work has focused on the links between food systems, health, and sustainability. In the early 1990s, Dr. Wilkins conceptualized and developed the first regional food guide in the United States—called the Northeast Regional Food Guide. This food guide promotes health, seasonal meal planning, and community food systems. While serving as a Kellogg Foundation Food and Society Policy Fellow from 2004 to 2006, she developed newspaper column, The Food Citizen, which appeared monthly in both the *Albany Times Union* and the *Ithaca Journal* from 2006 to 2011. Dr. Wilkins has held leadership positions in several professional organizations, including the Society for Nutrition Education and Behavior, the Academy of Nutrition and Dietetics, and the Agriculture, Food and Human Values Society. She is also an occasional visiting professor at the Università di Scienze Gastronomiche (University of Gastronomic Sciences) in Pollenzo, Italy.

**Derek Yach, M.B.Ch.B., M.P.H.,** is senior vice president at the Vitality Group®, part of the world's longest-standing and largest incentive-based wellness program. Prior to joining Vitality, Dr. Yach served as PepsiCo's senior vice president, global health and agriculture policy. In addition to his role at Vitality, he will continue to work closely with PepsiCo as an advisor on key topics related to the food and beverage company's ongoing health and agriculture initiatives. Dr. Yach has been a member of the board of directors for Vitality since 2009. He helped place tobacco control, nutrition, and chronic diseases, such as diabetes and heart disease, prominently on the agenda of governments, nongovernmental organizations, and the private sector. He led the development of the World Health Organization's first treaty, the Framework Convention on Tobacco Control, and the development of its Global Strategy on Diet and Physical Activity. He established the Centre for Epidemiological Research at the South African Medical Research Council, which focused on quantifying inequalities and the impact of urbanization on health. Dr. Yach has authored or co-authored more than 200 articles covering a breadth of global health issues. He received an honorary D.Sc. degree from Georgetown University.