Data and Research to Improve the U.S. Food Availability System and Estimates of Food Loss: A Workshop Report

ISBN
978-0-309-31417-6

200 pages
6 x 9
PAPERBACK (2014)

Nancy J. Kirkendall, Rapporteur; Committee on National Statistics; Division of Behavioral and Social Sciences and Education; National Research Council

DATA AND RESEARCH TO IMPROVE THE U.S. FOOD AVAILABILITY SYSTEM AND ESTIMATES OF FOOD LOSS

A WORKSHOP SUMMARY

Nancy J. Kirkendall, *Rapporteur*

Committee on National Statistics

Division of Behavioral and Social Sciences and Education

Food and Nutrition Board

Institute of Medicine

NATIONAL RESEARCH COUNCIL *AND*
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 project that is the subject of this report 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. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This study was supported by Contract/Grant No. AG-32SB-C-13-0017 between the National Academy of Sciences and the U.S. Department of Agriculture's Economic Research Service. Support of the work of the Committee on National Statistics is provided by a consortium of federal agencies through a grant from the National Science Foundation (No. SES-1024012). Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the organizations or agencies that provided support for the project.

International Standard Book Number-13: 978-0-309-31417-6
International Standard Book Number-10: 0-309-31417-8

Additional copies of this report are available from the National Academies Press, 500 Fifth Street, NW, Keck 360, Washington, DC 20001; (800) 624-6242; http://www.nap.edu.

Printed in the United States of America

Suggested citation: National Research Council and Institute of Medicine. (2015). *Data and Research to Improve the U.S. Food Availability System and Estimates of Food Loss: A Workshop Summary*. N.J. Kirkendall, Rapporteur. Committee on National Statistics, Division of Behavioral and Social Sciences and Education. Food and Nutrition Board, Institute of Medicine. Washington, DC: The National Academies Press.

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. Victor J. Dzau 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

STEERING COMMITTEE ON DATA AND RESEARCH TO IMPROVE THE U.S. FOOD AVAILABILITY SYSTEM AND ESTIMATES OF FOOD LOSS: A WORKSHOP

MARY MUTH (*Chair*), Food and Nutrition Policy Research Program, RTI International
SUSAN M. KREBS-SMITH, Division of Cancer Prevention and Control, National Cancer Institute
JEFFREY T. LAFRANCE, Department of Economics, Monash University
SARAH NUSSER, Department of Statistics, Center for Survey Statistics and Methodology, Iowa State University
JOSEF SCHMIDHUBER, Statistics Division, Food and Agriculture Organization, United Nations
JEAN SCHWAB, Office of Resource Conservation and Recovery, U.S. Environmental Protection Agency

ANN YAKTINE, *Study Director*
NANCY KIRKENDALL, *Senior Program Officer*
ANTHONY MANN, *Program Coordinator*

COMMITTEE ON NATIONAL STATISTICS
2013-2014

LAWRENCE D. BROWN (*Chair*), Department of Statistics, The Wharton School, University of Pennsylvania
JOHN M. ABOWD, School of Industrial and Labor Relations, Cornell University
MARY ELLEN BOCK, Department of Statistics, Purdue University
DAVID CARD, Department of Economics, University of California, Berkeley
ALICIA CARRIQUIRY, Department of Statistics, Iowa State University
MICHAEL E. CHERNEW, Department of Health Care Policy, Harvard Medical School
CONSTANTINE GATSONIS, Center for Statistical Sciences, Brown University
JAMES S. HOUSE, Survey Research Center, Institute for Social Research, University of Michigan
MICHAEL HOUT, Department of Sociology, New York University
SALLIE KELLER, Virginia Bioinformatics Institute at Virginia Tech, Arlington, VA
LISA LYNCH, The Heller School for Social Policy and Management, Brandeis University
COLM O'MUIRCHEARTAIGH, Harris School of Public Policy Studies, University of Chicago
RUTH PETERSON, Criminal Justice Research Center, Ohio State University
EDWARD H. SHORTLIFFE, Department of Biomedical Informatics, Columbia University, and Department of Biomedical Informatics, Mayo Clinic Campus of Arizona State University
HAL STERN, Donald Bren School of Information and Computer Sciences, University of California, Irvine

CONSTANCE F. CITRO, *Director*

Acknowledgment of 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 summary as sound as possible and to ensure that the summary meets institutional standards for objectivity, evidence, and responsiveness to the charge. The review comments and draft manuscript remain confidential to protect the integrity of the process.

We thank the following individuals for their review of this workshop summary: Barbara Burlingame, independent nutrition consultant, Center for Food Studies, American University of Rome, and honorary professor at Deakin University in Australia; Susan M. Krebs-Smith, Applied Research Program, Division of Cancer Prevention and Control, National Cancer Institute; Brian Lipinski, People and Ecosystems Program, World Resources Institute; and Laurian J. Unnevehr, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign.

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 summary was overseen by Johanna T. Dwyer, senior nutrition scientist, Office of Dietary Supplements, National Institutes of Health, and Frances Stern Nutrition Center, Tufts Medical Center. Appointed by the National Research

Council, she was responsible for making certain that an independent examination of this summary was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this summary rests entirely with the author and the institution.

Contents

1

Introduction and Background[1]

The U.S. Department of Agriculture (USDA) Economic Research Service's (ERS) Food Availability Data System (FADS) produces three distinct but related data series on food and nutrient availability for consumption: food availability data, loss-adjusted food availability data, and nutrient availability.[2] FADS is illustrated in Figure 1-1.

The data serve as popular proxies for actual consumption at the national level for more than 200 commodities (e.g., fresh spinach, beef, and eggs). The core Food Availability (FA) data series provides data on the amount of food available, per capita, for human consumption in the United States with data back to 1909 for many commodities. As illustrated in Figure 1-1, FADS uses a food balance approach that relies on available data on annual supply of a commodity (e.g., sum of beginning stocks, production, and imports) in a specific year and subtracts known non-U.S. and nonfood uses of the product in that year (exports, farm and industrial uses, and ending stocks) to get an estimate of the amount of the

[1]This background information comes from three sources: the presentation of Mary Bohman, administrator of the Economic Research Service, in the introductory session of the workshop; the presentation of Mary Muth, RTI International and chair of the steering committee that organized the workshop, in the introductory session of the workshop; and the Request for Proposal prepared by the Economic Research Service of the U.S. Department of Agriculture as part of the contract for convening the workshop.

[2]For an overview of the three series, see http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system.aspx [July 2014].

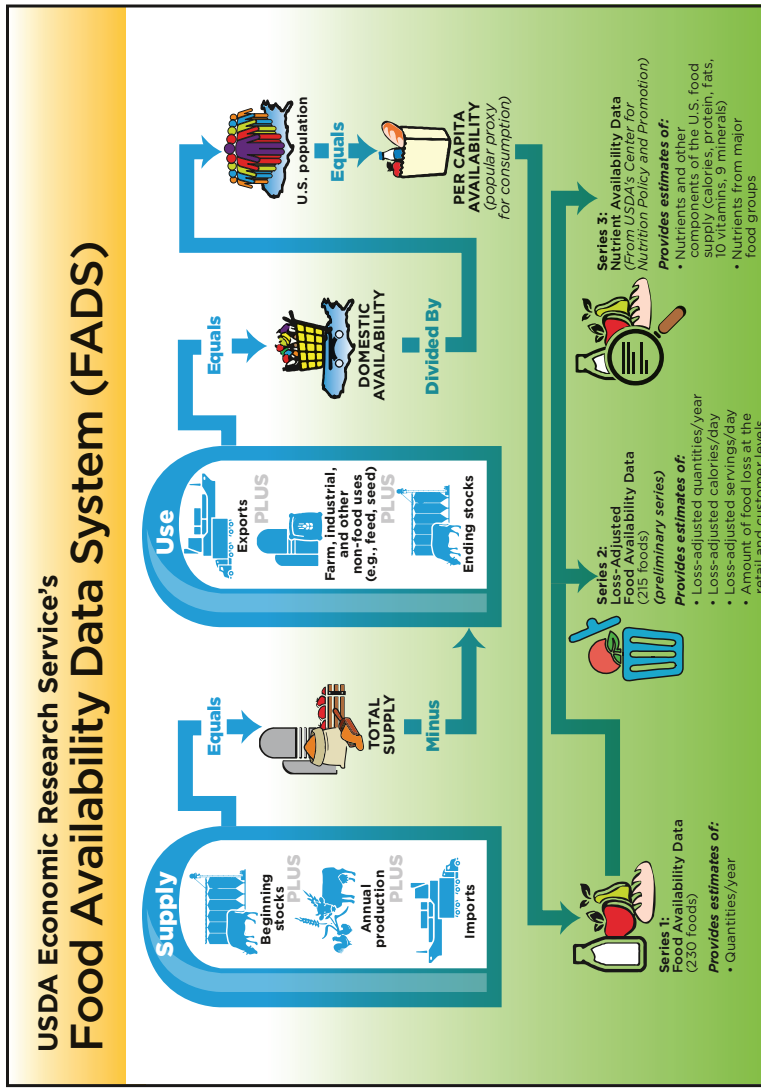


FIGURE 1-1 Food Availability Data System.
SOURCE: Information from USDA's Economic Research Service. Available: http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system.aspx [September 2014].

commodity available for consumption, called domestic availability.[3] The FA data are often referred to as food disappearance data because the data represent the amount of the food supply that "disappears" from farms, net imports, and storage facilities into the food marketing system and is available for consumption in the United States during a year. The FA data series provides annual total and per capita food availability estimates, which are useful for studying food consumption trends. As another use of the food availability data, USDA's Center for Nutrition Policy and Promotion (CNPP) uses the FA data to calculate the nutrient content of the U.S. food supply and provides these data on the CNPP website. These data are also published as part of FADS by ERS.

The Loss-Adjusted Food Availability (LAFA) data series is derived from the FA data series by adjusting for food spoilage, plate waste, and other losses to more closely approximate actual intake.[4] LAFA data provide daily estimates of the per capita loss-adjusted availability amounts (e.g., in pounds, ounces, grams, or gallons, as appropriate), calories, and food pattern equivalents (i.e., "servings") of the five major food groups (dairy, fruit, grains, meat, and vegetables), plus added sugars and sweeteners and added fats and oils available for consumption. Per capita calorie consumption and food pattern equivalents are estimated for more than 200 agricultural commodities from 1970 to the most recent year of data available. Data are reported for individual commodities, aggregated food groups, and totals (e.g., total calories per day).

ERS also uses the loss assumptions embedded in the LAFA data series to estimate the amount and value of food loss at the retail and consumer levels in the United States. (Figure 1-2 provides an illustration of food loss and its economics.) Food loss represents the edible amount of food, postharvest, available for human consumption but not consumed. It includes cooking loss and natural shrinkage (e.g., moisture loss); loss from mold, pests, or inadequate climate control; and food waste. While ERS developed LAFA to monitor food intake and diet quality, the food loss estimates have been used to inform the discussion of food loss, food waste, recovery, and gleaning. Using the LAFA data, ERS researchers calculated that at the retail and consumer levels, an estimated 133 billion pounds, or 31 percent of the 430 billion pounds of food available for human consumption in the United States in 2010, were losses and were not eaten in that year. At 2010 retail prices, this loss translates into $161.6 billion worth of food (Buzby, Wells, and Hyman, 2014). As another example of the use

[3]For more information, see http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system/food-availability-documentation.aspx [June 2014].

[4]For more information, see http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system/loss-adjusted-food-availability-documentation.aspx [June 2014].

Estimates of Food Loss at the Retail and Consumer Levels

Economic Research Service (ERS), U.S. Department of Agriculture

What Is Food Loss?

FOOD LOSS represents the edible amount of food, postharvest, available for human consumption but not consumed for any reason. Food loss includes:

- loss from mold, pests, or inadequate climate control;
- cooking loss and natural shrinkage (e.g., moisture loss); and
- food waste (e.g., food left on plate).

Why and Where Does Food Loss Occur?

Food loss occurs for many reasons, with some types of loss—such as spoilage—occurring at every stage of the production and supply chain. Between the farm gate and retail stages, food loss can arise from problems during drying, milling, transporting, or processing that expose food to damage by insects, rodents, birds, molds, and bacteria. At the retail level, equipment malfunction (such as faulty cold storage), over-ordering, and culling of blemished produce can result in food loss. Consumers also contribute to food loss when they cook more than they need and throw out the extras.

How Much Food Loss Is There?

ERS estimates that in 2010, a total of 31 percent, or 133 billion pounds, of the 430 billion pounds of the available food supply at the retail and consumer levels went uneaten, with an estimated retail value of **$162 BILLION**.

This translates into 141 trillion calories (kcal) of food available in the U.S. food supply but not consumed in 2010. Expressed on a per capita basis, food loss at the retail and consumer levels in 2010 totaled roughly **1.2 POUNDS OF FOOD PER PERSON PER DAY**, with a retail value of **OVER $1.40**.

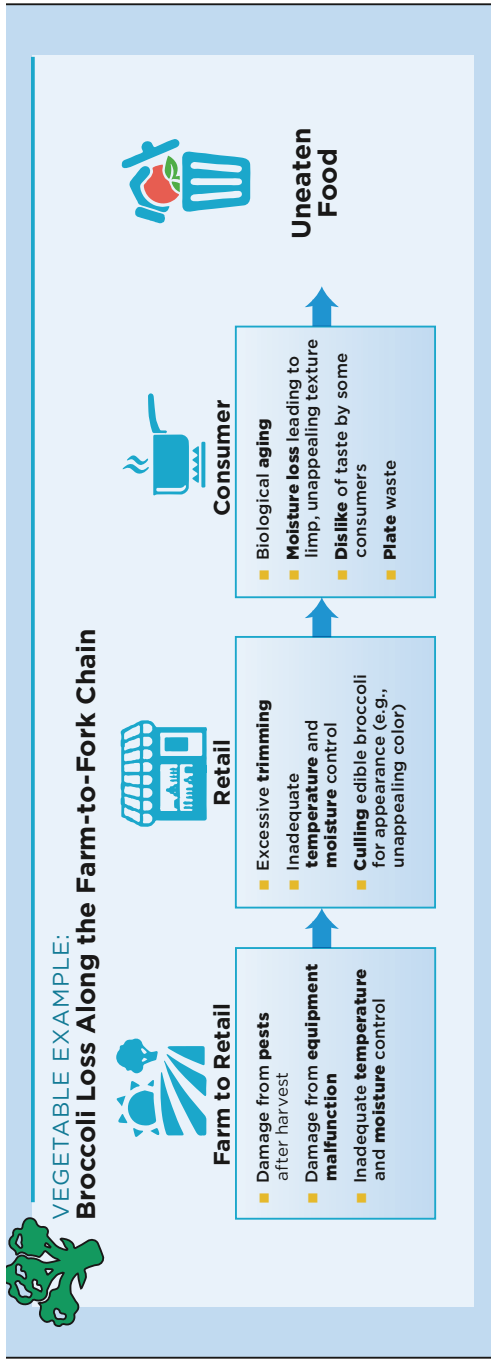
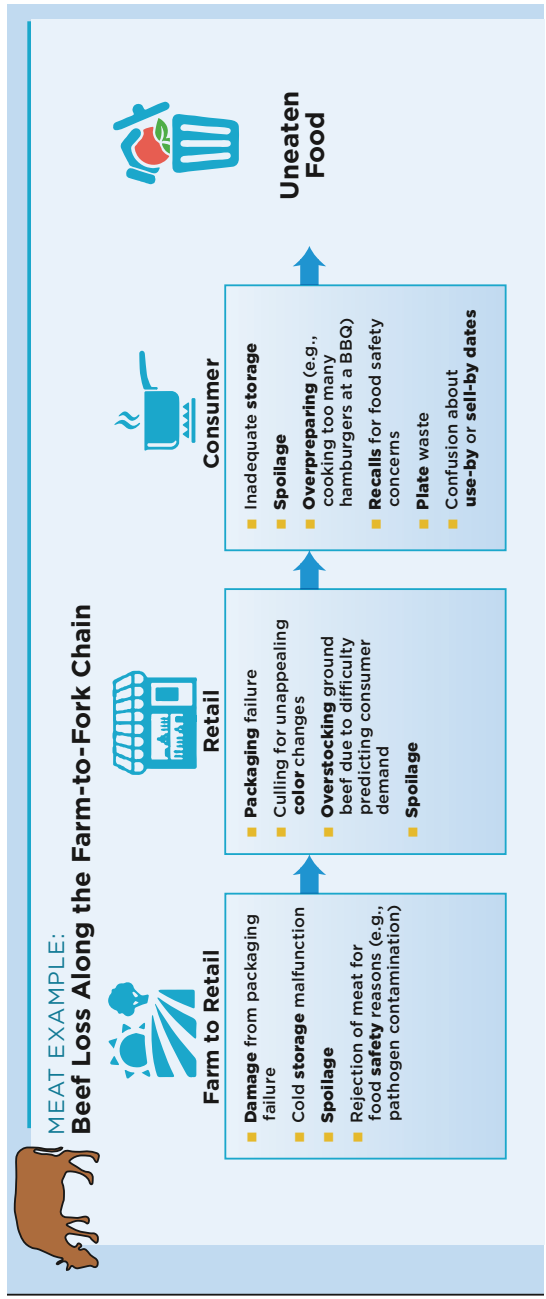


FIGURE 1-2 Continued



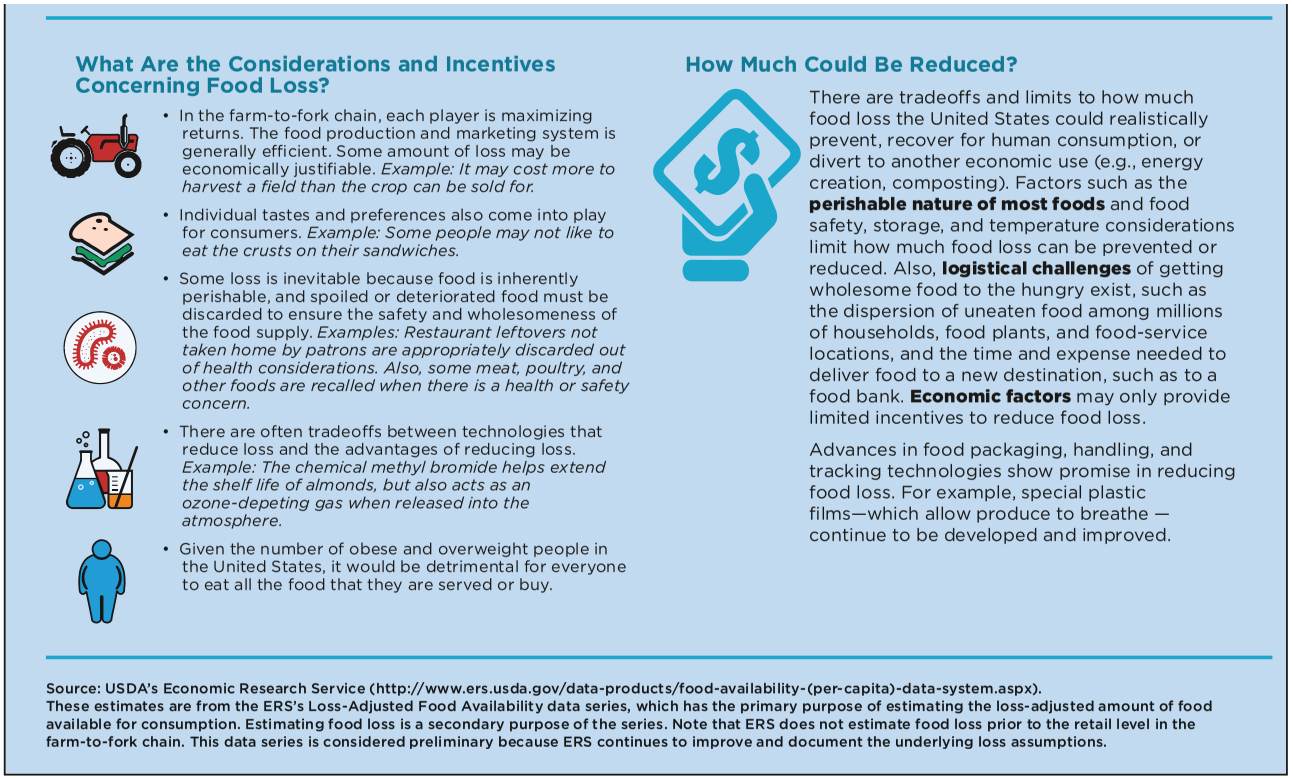


FIGURE 1-2 The economics of food loss.
SOURCE: Information from USDA's Economic Research Service. Available: http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system/loss-adjusted-food-availability-documentation.aspx [September 2014].

of the LAFA data, the Environmental Protection Agency's tool to estimate the economic feasibility for food waste anaerobic digesters uses the data as part of its background information (U.S. Environmental Protection Agency, 2010).

In fiscal year 2014, as part of an initiative to systematically review all of its major data series, ERS decided to review FADS. One of the goals of this review is to advance the knowledge and understanding of the measurement and technical aspects of the data supporting FADS so the FA and LAFA data can be maintained and improved.

Though relying on existing data is a strength of FADS, this reliance poses a challenge if these data are discontinued or suspended by other agencies. Such terminations or suspensions threaten the viability of FADS. For example, in 2012, the U.S. Census Bureau terminated its Current Industrial Reports (CIR) Program[5] that provided consumption data for some commodities. In 2013, USDA's National Agricultural Statistics Service (NASS) suspended the collection of key production and storage data for several commodities in FADS.[6] NASS has resumed publication of most of its surveys, however, and is considering establishment of new surveys to make up for the loss of the CIR.

ERS considers the LAFA data series to be preliminary because many of the underlying loss assumptions by commodity need to be updated to be more nationally representative and current, and need to be documented. For example, ERS noted that better data are needed in several areas: (1) the amount lost at the farm and the farm-to-retail levels in the United States for each of the commodities in the LAFA data series; (2) updated retail-level loss estimates for select commodities in the LAFA data series (i.e., dairy, added fats and oils, added sugars and sweeteners, grains, nuts, eggs, and fruits and vegetables in forms other than fresh, such as frozen or canned);[7] (3) consumer-level loss estimates in away-from-home settings (e.g., in restaurants); and (4) consumer-level loss estimates for select commodities eaten at home not calculated in FADS (as contained in Muth et al., 2011).

ERS also observed that there are structural considerations in FADS data, for example, determining the most appropriate place in the bal-

[5]For more information, see http://www.census.gov/manufacturing/cir/index.html [June 2014].

[6]To see the notice of the suspension, see http://www.nass.usda.gov/Newsroom/Notices/03_12_2013.asp [June 2014].

[7]Supermarket loss estimates for 2005-2006 were obtained from the Perishables Group Inc. and published in Buzby et al. (2009). New retail-level loss estimates for individual fresh fruits, meat, poultry, seafood, and vegetables for 2011-2012 were obtained by ERS in 2014 from the now-called Nielsen Perishables Group Inc. and are currently being analyzed for inclusion in LAFA.

ance and use spreadsheet to remove the inedible share of fresh fruits and vegetables, such as peelings and pits. Further, multi-ingredient products have become more popular in recent years. They are not tracked in FADS, which is based on individual commodities. This may be a source of understatement of imports and exports of commodities that are commonly used in multi-ingredient or processed products (e.g., underreporting grain in grain-based products like cookies and crackers). ERS noted that other data challenges to be addressed involve the use of residuals to estimate food availability for particular commodities, such as rice. The increasing availability of scanner data provides opportunities for better estimation of food availability.

ERS posed one overarching research question about whether it is treating all commodities the same within the FA data series (e.g., consistent inclusion of U.S. territories[8]) and within the LAFA data series (e.g., how food loss is removed at the different stages of the farm-to-fork chain). Lessons could potentially be learned from other countries and international organizations and entities, but the lack of universal definitions for food loss and food waste complicates the comparison of estimates in the few cases where national estimates are available. As ERS food loss estimates have been used to inform policy discussion on food waste and recovery, it is important to accurately characterize food loss along the supply chain from farm to fork.

Accordingly, to begin to address these issues, ERS requested that the Committee on National Statistics (CNSTAT) of the National Research Council (NRC) and the Food and Nutrition Board (FNB) of the Institute of Medicine (IOM) convene a joint workshop with a goal to advance knowledge and understanding of the measurement and technical aspects of the data supporting the FA and the LAFA data series so that these data series and subsequent food availability and food loss estimates can be maintained and improved. The statement of task for the steering committee that planned the workshop is as follows:

> An ad hoc steering committee will organize a public workshop, select and invite speakers and discussants, and moderate discussions on data and estimation issues for the food availability system of estimates developed and regularly published by the Economic Research Service (ERS) of the U.S. Department of Agriculture. The workshop agenda will feature invited presentations and discussions and will cover the core Food Availability (FA) data series, the Loss-Adjusted Food Availability (LAFA) data series, and the food loss estimates that are produced using

[8]As presented later in the workshop (see Chapter 2), shipments to U.S. territories are treated as exports in the balance sheet for beef (Table 2-2) but not in the balance sheets for oats (Table 2-1) or carrots (Table 2-3).

the LAFA series. Estimates from these series are important for studying food consumption trends, per capita calorie consumption for individual commodities, food groups, and totals (e.g., total calories per day), and food waste. Issues for the workshop to consider include: the effects of termination of selected Census Bureau and USDA data series on estimates for affected food groups and commodities; the potential for using other data sources, such as scanner data, to improve estimates of food availability; and possible ways to improve the data on food loss at the farm and retail levels and at restaurants. For each topic, the workshop will consider what are the most important knowledge gaps, what data sources may be available or could be generated to fill gaps, what can be learned from other countries and international organizations, ways to ensure consistency of treatment of commodities across series, and the most promising opportunities for new data for the various food availability series.

Following the workshop, a designated rapporteur will prepare an individually authored summary of the presentations and discussion. Commissioned papers may be published with the summary or posted on the Internet as background for the workshop. A transcript of the workshop discussions will also be provided to the sponsor.

The steering committee, working by teleconference and e-mail, planned the workshop to fulfill the statement of task. The workshop consisted of four technical sessions, plus introductory and final wrap-up sessions. The technical sessions covered the following topics.

1. Current methods, data, and uses of the food availability system and food loss estimates.
2. Historical and current uses of the data for economic modeling and reporting of statistical trends.
3. Alternative approaches for estimating food availability—international and domestic.
4. Alternative approaches for estimating food loss—international and domestic.

The first session was intended to introduce the audience to the details of FADS, both food availability and food loss, and featured two speakers from ERS. Each of the remaining sessions had four presentations to focus on different aspects of the topic, and the last two sessions also featured focused discussions between panelists and the audience. The steering committee identified potential speakers for each topic based on the individual's unique expertise and selected speakers with a range of disciplines and viewpoints. Based on the charge, the committee asked the following key questions to be addressed during the workshop:

- Where are the most important knowledge gaps?
- Do data exist to support research to fill any remaining substantial knowledge gaps? If not, could such data be generated?
- Are there lessons to be learned from other countries and international organizations?
- Are commodities and commodity groups treated the same within the FA and the LAFA data series?
- What are the most promising opportunities in terms of new data for the FA data series, the LAFA data series, or the associated food loss estimates?

The day-and-a-half workshop was held April 8 and 9, 2014. Chapters 2 through 5 provide a summary of the presentations and discussions from Sessions 1 through 4. Chapter 6 is a summary of the final session. A glossary of acronyms and terms can be found in Appendix A. The workshop agenda can be found in Appendix B, the list of participants can be found in Appendix C, and brief biographies of the speakers and steering committee members can be found in Appendix D.

This workshop summary was prepared by a rapporteur as a factual summary of what occurred at the workshop. The steering committee's role was limited to planning and convening the workshop. The views contained in the report are those of individual workshop participants and do not necessarily represent the views of nonparticipants, other workshop participants, the steering committee, the NRC, or the IOM.

2

The Food Availability System and Food Loss Estimates: Current Methods, Data, and Uses

The purpose of the first technical session of the workshop, as summarized in this chapter, was to introduce the current methods, data, and uses of the food availability (FA) and loss-adjusted food availability (LAFA) data provided to the public through the Economic Research Service (ERS) Food Availability Data System (FADS). Cheryl Christensen (ERS) moderated the session and introduced the two speakers, also from ERS: Mark Jekanowski and Jean Buzby. The first section of this chapter reports on Jekanowski's description of the FA data structure and uses, followed by Buzby's description of the food loss estimates and the LAFA data structure and uses. The final section of this chapter summarizes the open discussion between the speakers and audience.

STATEMENT OF MARK JEKANOWSKI FOOD AVAILABILITY DATA STRUCTURE AND USES

Jekanowski described the core data series that ERS provides on FA as a general proxy for consumption. He explained the mechanics of how the estimates are prepared, how they are used, and some of their strengths and weaknesses.

He described FA as a massive dataset, with more than 200 common food categories (commodities), including grains (oats, rye, wheat, etc.); dairy products (cheeses, dry, fluid, frozen, etc.); meats (fish, poultry, red meat); eggs; sweeteners (caloric, by type: sugar, honey, high-fructose corn syrup, dextrose); peanuts and tree nuts; coffee, tea, and cocoa; spices;

vegetables (more than 50 types: fresh, frozen, canned); and fruits (about 40 types: fresh, canned, dried, frozen, juice). FADS is the only source of time-series FA data, and, for many items, the data extend back to 1909. He noted that it is a very rich source of data for tracking a proxy of food consumption or dietary changes over time.

Jekanowski pointed out that the FA data do not provide a direct measure of consumption. Instead, they provide a measure of disappearance of a food commodity from the supply chain, with the result often referred to informally as per capita consumption. Per capita consumption by commodity, computed from the FA data, overstates actual consumption because it does not account for waste or loss along the retail marketing chain.

Jekanowski used a flowchart to illustrate FA supply and disappearance (see Figure 2-1). For each commodity, the data system relies on annual measures of U.S. agricultural production and stocks (inventories) at the farm level from the National Agricultural Statistics Service (NASS) and on estimates of U.S. imports and exports from the Census Bureau's trade data. Total supply is the sum of beginning stocks, production, and imports. Disappearance from supply is the aggregate of ending stocks,

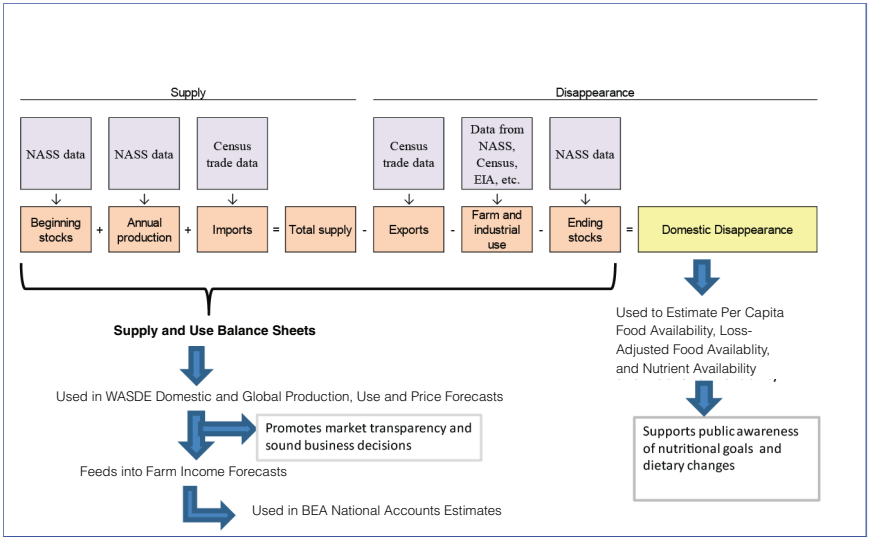


FIGURE 2-1 Commodity supply and disappearance flowchart. Accounting relationships that illustrate food availablity supply and disappearance.
NOTE: BEA = Bureau of Economic Analysis, NASS = National Agricultural Statistics Service, and WASDE = World Agricultural Supply and Demand Estimates.
SOURCE: Prepared by M. Jekanowski for presentation at the workshop.

exports, food use, and an estimate for farm and industrial use. The data to estimate farm and industrial (nonfood) use, if available, come from a variety of sources depending on the commodity, and include products used on the farm for seed, feed, or industrial uses such as ethanol or biofuels.[1] If an estimate of food use is available, as it is for a few commodities, the estimate for farm and industrial use is the residual computed as supply minus the aggregate of exports, ending stocks, use by the food industry, and use by any other industry for which data are available, such as biofuels. For commodities like wheat and for various fats and oils, usage by the food industry was historically measured directly and published in the Census Bureau's Current Industrial Reports (CIR), a data series terminated in 2012 due to budget constraints.

Supply and use balance sheets are used to estimate domestic disappearance from supply during a year, and each provides the estimate of food availability for that commodity. In Figure 2-1, the box labeled Domestic Disappearance on the far right provides an estimate for the amount of food that was available for consumption.

Jekanowski said the supply and use balance sheets on which FADS is based are used for all of USDA's World Agricultural Supply and Demand Estimates (WASDE).[2] They provide routine ongoing estimates of supply and demand conditions that assist analysts in better understanding price conditions and in forecasting production and market outcomes. In addition to FADS, commodity balance sheet data also feed directly into farm income forecasts and provide a fundamental way to look at the agricultural economy.

He illustrated FADS methodology by showing three examples of how food availability is estimated, for a grain (oats, see Table 2-1), a meat product (beef, see Table 2-2), and a vegetable (fresh carrots, see Table 2-3).

In Table 2-1, the spreadsheet for oats includes data for the most recent year then available, 2011.[3] Although data for oats go back to 1921, Jekanowski said he included fewer years on his table for space considerations.

The first column under Supply is production, based on NASS acreage and yield estimates for oats. Data for imports, the second column under Supply, come from Census Bureau trade information, while the third column is NASS information on stocks of oats in storage at the beginning of the given year. Total supply is the aggregate of production, imports, and beginning stocks for the marketing year.

[1]The Energy Information Administration provides information on biofuels production.

[2]For information on WASDE, see: http://www.usda.gov/oce/commodity/wasde/ [July 2014].

[3]The data were updated on the website to 2012 at about the time of the workshop.

Under Disappearance, the first column is exports from the Census Bureau's trade statistics. The third column is stocks of oats in storage at the end of the marketing year, in millions of bushels.[4] Historically through 2011, total food disappearance of oats came from the CIR series. As mentioned above, the Census Bureau used to conduct quarterly surveys of the milling industry that reported production volumes of different types of grain-based flours, which provided a more direct measure of food availability for oats and other grains.

Returning to the second column under Disappearance, Jekanowski said nonfood use for oats is primarily feed and seed. Since total disappearance is the sum of exports, ending stocks, nonfood use, and food use—and total disappearance balances with total supply—the difference between supply and the aggregate of exports, ending stocks, and food use provides an estimate for nonfood use as the residual use category. Without a direct estimate of food use, he said, it cannot be separated from residual use and would be lumped together with feed and seed use. The spreadsheet for oats is similar to those for wheat and several other commodities that relied on the CIR for direct food availability. Most of these have not been updated to 2012 because of the loss of the CIR, but in a few cases, he noted, food use has been updated by extending long-term trends and using data provided by industry. NASS is planning to start collecting some of the data formerly provided by the CIR by the end of 2014, he said.

Finally, the total disappearance quantity in bushels is converted to pounds and divided by the U.S. population to give a grain equivalent estimate of per capita availability. This is multiplied by an adjustment factor[5] of 0.60 (in this case) to adjust for milling rates and to get per capita availability on a product equivalent basis for oats.

Table 2-2 shows a similar spreadsheet for beef, he explained. The concept is the same, but with all columns measured in pounds, starting out with measures of production,[6] imports, and beginning stocks,[7] to give total supply for beef. For Disappearance, the columns are exports, shipments to U.S. territories (also from the Census Bureau's trade data), and ending stocks. ERS does not provide an estimate of nonfood use for beef, although some nonfood uses exist.[8] Total beef supply less exports,

[4]The difference between stocks at the beginning of a year and the stocks at the end of a year represents amounts of product that were available to be consumed during that year.

[5]The adjustment factor varies for different types of grains or different types of products.

[6]Production of meat comes from NASS data on slaughter from three sources: slaughter under federal inspection, other commercial slaughter, and slaughter on farms. See http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system/food-availability-documentation.aspx#meat [June 2014].

[7]Stocks of meat products are amounts in cold storage at a particular point in time.

[8]Pet food and rendering, for example.

TABLE 2-1 Example of Oats Supply and Use

		Supply (millions of bushels)			
Year	U.S. Population, Jan. 1 (millions)	Production	Imports	Beginning Stocks	Total Supply
1998	274.626	166.0	107.7	74.0	347.7
1999	277.790	146.2	98.6	81.4	326.2
2000	280.976	149.5	106.0	76.0	331.6
2001	283.920	117.6	96.0	72.7	286.3
2002	286.788	116.0	95.1	63.2	274.3
2003	289.518	144.4	89.7	49.8	283.9
2004	292.192	115.7	90.3	64.9	270.9
2005	294.914	114.9	91.2	57.9	264.0
2006	297.647	93.5	106.2	52.6	252.3
2007	300.574	90.4	123.3	50.6	264.3
2008	303.506	89.1	114.6	66.8	270.5
2009	306.208	93.1	94.9	84.1	272.1
2010	308.833	81.2	85.1	80.3	246.7
2011	310.939	53.6	94.1	67.6	215.3

[a]Total food availability = total supply minus the sum of exports, nonfood use, and ending stocks.

[b]Conversion factor from grain to product equivalent = 0.60.

shipments to U.S. territories, and ending stocks gives a value for carcass beef availability in any given year.

For animal products, Jekanowski explained, the spreadsheet is somewhat more complicated because three units of measure can be of interest: a carcass equivalent, a retail equivalent (retail cuts of beef that include bone[9]), and a boneless equivalent. The boneless equivalent allows the user to put all meats on an equal basis, for purposes of evaluating consumption and calorie intake.

The last two columns of the beef spreadsheet provide the adjustment factors to use to convert carcass weight to retail, and carcass weight to boneless. These three categories of beef availability are used to compute

[9]The bone is not consumed, but it is purchased by the consumer.

Disappearance (millions of bushels)			Food Availability		
				Per Capita (lbs.)	
Exports	Nonfood Use	Ending Stocks	Total[a] (millions of bushels)	Grain Equivalent	Oat Products Equivalent[b]
1.7	207.6	81.4	57.0	7.5	4.5
1.8	191.6	76.0	56.8	7.4	4.4
1.7	200.4	72.7	56.7	7.3	4.4
2.8	161.1	63.2	59.2	7.5	4.5
2.6	161.7	49.8	60.2	7.6	4.5
2.5	154.2	64.9	62.4	7.8	4.7
2.7	147.2	57.9	63.0	7.8	4.7
2.1	146.4	52.6	62.9	7.7	4.6
2.6	134.6	50.6	64.5	7.8	4.7
2.9	128.6	66.8	66.0	7.9	4.7
3.3	115.4	84.1	67.6	8.0	4.8
2.2	122.8	80.3	66.8	7.9	4.7
2.9	108.5	67.6	67.7	7.9	4.7
2.4	98.6	55.0	59.4	6.9	4.1

SOURCE: Prepared by M. Jekanowski for presentation at the workshop. Data from ERS Food Availability Data System: http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system.aspx [July 2014].

the three categories of per capita beef availability by dividing by the U.S. population. Similar methods and spreadsheets are used for all common meat products in addition to beef, such as pork and poultry.

Jekanowski also presented a spreadsheet example for fresh carrots (see Table 2-3). In general, there is less available information concerning the vegetable industry for a given year. In particular, because vegetables are perishable, no stocks carry over from one year to another. Estimates of production (the product of acreage and yield) are available from NASS, and the Census Bureau has trade data. There is no nonfood use for most vegetables. The supply and use balance sheet consists only of production[10] plus imports to yield supply, minus exports to yield total disappear-

[10]With declining budgets in 2012, some NASS surveys for production of fresh vegetables were terminated. Fortunately for FADS, these surveys were reinstated.

TABLE 2-2 Example of Beef Supply and Use

Year	U.S. Population, July 1 (millions)	Supply (millions of lbs.) Production	Imports	Beginning Stocks	Total Supply
2005	296.186	24,787.0	3,599.0	637.0	29,023.0
2006	298.996	26,256.4	3,084.7	571.0	29,912.1
2007	302.004	26,523.2	3,052.2	630.0	30,205.4
2008	304.798	26,663.6	2,538.1	630.0	29,831.7
2009	307.439	26,067.7	2,626.2	642.0	29,335.9
2010	309.750	26,411.9	2,297.0	565.0	29,273.9
2011	312.009	26,291.7	2,056.5	585.0	28,933.2

Year	U.S. Population, July 1 (millions)	Food Availability Total (millions of lbs.) Carcass[a]	Retail	Boneless
2005	296.186	27,658.8	19,361.1	18,503.7
2006	298.996	28,054.8	19,638.3	18,768.6
2007	302.004	28,042.4	19,629.7	18,760.4
2008	304.798	27,060.9	18,942.6	18,103.7
2009	307.439	26,703.1	18,692.1	17,864.3
2010	309.750	26,262.9	18,384.0	17,569.9
2011	312.009	25,399.0	17,779.3	16,992.0

[a]Carcass food availability = total supply minus the sum of exports, shipments to U.S. territories, and ending stocks.

ance from supply for carrots. Dividing by the total population provides a measure of per capita carrot availability. For carrots, the adjustment factor of 0.97 accounts for the losses from farm production to retail. Jekanowski explained that the adjustment accounts for things like creating baby-cut carrots and other moderately processed products.

Jekanowski noted that one of the most powerful uses of these data is to examine availability trends over time, which he illustrated with Figures 2-2, 2-3, and 2-4. He noted that Figure 2-2 shows a dramatic increase in

Food Disappearance (millions of lbs.)		
Exports	Shipments to U.S.Territories	Ending Stocks
698.0	95.2	571.0
1,144.9	82.4	630.0
1,434.0	99.0	630.0
1,996.00	132.9	642.0
1,934.8	133.0	565.0
2,299.0	127.0	585.0
2,784.8	149.4	600.0

Per Capita (lbs.)			Factors (%) for Converting Weight to	
Carcass	Retail	Boneless	Retail	Boneless
93.4	65.4	62.5	0.70	0.669
93.8	65.7	62.8	0.70	0.669
92.9	65.0	62.1	0.70	0.669
88.8	62.1	59.4	0.70	0.669
86.9	60.8	58.1	0.70	0.669
84.8	59.4	56.7	0.70	0.669
81.4	57.0	54.5	0.70	0.669

SOURCE: Prepared by M. Jekanowski for presentation at the workshop. Data from ERS Food Availability Data System: http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system.aspx [July 2014].

chicken availability over time, a decline in the availability of beef, and relatively stable availability of pork. He clarified that Figure 2-2 presents data on a retail equivalent basis. It is often presented on a boneless equivalent basis that reduces availability for all products, but not by the same amount. For example, chicken availability would shift down more than beef or pork, since bones account for a larger proportion of chicken available at the retail level.

He noted that Figure 2-3 shows steady increases in wheat flour avail-

TABLE 2-3 Example of Fresh Carrots Supply and Use

		Supply (millions of lbs.)		
Year	U.S. Population, July 1 (millions)	Production	Imports	Total Supply
1998	276.115	2,706.8	179.2	2,886.0
1999	279.295	2,661.7	184.8	2,846.5
2000	282.385	2,708.0	167.5	2,875.5
2001	285.309	2,783.9	201.4	2,985.3
2002	288.105	2,586.5	190.2	2,776.7
2003	290.820	2,696.4	187.2	2,883.6
2004	293.463	2,628.0	215.2	2,843.2
2005	296.186	2,654.5	196.6	2,851.1
2006	298.996	2,429.0	248.4	2,677.4
2007	302.004	2,443.0	245.5	2,688.5
2008	304.798	2,456.5	276.6	2,733.1
2009	307.439	2,216.3	298.5	2,514.8
2010	309.750	2,323.7	322.9	2,646.6
2011	312.009	2,201.2	393.6	2,594.8

[a]Conversion factor from farm to retail = 0.97.

SOURCE: Prepared by M. Jekanowski for presentation at the workshop. Data from ERS Food Availability Data System: http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system.aspx [July 2014].

ability through the mid- to late-1990s. At about that time, the Atkins diet, a low-carbohydrate diet, became popular, and the diet's effect can be seen in the data. A fairly sharp turnaround in wheat availability occurred from the late 1990s through the early 2000s that ultimately leveled off.

Jekanowski noted that a common perception is that healthier diets might mean greater vegetable consumption. However, he said Figure 2-4 shows this trend does not show up in the availability of types of vegetables. The figure shows a sharp increase in availability of broccoli, and relatively stable availability of cauliflower and asparagus with some ups and downs. He reminded the audience that in 1990, President George H.W. Bush talked about not liking broccoli, around the same time as the dip in broccoli availability. Although he said he did not know whether

Disappearance (millions of lbs.)	Food Availability		
		Per Capita (lbs.)	
Exports	Total (millions of lbs.)	Farm	Retail[a]
255.5	2,630.5	9.5	9.2
262.3	2,584.2	9.3	9.0
276.5	2,599.0	9.2	8.9
309.1	2,676.2	9.4	9.1
351.6	2,425.1	8.4	8.2
330.6	2,553.0	8.8	8.5
283.9	2,559.3	8.7	8.5
284.7	2,566.4	8.7	8.4
253.1	2,424.3	8.1	7.9
257.5	2,431.0	8.0	7.8
274.3	2,458.8	8.1	7.8
244.1	2,270.7	7.4	7.2
244.0	2,402.6	7.8	7.5
238.9	2,355.9	7.6	7.3

the dip was related to the President's remarks or just coincidence, broccoli availability has increased since then.

Jekanowski next discussed advantages of the supply and use approach. First, the approach provides a full accounting of commodity use and supply for all commodities. Volumes and shares of U.S. supply that come from imports are known, as are volumes carried over from one year to the next. The data give analysts the ability to put food availability into the context of the overall food economy. He said that because the time series of the data is so long and has been estimated consistently, it is very powerful for identifying long-term dietary trends, even accounting for the fact that it is only a proxy for, and likely overestimates, consumption.

He went on to say FA data are very commonly used in estimating

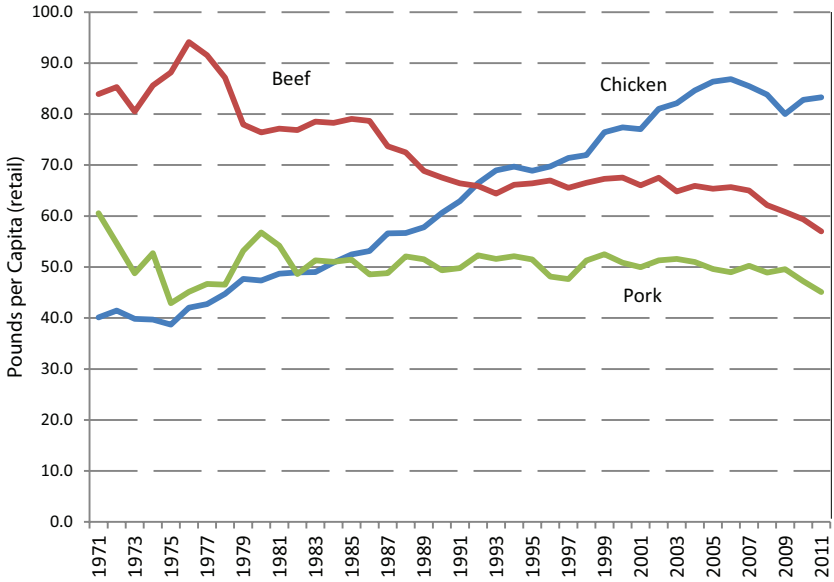


FIGURE 2-2 Trends in per capita meat availability.
SOURCE: Prepared by M. Jekanowski for presentation at the workshop. Data from USDA's Economic Research Service Food Availability Data System. Available: http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system.aspx [July 2014].

complete demand systems, especially for meats, and for estimating elasticities for beef, pork, and chicken. By relying on existing data, FADS is less data-intensive than trying to track actual consumer purchases.

Jekanowski reminded the audience that use of scanner data in FADS has been mentioned. In his view, it would be useful to consider such new approaches, at least as a backup or as a companion to the current methodology. He noted one complication with scanner data is that, in most cases, they are product-based (e.g., baked goods or pizza) rather than commodity-based (ingredients). Accounting for all the different ingredients in the vast array of consumer products is not an easy task.

According to Jekanowski, an additional advantage is that FADS data measure the total amount of supply going into the food industry without regard to how it is used within that industry. As a result, FADS is immune to changes in the style or form of consumer food purchases and uses. He noted that direct surveys of consumers would likely entail significant levels of self-reporting biases. People tend to overestimate the amount of healthy foods they consume and underestimate the amounts of snacks and desserts.

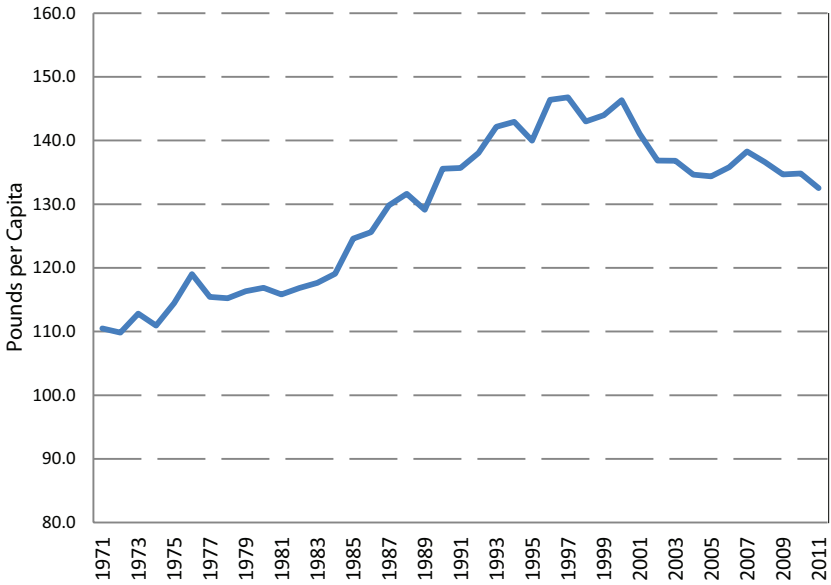


FIGURE 2-3 Trends in per capita wheat flour availability.
SOURCE: Prepared by M. Jekanowski for presentation at the workshop. Data from ERS Food Availability Data System. Available: http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system.aspx [July 2014].

As a final advantage, he said the FADS data are based almost entirely on widely available public data sources. As a result, FADS is very transparent.

He then described what he sees as limitations. First, FADS takes a commodity focus, starting at the farm level with production and inventories, and staying at that level. It provides no information about specific food items, such as individual retail cuts of meat or different kinds of processed foods. Clearly, he said, from a health policy perspective, better knowledge about consumption patterns would be useful.

Second, FADS does not capture all common food categories. For example, total grain consumption is known, but not how much of that grain is consumed as whole versus highly refined grains. Some categories are omitted because there are no good data. For example, game meat, home garden production, and niche markets such as soy foods are excluded because of a lack of data.

Third, the data are available only annually and at a national level. While there are likely seasonal consumption patterns for different foods, FADS data cannot be used to analyze seasonal effects. The data also do

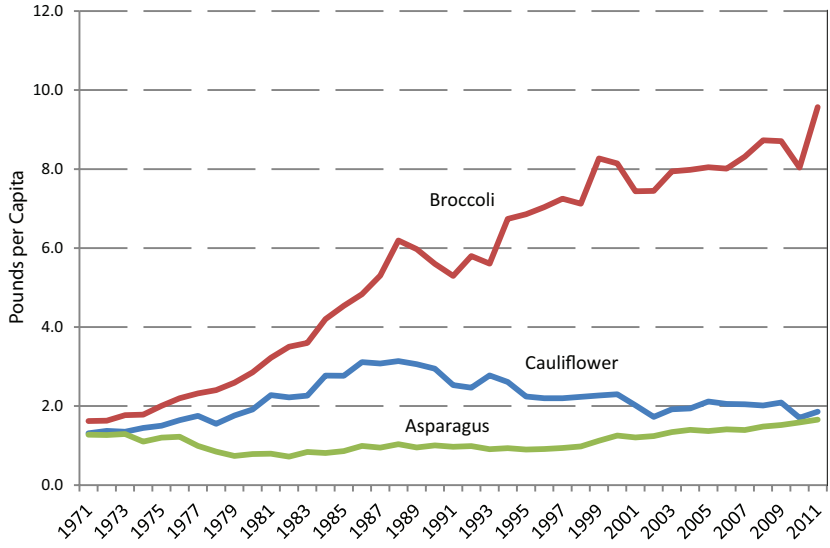


FIGURE 2-4 Trends in per capita availability of selected vegetables.
SOURCE: Prepared by M. Jekanowski for presentation at the workshop. Data from USDA's Economic Research Service Food Availability Data System. Available: http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system.aspx [July 2014].

not support analysis of regional consumption patterns or an analysis of demographic or socioeconomic patterns of consumption.

Fourth, there is a lag between the date of the data and when the data are made available to the public. At the time of the workshop (April 2014), for instance, ERS had just released the data for 2012. Because FADS relies on data from other sources (particularly NASS and the Census Bureau), it cannot be finalized until all components from all sources are available and final.

An additional limitation he highlighted is that food availability overstates consumption because it does not account for waste or spoilage. Finally, he said, since FADS requires data from many sources, it is vulnerable to decisions by other agencies that impact the availability or content of their data, such as the Census Bureau decision to terminate its CIR series. FADS relied heavily on these data for consumption of many grains, added fats and oils, and items like margarine and salad dressing. ERS is hopeful that, within a year or so, the data will be available from NASS to report on those categories once again, he said.

STATEMENT OF JEAN BUZBY
LOSS-ADJUSTED FOOD AVAILABILITY DATA

Buzby described the LAFA data series that was developed by Kantor et al. (1997) to help account for the fact that the core FA data series overstates the amount of food consumed. She stressed ERS refers to the LAFA series as *preliminary* because the underlying loss assumptions and estimates continue to be refined. She noted that the LAFA series takes into account the substantial quantities of food that go uneaten because of spoilage, moisture loss, plate waste, and other reasons from farm to plate. The primary goal is to more closely approximate actual consumption.

She provided the ERS definitions of food loss and food waste:

- *Food loss* represents the edible amount of food, postharvest, that is available for human consumption but is not consumed for any reason. It includes cooking loss and natural shrinkage (e.g., moisture loss); loss from mold, pests, or inadequate climate control; and food waste.
- *Food waste* is a component of food loss and occurs when an edible item goes unconsumed, as in food discarded by retailers due to color or appearance and plate waste by consumers.

Buzby emphasized that food waste in the LAFA series is just one component of food loss, and that ERS does not have estimates for all different components of food loss. She then provided examples of where food loss can occur at different levels. At the farm level, preharvest losses can be due to severe weather, disease, or predation from insects, birds, and animals. Losses during harvest can be caused by machinery or production problems, as well as business decisions to leave portions of a field unharvested. Postharvest loss refers to loss after harvest, or in the case of milk, after a cow has been milked. Estimates of production from NASS are supposed to be net of farm loss.

She said losses at the processing and wholesaling levels can arise from discarding substandard products, such as bruised fruit or oddly shaped vegetables that do not meet supermarkets' quality standards. Losses can also arise from shrinkage, poor handling, cold storage failure, or transportation problems. There are also cooking and preparation losses, food removed from the system because of food safety concerns, and plate waste that occurs due to differing tastes and preferences or preparation of more food than needed. The bottom line, she said, is many different reasons account for food loss from the farm to the fork. At this time, ERS only produces summary statistics for losses at the retail level (supermarket) and the consumer level.

Buzby illustrated the loss adjustment for fresh carrots (see Table 2-4). Loss adjustment starts from farm-level food availability from FADS, illustrated in Table 2-3. There are adjustments for three types of losses: (1) loss from the farm (primary) to retail, (2) loss at the retail (supermarket) level, and (3) loss at the consumer level. Consumer loss is further split into a nonedible share and other losses (e.g., cooking and uneaten food). All loss adjustments are expressed as a percentage.

The second column in Table 2-4,[11] referred to as primary weight, is the weight in pounds of per capita farm availability of fresh carrots from the FA spreadsheet (Table 2-3). The third column shows the 3 percent loss from primary to retail weight used to calculate retail food availability in Table 2-3. The fourth column shows the retail food availability of fresh carrots.

The next column shows retail loss, or loss at the supermarket, to be 5.1 percent for all years. After accounting for supermarket loss, the result is consumer weight. There are two adjustments made at the consumer level. The first is the nonedible share, estimated to be 11 percent for carrots. Buzby noted that ERS has very good data on the percentage of a food that is nonedible by commodity from the USDA's National Nutrient Database for Standard Reference. The second is other losses (cooking and uneaten food), estimated to be 34 percent.

Buzby clarified the total loss at all levels (49 percent) is not the sum of the different losses because losses are taken sequentially. After all losses are accounted for, the result is per capita availability adjusted for loss and is presented in three different units: pounds per year, ounces per day, and grams per day.

The final columns in the spreadsheet in Table 2-4 use conversion factors to get calories per cup equivalent or grams per cup equivalent, she explained. The next-to-last column shows calories available per day and food pattern equivalents (a measure of the number of servings) available per day. These figures are frequently compared against federal dietary recommendations.

Buzby stated that an aggregate view of food loss is provided in a new ERS report that she coauthored (Buzby, Wells, and Hyman, 2014). It provides loss-adjusted estimates in terms of weight, value, and, for the first time, calories. In 2010, according to the report, the aggregate of loss at the retail and consumer level was 133 billion pounds, valued at $162 billion (using retail prices from the Nielsen Homescan data) and accounted for 141 trillion calories. The report also presents annual per capita LAFA, both per year and per day.

[11]Table 2-4 shows preliminary data for 2010. The data for 2010 were revised in Table 2-3. The two tables also use different numbers of significant digits.

Buzby provided examples of how LAFA estimates are used. For example, Figure 2-5 illustrates the most popular fruits in terms of loss-adjusted availability in 1970 versus 2011. In 1970, apples were the most popular fruit in terms of the amount available for consumption. However, by 2011, bananas had caught up and surpassed apples. Watermelon and grapes moved up in popularity from 1970 to 2011.

She went on to describe a chart showing LAFA in calories by category in 2010 (see Figure 2-6). This figure shows flour and cereal products provided 610 calories per day for the average American in 2010, more than any other food group, followed by added fats and oils (not including naturally occurring fats and oils, such as the fat in meat). Availability of caloric sweeteners (added sweeteners) was 400 calories per day, excluding naturally occurring sugars, such as fructose and fruit.

Buzby referred to Figure 2-7 to illustrate per capita loss-adjusted data for the five food groups in 2012 as a percentage of the federal dietary recommendations for a 2000-calorie diet. The average U.S. diet falls short of USDA's MyPlate recommendations for vegetables, dairy, and fruit. On average, Americans consumed more than the recommended amounts of meat and grains in 2012. Looking back to 1970, she noted an increase in loss-adjusted availability of fruits and vegetables, even though availability still does not come close to the MyPlate recommendations.

Buzby shared data on food loss at the retail and consumer level for a variety of commodities in 2010 (see Table 2-5). As noted earlier, the estimated total postharvest food loss was 133 billion pounds, or 31 percent of the food supply. Total loss at the retail level was 43 billion pounds, or about 10 percent of the food supply. At the consumer level, losses were almost 90 billion pounds, or 21 percent of the food supply.

Food losses vary by commodity, as Buzby illustrated in Figure 2-8. She explained that the figure shows the amount of food loss for each food group by the length of the bar, measured in billion pounds. For each bar, the two colors show the amount of retail loss (yellow) and consumer loss (blue). She noted the split in losses between retail and consumer, as well as the variance in total losses by food group. For example, for grain products, 39 percent of the loss occurred at the retail level and 61 percent occurred at the consumer level. Added fats and oils was the only food group where a larger portion of loss occurred at the retail level than at the consumer level. Dairy products had the largest loss at the retail level, while vegetables had the largest loss at the consumer level.

Figure 2-9 depicts the three food groups with the highest share of food loss in the United States in 2010 (plus a residual "other" category), as measured by amount (weight in pounds), value (measured in dollars), and calories. If measured in pounds, the top three food groups in terms of loss are dairy, vegetables, and grains. If measured by value, the top three

TABLE 2-4 Loss-Adjusted Food Availability for Carrots (per capita)

Year	Weight[a] (lbs/year)	Loss from Primary to Retail %	Retail Weight (lbs/year)	Loss from Retail to Consumer %
1998	9.53	3	9.24	5.1
1999	9.25	3	8.98	5.1
2000	9.20	3	8.93	5.1
2001	9.38	3	9.10	5.1
2002	8.42	3	8.16	5.1
2003	8.78	3	8.52	5.1
2004	8.72	3	8.46	5.1
2005	8.66	3	8.40	5.1
2006	8.11	3	7.86	5.1
2007	8.05	3	7.81	5.1
2008	8.07	3	7.82	5.1
2009	7.39	3	7.16	5.1
2010	7.61	3	7.38	5.1

Per Capita Availability Adjusted for Loss

Lbs/Year	Ozs./Day	Grams/Day	Calories per Cup Equivalent
4.82	0.21	5.99	52.0
4.68	0.21	5.82	52.0
4.66	0.20	5.79	52.0
4.75	0.21	5.90	52.0
4.26	0.19	5.29	52.0
4.44	0.19	5.52	52.0
4.41	0.19	5.48	52.0
4.39	0.19	5.45	52.0
4.10	0.18	5.10	52.0
4.07	0.18	5.06	52.0
4.08	0.18	5.07	52.0
3.74	0.16	4.65	52.0
3.85	0.17	4.79	52.0

[a]Primary weight for carrots pertains to per capita farm availability.

SOURCE: Prepared by J. Buzby for presentation at the workshop. Data from USDA's Economic Research Service Food Availability Data System. Available: http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system.aspx [July 2014].

	Loss at Consumer Level		
Consumer Weight (lbs/year)	Nonedible Share %	Other (cooking loss and uneaten food) %	Total Loss, All Levels %
8.77	11.00	34.0	49
8.51	11.00	34.0	49
8.47	11.00	34.0	49
8.63	11.00	34.0	49
7.75	11.00	34.0	49
8.08	11.00	34.0	49
8.02	11.00	34.0	49
7.97	11.00	34.0	49
7.46	11.00	34.0	49
7.41	11.00	34.0	49
7.42	11.00	34.0	49
6.80	11.00	34.0	49
7.00	11.00	34.0	49

Grams per Cup Equivalent	Calories Available Daily	Food Pattern Equivalents Available Daily (cups)
128.0	2.4	.047
128.0	2.4	.045
128.0	2.4	.045
128.0	2.4	.046
128.0	2.2	.041
128.0	2.2	.043
128.0	2.2	.043
128.0	2.2	.043
128.0	2.1	.040
128.0	2.1	.040
128.0	2.1	.040
128.0	1.9	.036
128.0	1.9	.037

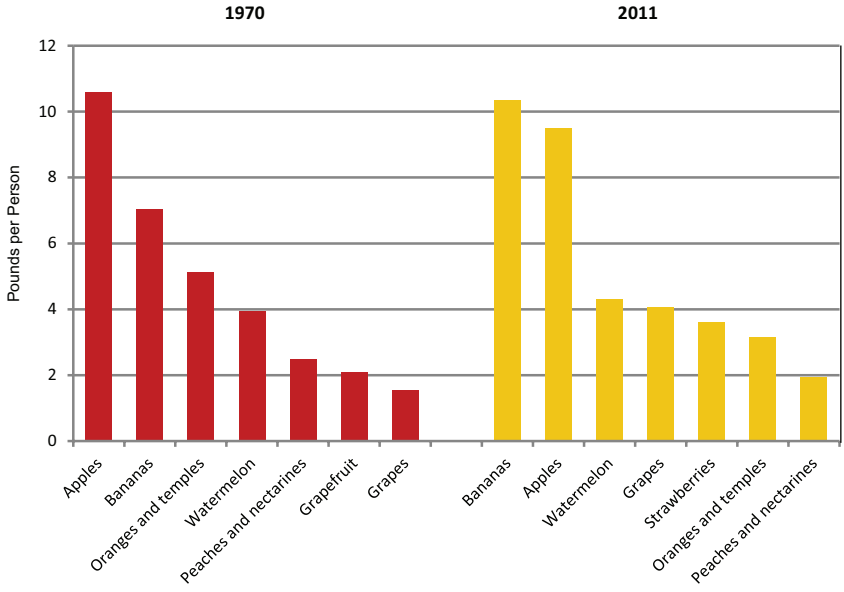


FIGURE 2-5 Most common fruits available for U.S. consumers, 1970 versus 2011.
SOURCE: Updated by J. Buzby for the workshop, based on http://www.ers.usda.gov/data-products/chart-gallery/detail.aspx?chartId=30486 [July 2014].

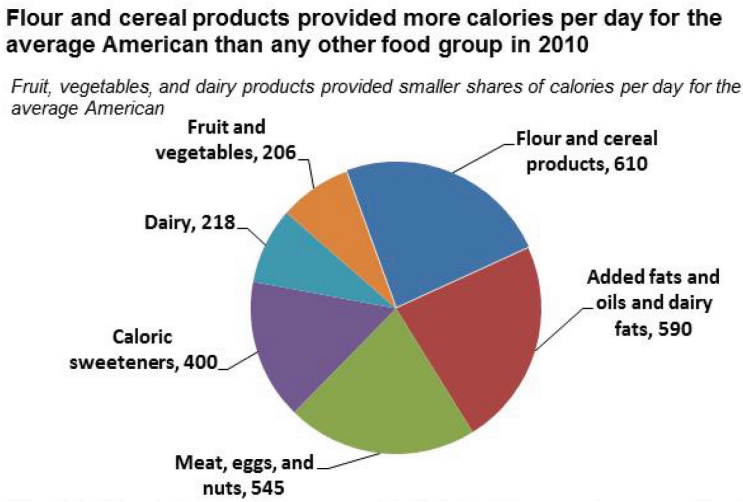


FIGURE 2-6 Loss-adjusted food availability (LAFA) in calories per day by category, 2010.
SOURCE: Available: http://www.ers.usda.gov/data-products/food-availability-%28per-capita%29-data-system/summary-findings.aspx#.U8QhKkA_wwc [July 2014].

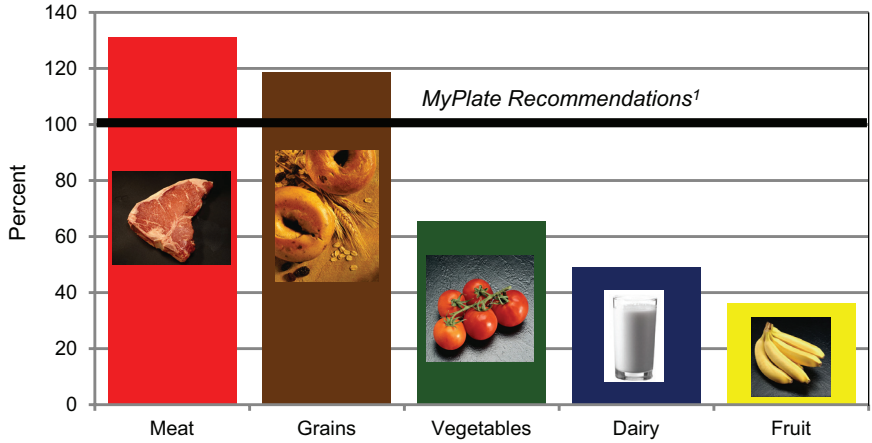


FIGURE 2-7 U.S. diet in five food groups as compared with USDA MyPlate recommendations.
NOTE: Rice data were discontinued and thus were not included in the grains group. Loss-Adjusted Food Availability data serve as proxies for food consumption.
[1]Based on a 2,000-calorie diet.
SOURCE: Updated by J. Buzby for the workshop, based on figure in http://www.ers.usda.gov/data-products/food-availability-%28per-capita%29-data-system/summary-findings.aspx#.U8QhKkA_wwc [July 2014].

food groups in terms of loss are meats, dairy, and vegetables. If measured by calories, the top three groups in terms of loss are grains, added sugar and sweeteners, and added fats and oils—the ingredients in calorie-dense foods, she pointed out. Comparing the first two charts in Figure 2-9, on a value basis the meat, poultry, and fish category constitutes 30 percent of the total value, but only 12 percent of the total weight, because foods in this group tend to cost more per pound than many other foods.

Buzby turned her presentation to ERS initiatives for improving the LAFA data series, noting that the ERS long-run goal is to update the data series by reviewing, updating, and documenting each loss estimate for each individual commodity to the most recent year of data available.

In the past two decades, ERS had two cooperative agreements to update the farm-to-retail weight loss factors, one with the University of Minnesota's Food Industry Center (TFIC), and the other with Pennsylvania State University and the International Life Sciences Institute (ILSI). ERS commodity analysts are using some of these estimates in both the supply and use spreadsheets and the loss-adjusted spreadsheets.[12]

[12]See the following link for more detail: http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system/loss-adjusted-food-availability-documentation.aspx [June 2014].

TABLE 2-5 Estimated Total Food Loss in the United States, 2010

	Losses from Food Supply[a] (billion pounds)		
Commodity	Retail	Consumer	Total
Dairy products	9.3	16.2	25.4
Vegetables	7.0	18.2	25.2
Grain products	7.2	11.3	18.5
Fruit	6.0	12.5	18.4
Added sugar and sweeteners	4.5	12.3	16.7
Meat, poultry, and fish	2.7	12.7	15.3
Added fats and oils	5.4	4.5	9.9
Eggs	0.7	2.1	2.8
Tree nuts and peanuts	0.2	0.3	0.5
Total	43.0	89.9	132.9

[a]Totals may not add due to rounding.
SOURCE: Prepared by J. Buzby for presentation at workshop, based on Buzby, Wells, and Hyman (2014, p. 12).

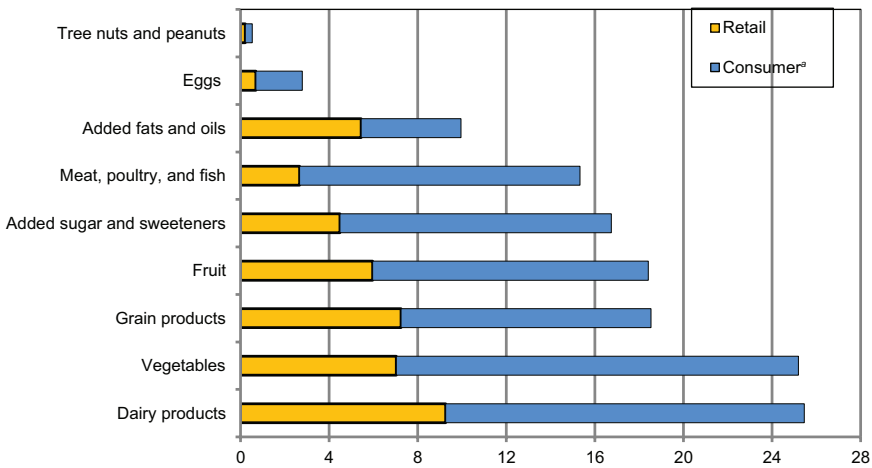


FIGURE 2-8 Quantity losses at the consumer and retail levels for nine food categories (measured in billion pounds).
[a]Includes loss in the home and away-from-home locations. Includes cooking shrinkage and uneaten foods.
SOURCE: Buzby, Wells, and Aulakh (2014).

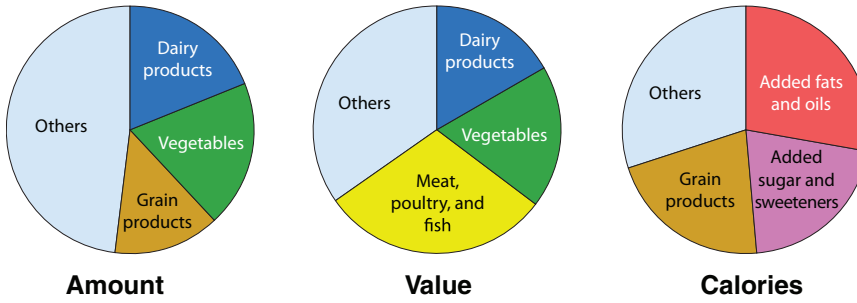


FIGURE 2-9 Annual food loss of top three food groups measured by amount, value, and calories.
SOURCE: Buzby, Wells, and Aulakh (2014).

Buzby went on to say that for the losses at the retail level in 2005-2006, ERS sponsored retail-level loss assessments for fresh fruits, vegetables, meat, poultry, and seafood, and it adopted the new methods in February 2009 (see Buzby et al., 2009). ERS recently received new data from the Perishable Groups, now part of Nielsen, for 2011 and 2012, and is in the process of reviewing this new information. Buzby noted that the new data include qualitative information from produce, meat, and seafood managers about where and why food loss occurs at the retail level. She said many retail-level loss estimates need updating and documenting, particularly added fats and oils, added sugars and sweeteners, fluid milk and dairy products, grain products, processed fruits and vegetables, eggs, and peanuts and tree nuts. Retail losses for some of these commodities have not been updated since 1997 (see Kantor et al., 1997).

Through a grant with RTI International, ERS obtained loss estimates at the consumer level for most of the commodities in the LAFA data series and adopted them in the LAFA data in August 2012 (see Muth et al., 2011). However, she noted, not all consumer-level loss estimates were reviewed and revised at that time, and many could be revisited, such as dry edible beans, peas and lentils, and certain commodities in the following food groups: fruits and vegetables, beverage milks, grains, sugar and sweeteners, and added fats and oils.

Many of the challenges associated with the core FA data described by Jekanowski in the previous section also apply to the LAFA series, Buzby said. Additionally, she stated, the preliminary loss-adjusted series has some of its own challenges. Buzby noted that data limitations prevent ERS from estimating total food loss across all commodities at the farm level and at the farm-to-retail levels. Although ERS could consider doing

an exploratory analysis to see if they could do a summary total for retail, this would require a new study, she explained.

Buzby summarized additional challenges and potential opportunities with the LAFA series. First, as noted previously, the loss-adjustment percentage estimates are the same each year from 1970 to the most recent year, with a few exceptions. (Beef is one such exception, where some conversion factors, from the carcass weight to the boneless weight, changed between 1986 and 1996, reflecting a closer trimming away of fat.[13]) She said validating and updating adjustment factors is a potential opportunity for improvement.

Another limitation she noted is that the data series does not adequately reflect retail-level food donations to food banks and other charitable organizations, or the transfers of unsold food to thrift shops for sale at lower prices. This means that some food currently classified as a loss may be consumed, and thus is not a food loss.

Buzby questioned the structure of the data series, in particular the point at which the inedible share of food is removed. She asked whether the ERS approach is as consistent and accurate as possible. She also said users have said they would like to see the consumer-level food loss estimates split into loss at home and loss away from home. She noted that the same could be said for food available at home versus food available away from home.

Other users have asked for finer levels of consumer-level loss detail, such as plate waste, or cooking loss, but these requests may require data that do not yet exist. She suggested a possible solution might be the addition of a separate column for cooking loss, although this addition would require work to verify its feasibility. She said the series could also be improved by better accounting for processed foods, especially in food imports and exports.

Buzby reminded the audience that unlike the core FA series, the LAFA series only goes back to 1970. She stated that the LAFA data expressed in terms of calories and food pattern equivalents are particularly important. ERS also uses the embedded loss assumptions to estimate the amount, value, and calories of food loss at the retail and consumer levels.

She said that, like the FA estimates, the LAFA series serves as a proxy for actual consumption for over 200 commodities in the United States. LAFA provides estimates for individual commodities and food groups. There are some commodities for which FA data are available, but LAFA data are not. For example, coffee, tea, and cocoa are not part of the major food groups tracked in LAFA.

She ended by saying that like the FA data series, the LAFA series is

[13]This change is illustrated in Table 3-1 in Chapter 3, but for pork rather than beef.

particularly useful for studying food consumption trends, and pointed to a later session in the workshop (summarized in Chapter 3) for a discussion of uses of the data. She pointed out the additional limitation of keeping up with changes that impact assignment of losses to a sector. For example, in recent years, supermarkets are providing more fruits and vegetables in cut-up form. This packaging probably shifts loss formerly taken at the consumer level to the retail (supermarket) level and has not yet been accounted for in ERS estimates, she said.

OPEN DISCUSSION

Sarah Nusser (Iowa State University) asked whether the new data from NASS on consumption of grains and oils that will replace the Census Bureau's discontinued Current Industrial Reports (CIR) will use the same methodology. Jekanowski replied that for the most part, NASS is planning to replicate what the Census Bureau produced. However, the agency is rethinking what data can be collected and what would be useful to collect. NASS is surveying the major USDA users, such as ERS and the World Board, to make sure the new survey will satisfy the needs of the greatest number of users. For example, NASS may collect information on the amount of grain sold from mills as whole versus refined grain, data the Census Bureau did not collect.

Laurian Unnevehr (University of Illinois at Urbana-Champaign) noted that the level of commodity disaggregation in the FA data has increased over time. As an example, she said she found 10 years of data on kale in the vegetable series. She asked how the FA data series has evolved and whether it is because NASS is collecting more detailed data on things like horticultural crops. Jekanowski replied that if kale and other foods are reported in FADS, it is because the data are available from NASS. He reminded the audience that because of budget cuts, NASS planned to suspend reporting on most of their vegetable production data for the 2012 production season. ERS was concerned about the potential impact on the FADS data, but NASS reinstated most of those reports.

Helen Jensen (Iowa State University) asked if FADS incorporates grains produced and put in multi-ingredient or composite products that are exported or imported. For example, she asked, if wheat is put into cookies that are exported, is that counted as a loss? Buzby replied that FA and LAFA data are commodity-based; as such, they include foods like wheat flour and oats but exclude multi-ingredient foods like pasta, breads, and cookies. She noted a study (Batres-Marquez and Jensen, 2002) that analyzed imports and exports of processed grain products as the only work done in this area, but agreed, with increasing imports and exports of processed foods, it is becoming a more important issue. She said it might

be possible to make such an adjustment at the retail level, but the details would need to be worked out. She said this is an area where the LAFA data could be improved.

Josef Schmidhuber (Food and Agriculture Organization [FAO]) referred participants to his later presentation on the FAO approach to identifying imports and exports of commodities in processed foods (summarized in Chapter 4). A commodity like wheat is not eaten as wheat but in products like noodles and bread, he pointed out. The challenge is not just accounting for traded processed products, but many foods, such as breakfast cereals, are composite foods of many ingredients, and it is not clear how spreadsheets can account for them. He noted that FAO is confronted with the same problem, but for more than 180 countries, including the United States.

The FAO approach to dealing with multi-ingredient or processed foods is quite complex, he said. Methods to account for such foods are needed not only for trade, but also for all elements of the balance sheet. Processed products are also in storage, and all are consumed. Wheat can be stored as grain, but it can also be stored as flour and cookies. Buzby agreed that the lack of data on composite or multi-ingredient foods is an issue for the FADS estimates of food availability and loss.

Schmidhuber asked whether FADS considers availability to occur at the farm level or at the retail level and whether the system makes any adjustment for waste at the farm level. Jekanowski replied that for the most part, FADS starts with availability at the farm level. There are some minor adjustments, for example, going from carcass weight to retail weight to boneless weight, that will account for loss at the retail level. However, it all derives from the farm level.

Schmidhuber reminded the audience of Jekanowski's statement that food availability is sometimes computed as a residual, noting that FAO faces the same problem. In an ideal situation, food consumption would be estimated directly, not as a residual. He noted that food consumption is the least elastic of all forms of consumption, at least in the United States. If it is computed as a residual, the estimate includes all the uncertainty that is actually in all the other variables of the balance. He noted this is one of the elements that the FAO would like to change in its system. Jekanowski replied that the way food availability is computed in FADS reflects the data that are available. He reminded the audience that for most of the major grains, oil, and seeds, nonfood use was the residual because the CIR data provided food consumption directly.

Schmidhuber noted the adjustment factors and loss coefficients at various stages in FADS are constant over time, but in reality, they are not constant because of such factors as weather or the magnitude of a crop (bumper or failure). He asked whether FADS is considering accounting

for changes in adjustment factors over time. Buzby agreed with the need, noting the impact of new technology such as packaging for fresh fruit to enhance shelf life. ERS calls their loss-adjusted data preliminary because of these data limitations, she explained. She underscored the size of the task of computing time-varying adjustment factors because of the many commodities, many adjustments, and little data. ERS is in the process of analyzing new data on food loss at the supermarket level from the Nielsen's Perishables Group for 2011 and 2012, which may potentially be used to update the current 2005 and 2006 estimates. With these data, she said, ERS may be able to compare the 2005-2006 estimates with the 2011-2012 estimates to obtain a snapshot of change.

Schmidhuber praised the FADS presentation of its aggregates in pounds, calories, and value[14] and asked whether FADS might ever consider aggregating food losses in terms of CO_2 equivalents. He noted the biggest externality of waste in developed companies is in having a too-deep resource footprint, such as too many carbon greenhouse gas emissions. Buzby said that Venkat (2012) documented some of the work to translate food use and losses to climate change impact, but she is not yet sure how ERS will be able to make use of that work.

In answer to a question from Harry de Gorter (Cornell University), Buzby said the food loss estimates consider only the retail (grocery stores, restaurants, small corner shops, hotels, restaurants, hospitals, schools, and so on) and consumer levels. She clarified that at the consumer level, food loss includes both food at home and food away from home. She said that separating these two types of consumer-level losses could be done in the future.

De Gorter referred to Buzby's statement that total postharvest loss is 31 percent of supply and asked how much larger the figure would be if losses on the farm and between farm and processing to retail were included. Buzby explained, in general, that there are very little data on food loss at the farm level. She referred to one study (Kader, 2005), which published estimates of farm loss for fruits and vegetables, but said the data are spotty and not all are recent. She noted internal discussions about an exploratory analysis of the potential for better estimating farm-to-retail level loss. Using cheese as an example, however, she said coming up with estimates would be complicated.

A participant asked whether ERS has had the opportunity to break down the data based upon regional differences that might lead to commodity loss differences, such as rural versus urban, or even geospatial differences. Buzby said data in both the FA and LAFA series are national

[14]See Buzby, Wells, and Hyman (2014).

only, with no demographic breakdowns. She suggested a food consumption survey would be a better fit for this application.

Morvarid Bagherzadeh (Organisation for Economic Co-operation and Development) remarked the supply and use balance sheets are a great input to her work. She asked Jekanowski about reconciling classifications in trade and production. For example, she noted that the spreadsheets seem to start from raw commodities, but most commodities are not traded in raw form. Jekanowski replied that analysts, who work on different commodities, go to great lengths to stay up to date on the most recent and accurate import/export codes for trade. They try to capture all forms of the product.

Erik Dohlman (ERS) said he has worked with trade codes. For beef and other animal products, most exports would be classified and captured as either frozen or chilled, with few meat exports cooked or in other processed forms. In response to de Gorter's earlier question about farm loss, he posited that collecting data on farm loss would be challenging, because they would change every year by commodity. For example, with the California drought, the 2014 almond loss will be very different than a normal year. An analyst would have to go through the entire time series commodity by commodity to estimate farm loss accurately.

Bagherzadeh noted that in other parts of the world, retailers return food that is not consumed to producers, so they shift the loss to another part of the supply chain. She asked whether this is something that ERS would observe. Buzby replied that ERS is not capturing food that might be sent from the supermarket and donated to charity for a tax write-off, but it is another avenue that could be explored.

Alison Kretser (ILSI) asked Buzby if reporting of loss in terms of calories links back to what is reported concerning caloric consumption in the U.S. population from consumption survey data. She also asked whether the LAFA data were integrated with data from the National Health and Nutrition Examination Survey (NHANES). Buzby responded the data are not linked at this time. The estimates for calories available for consumption are provided on the LAFA spreadsheets for individual commodities. On the right-hand side of each spreadsheet, the amount of commodity available for consumption is converted to calories available for consumption per day.

Kretser also asked whether the 34 percent loss at the consumer level for carrots varies by commodity and whether it changes over time. Buzby replied that when she inherited the original FADS from Linda Kantor over a decade ago, the LAFA data series was static across time and commodities.[15] For example, for all fresh vegetables, consumer-level loss was 30

[15]See Kantor (1998).

percent. Since then, ERS has adopted different loss adjustments for each individual commodity at the consumer level using data from Muth et al. (2011) and where data are available.

Susan Krebs-Smith asked if the new estimates for consumer-level loss were applied for all years or for recent years. Buzby replied that ERS adopted the new consumer-level loss estimates for the entire span of the LAFA data series, namely from 1970 to the most recent year available, although some loss estimates have not been updated. For example, ERS has not had an opportunity to update many of the estimates at the retail level, such as for all canned vegetables. This is because the Perishables Group provided ERS with updated loss estimates only for fresh fruits and vegetables, meat, poultry, and seafood at the retail level.

Krebs-Smith said she views the FA and LAFA data in the way Jekanowski introduced them, as a measure of food entering retail distribution channels. She noted that ERS adds caveats to say that the data are not direct measures of food consumption. In her view, the LAFA data provide a good indicator of foods entering retail distribution channels. She said it would be good if there were measures along the food supply chain for the amount of foods, characterization of those foods that manufacturers are producing, the amount that enter retail outlets, the amount that go through food service outlets, and so on. She noted other surveys capture food that comes into the house and food intake. Ideally, she said, the different measures would be aligned so comparisons could improve the understanding of all series. For example, she observed that consumption estimates from NHANES may be biased because of a tendency to underreport. The LAFA data could be used to get a sense of an upper bound on underreporting.

She reminded the audience that it is suspected that the LAFA data do not include all losses. However, when LAFA data, even those from Kantor (1998) with static loss percentages, are compared with consumption data, they align very well for many food groups. Such comparisons provide a system of checks and balances, but, she noted, one series is not supposed to be a proxy for the other. The different data systems are measuring different things, and, she said, it helps to keep those things separate. Buzby noted that Muth et al. (2011) looked at consumer-level loss in many ways, including what people purchased using Nielsen Homescan data minus what people said they consumed in NHANES.

Mary Muth asked Jekanowski about the origins of the data ERS receives from NASS, asking how ERS knows quantities that are used are fresh versus in processed forms, such as canned and frozen. Jekanowski relied ERS generally uses data from NASS directly without adjustment. For many vegetables or fruits, ERS gets estimates from NASS of acres planted for fresh versus acres planted for frozen or canned products. The

product of acreage by yield gives an estimate for production of fresh, frozen, or canned. For most other crop commodities, such as grains, everything gets processed.

Responding to Krebs-Smith, Jekanowski stated that he thinks farm and processing sector losses are minor because farmers and processers have an incentive to minimize losses. They want to maximize the yield and minimize losses for every product. This might not be true in cases where weather events cause products to not be harvested or where products were lost from the food supply for other reasons.

Jensen asked about ways, now that Census has discontinued the CIR, that ERS or NASS could engage industry to collect more data. She suggested some of the larger manufacturers have collected information about losses because of the recent interest in sustainability. They have been recapturing ingredients that might be used in processing or diverting product into food for people that used to go into food for animals. Jekanowski said ERS has not considered engaging industry from a loss perspective, but it would be interesting to consider. He said there may be an opportunity in the future to add new questions now that NASS will be managing the surveys that collect information from industry.

Jekanowski discussed the definition of a loss. If a retailer sends its spoiled meat to a rendering facility and it is recycled into feed, is that really loss, or is it just an alternative use of the product? He noted that the product is not entering a landfill, but it is not being used for human consumption. He stated that it would be useful to sort out some of the terminology.

Schmidhuber noted that according to FAO data, there are very few losses at the farm level in developed countries. However, there are farm losses in developing countries. In a developed country, losses typically occur at the retail and household level, which means policy conclusions in developed countries are entirely different from those in developing country situations. He stated that the real externality in a developed country is that prices are too low and the externality of a too-deep resource footprint (water, land, biodiversity, and greenhouse gasses) is too high. In developing countries, he said, the situation is reversed. The losses take place at the farm or transportation level because of inadequate transportation and storage facilities. The policy implication is hunger can be alleviated by investing in loss reduction, but he said it would not make sense in a developed country to reduce waste in order to fight hunger. However, such a policy is considered, not only in the popular press, but also in other studies.

Schmidhuber said he shares the ERS concern about classifications, particularly because of the massive increase in processed products. As described later in the workshop (see Chapter 4), FAO has tried to address

this through a proposal adopted by the UN Statistical Committee. FAO has worked on mapping the Harmonized System of codes for trade and the Central Product Classification (CPC) for production. At the level of trade disaggregation that is made available by Comtrade, a United Nations' international trade statistics database, there was a one-to-one match. He characterized this as a huge benefit because there is no need for split factors that are required when the result of matching is many-to-many or one-to-many. He noted that the challenge is that not all countries report in CPC, and very few report in the expanded version of CPC. It would be a huge advantage for statistical systems if all countries reported in the expanded version of CPC, he said.

Bagherzadeh said farm-level loss is not small. Instead, she asserted, agencies decide to start from the farm because it is simpler. She noted times when it can make sense economically not to harvest and leave the result on farm. For example, many retail industries in developed countries have contracts with developing countries for fresh fruits and vegetables. However, standards differ by country, and not all loss data are collected. She said some losses in a developing country occur because of the specifications of products wanted by developed countries.

3

Historical and Current Uses of the Data for Economic Modeling and Reporting of Statistical Trends

This chapter summarizes the second session of the workshop, describing historical and current uses of the data from the Food Availability Data System (FADS) for economic modeling and reporting of statistical trends. The moderator of the session was Sarah Nusser (Iowa State University). The presentations of the four speakers in the session are summarized in the following sections of the chapter. Laurian Unnevehr (University of Illinois at Urbana-Champaign) provided an overview on the importance of FADS for research. Helen Jensen (Iowa State University) talked about use of FADS data in economic modeling of food consumption, production, and policy. Susan Krebs-Smith (National Cancer Institute) talked about using food availability (FA) data to examine issues of nutrition and diet quality. Finally, Tabitha Rich (Department of Agriculture and Agri-Food [DAAF], Canada) talked about food availability estimates in Canada. The last section in this chapter summarizes the open discussion at the end of the workshop session.

STATEMENT OF LAURIAN UNNEVEHR IMPORTANCE OF FADS FOR RESEARCH

Unnevehr stated she had two propositions: First, the research stakeholder community for FADS data has greatly expanded over time in interesting ways, and second, while FADS data have been around for a while, they have fresh relevance because they are uniquely suited to answering questions about food system performance via their link between supply

and demand. Some of her comments are informed by looking back at the history of demand analysis, she said, and she pointed to Unnevehr et al. (2010), a review of the field over the past 100 years.

As background, Unnevehr explained that FADS grew out of an agricultural statistical system focused on production estimates. From this early focus, the U.S. Department of Agriculture (USDA) developed an estimate of aggregate demand (disappearance) that reflects basic components of supply: production, trade, processing, and stocks. She added that she uses the word "disappearance," although she said she understands USDA has moved away from the term. She observed that articles published in 2013 include citations using USDA "disappearance" data. To find references to use of FADS data through a Google search, she said it is important to search on both "disappearance" and "availability." She noted the term "disappearance" describes what the data really are—disappearance into the retail system—as Krebs-Smith observed during the previous open discussion (see Chapter 2).

According to Unnevehr, FADS data are uniquely suited for understanding demand at the aggregate or population level, and how supply and demand are linked. Among the questions that FADS is uniquely well suited to answer are: (1) what share of the food supply is imported; (2) which kinds of meats, fruits, vegetables, and dairy products are most consumed; (3) what is the trend in total calories per capita; (4) what share of the food supply is lost or wasted; and (5) how does the U.S. food system compare with other countries?

She noted, for example, that the trend in total calories per capita clearly tracks the rise in obesity. For example, Popkin and Nielson (2003) used food availability data from different countries to talk about the rise in sweetener consumption around the world and how the United States does or does not track with international trends.

She highlighted four main areas in which FADS has been used in research, noting that her list is not comprehensive. The first is in measuring aggregate demand response to changes in supply, market shocks, and advertising. The second is in basic forecasting models of demand, supply, and prices, which she called foundational to understanding what is going on in the food system domestically and globally. The third is in looking at how well aggregate demand reflects dietary guidance, while the fourth is looking at the environmental impact of food demand, the newest area of research.

Unnevehr noted that research stakeholders have expanded over time. Research stakeholders began with agricultural economists for whom FADS was, for a long time, the only source of data available to carry out demand analysis. She said this has become a less important use over time, as the research focus shifted with consumer behavior. Analysts

became more concerned with demand for quality attributes and specific products, and with how consumer demand varies between different types of households, such as those that do and do not receive Supplemental Nutrition Assistance Program (SNAP) benefits. These new needs caused agricultural economists to look for other sources of data, such as retail scanner data and data from the National Health and Nutrition Examination Survey (NHANES), to understand more specific kinds of health outcomes.

Since the development of the nutrient and serving data within FADS, she said, public health economists and nutritionists have published results that use these data to look at nutrition questions. The most recent and growing use of FADS data concerns industrial ecology, life-cycle analysis, and environmental systems, she said, referring to Venkat (2012) as one example.

Unnevehr suggested it might be useful to track the use of FADS data in research through Internet search engines, warning, however, that the data are not always referred to as "food availability data" even though FADS data are being used. An analysis of use of the data over time might provide guidance about their value to research stakeholders, and identify who those researchers are and their real data needs.

She showed a figure from Morrison, Smith, and Lin (2009) to illustrate different data sources for unflavored milk consumption (see Figure 3-1). The four sources are Homescan, Nielsen household panel data based

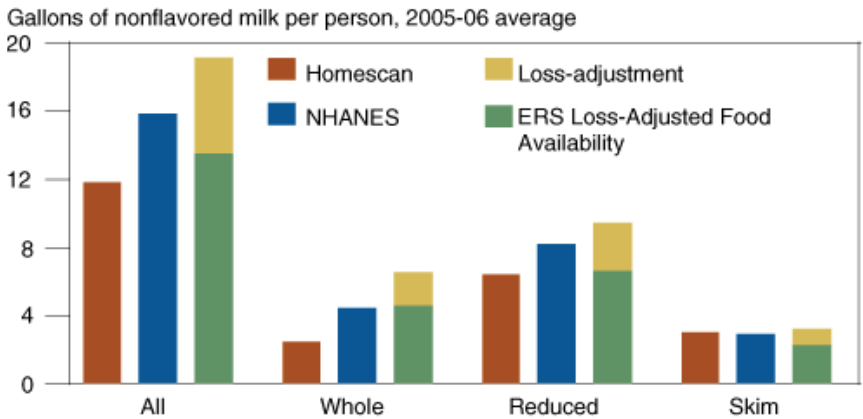


FIGURE 3-1 FADS as one source of food consumption data, with milk as an example.
SOURCE: Morrison, Smith, and Lin (2009).

on scanner data on purchases by households,[1] NHANES data, the Loss-Adjusted Food Availability (LAFA) series, and the FA data series (shown as the aggregate of the LAFA series and the loss adjustment). As she explained, the first bar in each series (red) represents purchases. The second (blue) bar represents intake. The third bar, with two colors, represents FA as aggregate of the LAFA (green) and the loss adjustment (gold) data. She noted that the figure illustrates how close all these estimates are even though different things are being measured, but also shows that the FA series consistently gives the largest estimate of consumption.

She reminded the audience about questions FADS cannot answer, such as the demand for specific food products. The level of disaggregation in FADS, while impressive, can never be complete, she noted. While there may be estimates for kale, for example, there may not be estimates for arugula or another green. Similarly, FADS cannot be used to answer questions about how food demand varies with household characteristics such as receipt of SNAP benefits. It cannot answer questions about demand for different food products and/or for quality attributes of food. And finally, it cannot be used to address the demand for food away from home versus food at home.

Unnevehr described several examples of research, beginning with the historical use of the data. By providing a consistent measure of aggregate demand over time, FADS supports models of supply and demand to answer questions such as how commodity prices are expected to change in the future. In general, in these kinds of models, per capita consumption of foods in major commodities is used to estimate the relationship between supply and demand and the changes that result in new prices. As has been noted previously, demand in the United States is inelastic. Population and income growth lead to growth in total demand. For many commodities, supply is predetermined in the period of analysis, and the analysis considers how changes in supply intersect with demand to give new equilibrium prices in the future. This kind of analysis is used for a wide variety of policy questions, as described by Jensen later in the workshop session.

Unnevehr emphasized that supply and demand analysis is a foundational use of FADS data. In the 1980s, there were many estimates of meat demand, all trying to answer the same question with the same limited FADS data. The question of concern was whether the rapid increase in chicken consumption relative to beef was driven by the decline in the relative price of chicken or by an actual shift in preference. All of the analyses used FADS data, with mixed results. These mixed results forced research-

[1]For a discussion of the accuracy of this dataset, see http://www.ers.usda.gov/publications/err-economic-research-report/err69.aspx#.U63LAxbXFfM [July 2014].

ers to conduct more detailed analysis of specific kinds of consumers and specific kinds of products. The most recent use of FADS data for analysis of meat demand changes was in McGuirk et al. (1995), she noted.

Unnevehr noted that the bibliography contains several references to food system demand estimates (Beatty and LaFrance, 2005; LaFrance, 2008). She said FADS remains one potential source for estimating demand systems, but there are many competing sources. Depending on the research questions, analysts may choose to use retail scanner data or some other source of information for estimating demand, with a decline in the use of FADS in published demand studies.

She provided a few exceptions to that trend, such as the generic advertising in the USDA-supported Got Milk campaign and campaigns for other commodities. Milk producers contribute a share of sales into a fund that pays for generic advertising for their commodity. Because an analyst is trying to measure the impact of advertising on aggregate commodity usage, FADS data are widely used. As another example, Zheng, Kinnucan, and Kaiser (2010) used FADS data on beverages to estimate how private advertising expenditures had a different kind of impact on demand for soda than the generic advertising expenditures for milk. This analysis estimated how advertising expenditures rotate demand curves with special interest in how generic dairy advertising influences milk demand.

She said that Piggott and Marsh (2004) provide another example, using one of the building blocks of FADS: quarterly data on meat disappearance from supply. Their analysis examined consumers' responses to food safety media coverage of major food safety events related to meat, such as major published recalls. They found short-lived effects of significant media events.

In contrast to Piggott and Marsh (2004), Unnevehr said most studies of food safety incidents have used scanner data, including a study by Arnade, Calvin, and Kuchler (2009) of the spinach *E. coli* outbreak in 2005 and its impact on lettuce demand. This analysis used scanner data to relate weekly changes in consumption of leafy greens to announcements about the outbreak and its severity. The advantage of scanner data for this type of analysis is that there is more time and product specificity. In summary, she said, FADS data are just one of several different sources that people can use to study market impact questions.

She described growing areas of importance concerning the use of FADS. The first is nutritional epidemiology, including Willett (2012), a work with more than 500,000 citations that she said might be the most cited reference that has used the food availability data. Willett addressed the question of how different patterns of food consumption correlate with the incidence of disease and devoted the first chapter to an example of

basic nutritional epidemiology: an examination of the simple correlation between meat consumption and incidence of colon cancer that indicates that countries that eat more meat have more colon cancer. Then, she said, the author discussed the limitations and value of these kinds of epidemiological studies. Such studies are valuable for setting up hypotheses for more controlled investigation.

Guo et al. (2011) provide another health sector use of FADS data: an examination of the incidence of pathogens and foodborne illness as they relate to food commodity sources. The authors developed a model that used many different data sources, including FoodNet[2] data on foodborne illness and FADS data to represent consumption. Their risk assessment model for salmonella found that chicken is likely the primary source of salmonella foodborne illness in the United States because of the high incidence of salmonella on chicken and high consumption of chicken.

Unnevehr also cited Young and Kantor (1999) and Buzby, Wells, and Vocke (2006) as examples of research that considered how U.S. food production might change if diets matched nutritional guidelines. She noted that these were fairly simple assessments that considered how crop acreage would need to shift for production to meet demand that follows dietary guidance, without consideration of how international trade might change or whether new equilibrium prices would alter demand. She noted renewed interest in this question as shown by recent citations of these articles in papers regarding local foods and sustainable food supply. These references provide a provocative thought experiment about what it would take for the U.S. population to eat a healthier diet and what it would mean for the food system, she observed.

Unnevehr said there are more in-depth analyses of different economic policies and how those policies would promote healthier diets. She noted that Jensen will discuss Miao, Beghin, and Jensen (2012), which used FADS data to look at the impact on consumption of taxing sweeteners at different places in the supply chain. In contrast, she said, Okrent and Alston (2012) built a complete system to look at the impact of a calorie tax or of a fruit and vegetable production subsidy without using FADS. Through a complex framework, the authors related supply elasticities based on NASS production data to intake and obesity data from NHANES. Unnevehr observed that these two recent and contrasting studies—one on sweeteners that was built on FADS data (Miao et al., 2012) versus one that considered the whole system and its relationship to an obesity outcome that did not use FADS data (Okrent and Alston, 2012)—illustrate that FADS is one of many data alternatives. It will meet some research-question needs better than others, she said.

[2]See http://www.cdc.gov/foodnet/ [July 2014].

Unnevehr talked about new work on the impact of the food system on the environment that uses FADS. For example, Venkat (2012) addressed the question about the extent to which food waste contributes to greenhouse gas emissions. He used FADS estimates of losses for 134 commodities and separated out losses at the consumer level versus those in the production supply chain. Venkat called the losses up to the consumer level unavoidable and losses at the consumer level avoidable, estimating that "avoidable" food loss (at the consumer level) accounted for 2 percent of U.S. greenhouse gas emissions.

Weber and Matthews (2008) used FADS in a paper highly cited because of its findings in environmental science and technology, she said. To look at how food transportation contributes to greenhouse gas emissions, the authors combined FADS with the U.S. Department of Commerce Commodity Flow Survey to evaluate the relative impact of changing transportation versus dietary patterns on greenhouse gas emissions. She noted that those familiar with the food system would not be surprised that the authors found transportation is a much smaller contributor to emissions than food production. Therefore, changes in diets that would spur changes in the production mix would reduce emissions more than eating locally produced foods. Part of the reason the article is widely cited, she said, is the current interest in sustainable diets and whether changes in consumption patterns in high-income countries might promote a more sustainable global food system.

Unnevehr closed by returning to her two initial propositions. First, a vastly expanded stakeholder group for the FADS data goes beyond the traditional agricultural economics constituency. Uses of the data now show up in a wide variety of fields in public health, nutrition, and various kinds of environmental analysis. Second, questions about food system performance; how well it meets social, environmental, and nutritional needs; and how well it is performing and delivering an affordable food supply are not going away, but are becoming more detailed and pressing. She said FADS is key to answering those questions, and the loss estimates, in particular, are critical because they lead to a better characterization of demand that gets closer to intake and to understanding environmental impacts.

STATEMENT OF HELEN JENSEN ECONOMIC MODELING OF FOOD CONSUMPTION, PRODUCTION, AND POLICY

Jensen talked about economic modeling relating to food consumption, production, and policy to provide a closer look at examples of the way FADS data are used to address policy questions. She noted that the

workshop session includes a lot of information about what FADS provides and that she will use the term "disappearance." The FA and LAFA data are estimates for food available for consumption. The system uses an accounting conversion to get from supply availability to retail availability. She stressed the importance of that conversion.

She reiterated that FADS data are in an aggregate form, so they are consistent with what is supplied. Consistency is important, she said, because it supports linkage of what is produced to what is available for consumption. Conversion factors are used to move from raw product to retail form. The methodology embedded in FADS allows for aggregation of commodities. To determine total fruit or greens availability, for instance, one adds up pounds of various kinds of fruits or pounds of greens to get at total pounds of food. For some uses, it is very important to have factors that allow this kind of aggregation.

She noted that the conversions are done in a consistent way, albeit possibly historic and not updated as frequently as is desirable, using food availability of pork to illustrate the updating of the conversion factors between 1981 and 2000 (see Table 3-1). She pointed out that in 1994, the conversion at retail for pork was 0.78 and for boneless it was 0.72. The conversion factor for retail is 0.78 for all years, but the conversion factor for boneless changed over the period from 1981 to 1989, then remained constant. She said that the change in the boneless conversion factor over time reflects an investment by the Economic Research Service (ERS) that resulted in an update to the series that was done in a consistent way.

Jensen then explained Table 3-2, which illustrates the conversion to retail factors for different products. The carcass weight conversion to boneless pork is 0.72, the carcass weight of beef to boneless beef is 0.67, and the carcass weight to boneless for broilers is 0.60. Jensen pointed out that potatoes are available in FADS in three different forms (fresh, frozen, and chips or shoestrings). As eaten fresh, the conversion to retail is 0.96, but to convert pounds of potatoes into pounds of chips the conversion factor is 0.24, reflecting the fact that 0.24 pounds of potatoes is in 1 pound of potato chips.

Jensen stated that to look at disappearance of potatoes and move back to the production system, the conversion factors allow the analyst to move between the food availability series and back to the raw product. She noted that this is important for some uses that have become more important over time, such as studying the land used in production or the energy used in processing products into different forms.

Jensen provided three examples of uses of FADS data. The first, documented in Miao et al. (2012), was a study that looked at policies to reduce consumption of sweeteners through a consumption tax and through a

TABLE 3-1 Segment of the Food Availability Spreadsheet for Pork

	Food Disappearance		
	Total (millions of lbs.)		
Year	Carcass	Retail	Boneless
1981	16,058.3	12,461.2	11,481.7
1982	14,528.0	11,288.2	10,416.6
1983	15,452.8	12,022.3	11,110.6
1984	15,482.6	12,060.9	11,163.0
1985	15,733.3	12,272.0	11,375.2
1986	15,003.0	11,687.4	10,877.2
1987	15,224.6	11,844.7	11,068.3
1988	16,422.6	12,760.4	11,955.7
1989	16,422.1	12,743.6	11,971.7
1990	15,912.3	12,348.0	11,600.1
1991	16,261.0	12,610.5	11,854.3
1992	17,317.0	13,438.0	12,624.1
1993	17,305.0	13,428.7	12,615.3
1994	17,698.0	13,733.6	12,901.8
1995	17,682.8	13,721.9	12,890.8
1996	16,727.0	12,980.2	12,194.0
1997	16,747.0	12,996.7	12,208.6
1998	18,247.0	14,159.7	13,302.1
1999	18,898.8	14,666.2	13,778.0
2000	18,503.0	14,358.3	13,488.7

SOURCE: Prepared by H. Jensen for presentation at the workshop. Data from Economic Research Service Food Availability System, see http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system.aspx [July 2014].

tax on the input sweeteners. Four different sweeteners were considered: sugar, corn sweetener, other (including honey), and artificial sweeteners.[3]

As Jensen explained, the study considered nine sweetener-intensive

[3]Artificial sweeteners include sugar substitutes (mannitol, sorbitol, etc.) and artificial sweeteners (solids).

Per Capita Availability (lbs.)			Factors (%) for Converting Carcass Weight to	
Carcass	Retail	Boneless	Retail	Boneless
69.8	54.2	49.9	0.78	0.715
62.6	48.6	44.9	0.78	0.717
66.0	51.3	47.4	0.78	0.719
65.5	51.0	47.2	0.78	0.721
66.0	51.5	47.7	0.78	0.723
62.3	48.6	45.2	0.78	0.725
62.7	48.8	45.6	0.78	0.727
67.0	52.1	48.8	0.78	0.728
66.4	51.5	48.4	0.78	0.729
63.6	49.4	46.4	0.78	0.729
64.1	49.8	46.8	0.78	0.729
67.4	52.3	49.1	0.78	0.729
66.5	51.6	48.5	0.78	0.729
67.2	52.1	49.0	0.78	0.729
66.3	51.5	48.4	0.78	0.729
62.0	48.1	45.2	0.78	0.729
61.4	48.6	44.7	0.78	0.729
66.1	51.3	48.2	0.78	0.729
67.7	52.5	49.3	0.78	0.729
65.5	50.8	47.8	0.78	0.729

food markets: breakfast cereal/bakery, cheese,[4] condiments, ice cream, juice, milk, processed fruits/vegetables, soft drinks, and sweetener products. The study considered the supply of sweetener-intensive foods from processors, used existing demand elasticities compiled by ERS, and con-

[4] Cheese spreads are examples of sweetened cheese products.

TABLE 3-2 Conversion Factors Reflecting Changes to the Product Through Processing from Commodity to Retail Product

Commodity (primary weight)	Conversion Factor	Retail Product
Pork (carcass weight)	0.729	Pork (boneless)
Beef (carcass weight)	0.669	Beef (boneless)
Broilers (carcass weight)	0.600	Broiler (boneless)
Potatoes (pounds)	0.960	Potatoes (fresh)
Potatoes (pounds)	0.500	Potatoes (frozen)
Potatoes (pounds)	0.245	Potatoes (chips and shoestrings)

SOURCE: Prepared by H. Jensen for presentation at the workshop. Data from Economic Research Service Food Availability System, see http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system.aspx [July 2014].

sidered the equilibrium between supply and demand. It looked at the effect on sweetener consumption of taxes applied either to the input or to the final product and evaluated consumer welfare changes.

The FA data measure the use of raw and semi-processed agricultural commodities from which a final food product is made. The study used the cost share of sweeteners (value of shipments) from the Current Industrial Reports (CIR).[5] The study created a ratio adjustment that looked at the food disappearance data relative to what was estimated as going into industry. She went on to say that for some products, like cereals, the ratio was close to 1. Amounts included in products of the cereal industry were close to amounts of food disappearance: in other words, there is not much loss from processing to final goods. For other products, this was less true, possibly because of trade (imports or exports) and also perhaps the data series are not completely aligned. These ratios allowed the authors to calibrate the model so that it reflected final use or consumption.

Jensen reported that the authors applied available ERS and other demand elasticities for foods. They estimated the tax rate required on caloric sweetener input to achieve a 10 percent reduction in use of sweeteners and found the rates required would be a 27.5 percent tax on sugars and a 43 percent tax on high-fructose corn sweetener, while for other products, a tax had no impact. If the tax were to be applied on final products, a tax of nearly 40 percent on sweetened products would be needed to achieve a 10 percent reduction in use of sweeteners. The study mea-

[5]Jensen stated she does not think that sweeteners are among the products NASS is considering adding back to their survey system to replace the CIR data. She said she hoped that the Miao et al. (2012) study might give some support for collecting data on sweeteners. In her view, there may be more uses for these data than for some of the commodities being considered, such as wheat and corn.

sured consumer welfare loss and found it to be five times greater when the tax was applied at the consumer level than it would be if applied at the manufacturing level. She said the analysis did not fully capture that processors can substitute input ingredients more easily than can consumers. The FADS contribution to this study, she noted, was the ability to link manufacturing shipments data to consumption through the FA data series and the adjustment ratio to analyze consumer demand for sweetened products. She reminded the audience of the caveats, saying that the analysis was not perfect, but it may be useful.

Jensen went through a second example, the Food and Agricultural Policy Research Institute[6] (FAPRI) model at the University of Missouri and Iowa State University. This large-scale model uses some FADS data and, she suggested, it might benefit from greater use. For example, the outcome could be expressed through FA to show results relative to food use. Methods used in FAPRI are similar to economic modeling done within ERS.

The objectives for FAPRI are to provide baseline projections for the U.S. agricultural sector and international commodity markets, and then to examine the impacts of policy changes on production, consumption, farm and retail prices, farm income, trade, and government costs. The FAPRI model is in equilibrium in the baseline period and makes projections for from 10 to 15 years forward from the year of the baseline to illustrate both the baseline and the policy change. As examples of policy analysis that used FAPRI, she listed

- multilateral trade and agricultural policy reforms in sugar markets;
- analysis of the link between ethanol, energy, and crop markets;
- effect of growth in ethanol's use on commodity prices and land use;
- long-run impact of corn-based ethanol on the grain, oilseed, and livestock sectors;
- renewable fuel standard waiver for 2014 and beyond;
- factoring greenhouse gas emissions from land use change into biofuel calculations; and
- impacts of selected provisions of the House and Senate Farm Bills (2013) (excluding the nutrition title).

Jensen pointed out that none of these areas of analysis mention diet and what goes on with respect to the consumer level. The FAPRI model is not well designed at this point to conduct that type of analysis, she said.

[6]See FAPRI (Missouri) http://www.fapri.missouri.edu [July 2014] and CARD (Iowa) http://www.card.iastate.edu/research/tap [July 2014].

Jensen reviewed the U.S. and international commodities covered in the FAPRI model, which include biofuels, dairy, grains, livestock, oilseeds, and sugar. Fruits and vegetables are included in a small satellite model that allows the model to solve and predict either the consumer price index (CPI) or the effect on categories within the CPI. She said these satellite models are fairly rudimentary, and one innovation might be to include adjustments to account for the processing sector. The model is used to estimate the expected price changes at the retail level.

She said country coverage in the international model is quite broad, though certain countries are included for only specific commodities, such as wheat only or corn only. Major countries are represented in the FAPRI models. Some large areas, such as Africa, are represented both by individual country models and by an aggregate to reflect the rest of the region.

Jensen described the structure of the FAPRI model, in which equilibrating supply and demand comes about through price changes. In the baseline period, the system is in equilibrium, and a policy change from that baseline affects the supply side, causing the different commodity markets to adjust. There is continual updating to find world (and some country-specific) market-clearing prices.

She said the models can be made so that changes in the livestock sector affect the food sector and vice versa. Macroeconomic conditions, including macroeconomic projections from large-scale databases, are included to reflect unemployment rates and aggregate income. She noted that if the livestock sector is going to try to expand, it takes a while for the expansion to occur for beef but less time for poultry. These kinds of constraints (including biological constraints) are based on historical data and built into large-scale models. Imports and exports determine the residual to equilibrium that is achieved through international prices.

Jensen pointed out that the focus of the model is on supply and production, not foods as consumed. The supply response depends on changes in net returns and behavioral responses. Calories and per capita food demand do not have an impact, at least for the industrial, higher-income countries, she said, although this is less so for countries with lower incomes, where the macro conditions (income) will have an impact and demand drives changes to the system.

She characterized FAPRI as a partial equilibrium model. It does not account for the impact of changes on population, income, or costs to all sectors of production. Other large-scale modeling systems have different modeling approaches and assumptions. For example, she noted, Global Trade Analysis Project (GTAP) models are general equilibrium models. Each large model has its own structure, whether driven by regional focus, general equilibrium, or partial equilibrium. In most cases, Jensen said, models have some biological constraints built into the supply response.

The FAPRI model is built on net returns and behavioral responses to returns. When prices increase and producers see a higher price, they respond by increasing available supply.

As her third example, Jensen described the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) developed through the International Food Policy Research Institute (IFPRI).[7] This large-scale model includes a system of equations to model global food demand, supply, trade, income, and population with 115 geopolitical regions in the world and the main agricultural commodities. Supply, demand, and prices are determined within regions, and the regions are linked through trade that is computed as a residual. The supply and demand functions incorporate elasticities to approximate the underlying production and demand. Demand (the sum of demand components) is determined by prices, income, and population. World agricultural commodity prices are determined annually at levels that clear international markets. IMPACT is used to analyze world and regional food and resource issues.

She noted a unique aspect of IMPACT: its effort to determine availability of calories at the equilibrium of supply and demand. The commodities are converted into consumption and estimates for a region's percentage of population; different outcomes, such as hunger, malnourished children, female access to education, and availability of health and sanitation, are examined under different policy changes.

Jensen pointed to Jensen (2011) to illustrate how international data from the United Nations' Food and Agriculture Organization, similar to FADS, can be used (also discussed later in the workshop, see Chapters 4 and 5). The study examined the share of protein that comes from animal products, by country, versus gross national income (GNI) measured in U.S. dollars. The author identified a possible relationship between protein consumption and GNI: a function that increases rapidly at lower levels of income, and increases at a declining rate with larger incomes. She noted that analyses like these rely on the availability of data series that are consistent over time and geography.

Jensen ended her presentation by noting several features of the FADS data that support their utility for policy analysis. First, the data provide a consistent series of food use (disappearance) over time. She emphasized the importance of the conversion factors, because they express the relationship between the agricultural product (commodity) and what is available for consumption (retail). That relationship changes with technology and with consumer taste.

[7]For more information, see http://www.ifpri.org/publication/international-model-policy-analysis-agricultural-commodities-and-trade-impact-0 [June 2014].

Large-scale models are developed to account for the interaction between supply and demand, and to look at policy changes relative to this baseline. For the United States and other industrialized economies, the issue of food production (supply) dominates policies; the United States makes fewer policy changes at the retail or consumer levels. In international global markets, she said, demand changes due to population and income growth, and trade effects are bigger drivers.

STATEMENT OF SUSAN KREBS-SMITH USES OF FADS DATA TO EXAMINE ISSUES OF NUTRITION AND DIET QUALITY

According to Krebs-Smith, one major use of the food availability data is to evaluate the American diet in its most generic sense. She said she views the FADS data not as a proxy for consumption, but as a measure of food entering retail distribution channels with implications for consumption. Two other key uses she identified are to examine the potential of the food supply to meet the nutritional needs of the U.S. population, and to monitor changes and historical trends. She noted that the FA data series goes back to 1909, and the LAFA data to 1970. ERS has used consistent methodologies, even through its activities to implement updates. This makes the data very good for studying historical trends.

Krebs-Smith noted her interest in using the food availability data to answer questions related to nutrition and diet quality because of the impact on the chance of developing disease. In thinking about the full food supply chain, what people eat is affected by what is available in the household, in food outlets and grocery stores, and so on up the chain. The FA data provide a metric for foods that are entering the food supply chain. Because food supply ends up downstream and influences what people eat, it is important in terms of health and disease, she said.

Although a major topic of this workshop is a consideration of waste and loss factors, she said measures of waste and loss can obscure the relationship between food availability and food use. She noted that if loss and waste are not accounted for or measured with differential bias, then the relative proportions of availability of one type of food to another might be distorted. She said it is important to understand how the different commodities fare in terms of their waste and loss factors.

Krebs-Smith summarized how nutrient availability data are derived as an example of an important use of the FA data for nutrition and diet quality-related analyses. She explained that to calculate the nutrition estimates, the annual per capita availability estimate for a commodity is multiplied by food composition data for about 27 nutrients found in the edible portion of the food. For all foods, the results are totaled and con-

verted to amounts per capita per day. Nutrients that are added to certain commodities for fortification and enrichment are also included in the nutrient content of the food supply. She noted that nutrient information is applied to the FA data, not the LAFA data, so the nutrient data represent an overstatement of the amounts people ingest. She pointed out that nutrient values exclude nutrients from inedible parts of the foods, such as bones, rinds, and seeds, but they include nutrients from edible parts of food that are not always eaten, such as the separable fat on meat.

Krebs-Smith noted that people who are interested in diet and health questions are not just interested in nutrients, but also in specific foods and food patterns. As an example, she cited Hiza and Bente (2011), a USDA report that provides nutrient data[8] to 2006. She noted that a report providing data through 2010 is planned for release.

She illustrated the concept of nutrient data through Figure 3-2, which shows trends in calcium availability per capita in the U.S. food supply from 1909 to 2006. Calcium available in the food supply rose until about 1940 and has been relatively flat since that time. She pointed out that Figure 3-3 illustrates another way of looking at the data by looking at the foods that are supplying calcium in the diet. She noted that the data do not necessarily reflect the richest sources of the nutrient. If a food is widely available, even if not a particularly rich source, it may be a major source of the nutrient in the U.S. diet. In the case of calcium, however, cheese, whole milk, and low-fat skim milk are the major sources of calcium in the diet and also happen to be the richest sources of the nutrient.

Krebs-Smith went on to talk about analysis considering dietary guidance in terms of foods. She first noted that Kantor (1998) was a landmark study about how the U.S. food supply compares to dietary recommendations and was one of the first uses of the LAFA data, also developed by Kantor. The servings used in this analysis were based on the 1996 Food Guide Pyramid. They were calculated for individual foods and commodity groups, and then aggregated into pyramid food groups, as well as added sugars and sweeteners and added fats and oils. Krebs-Smith pointed to Figure 3-4, which displays food supply servings measured with and without loss adjustment for various commodities. She noted if loss adjustments had not been included, the assessment of how well the diet compares to recommendations would have shifted for some food groups.

She described changes in food supply servings that would be needed to meet recommendations, developed by Kantor (1998), as shown in Figure 3-5. Although the grain group did not at the time require much change, whole grains were not assessed in this original report. Krebs-

[8]Nutrient data are computed using FA data as the basis rather than the LAFA data.

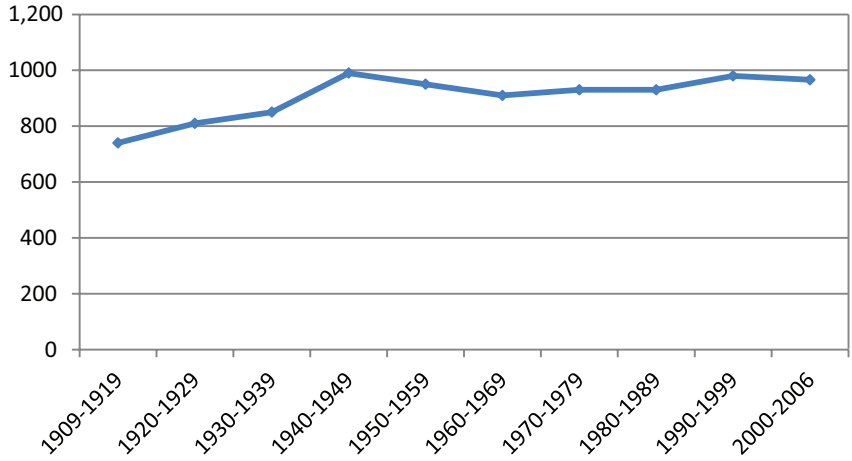


FIGURE 3-2 Trends in calcium per capita, U.S. food supply, 1909-2006 (milligrams).
SOURCE: Hiza and Bente (2011).

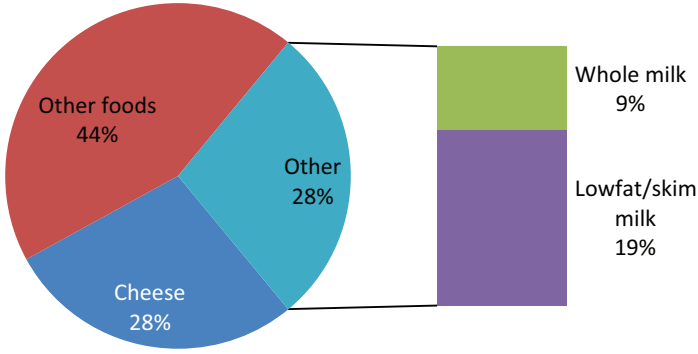


FIGURE 3-3 Food sources of calcium, U.S. food supply, 2006.
SOURCE: Hiza and Bente (2011).

Smith observed that the availability of vegetables, fruits, dairy, and meat all needed to change, some of them quite dramatically, while dramatic declines were needed in added sugars and added fats and oils.

According to Krebs-Smith, McNamara et al. (1999) took this analysis a step further by examining how Americans were eating relative to the Food Guide Pyramid recommendations. They quantified discrepancies at the individual and aggregate food supply levels, with an analysis

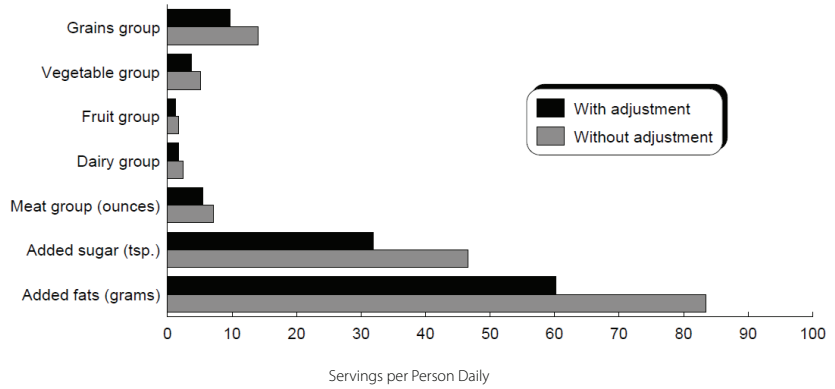


FIGURE 3-4 Food supply servings measured with and without loss adjustment. NOTE: Losses include retail, household, and institutional losses of edible food portions.
SOURCE: Kantor (1998).

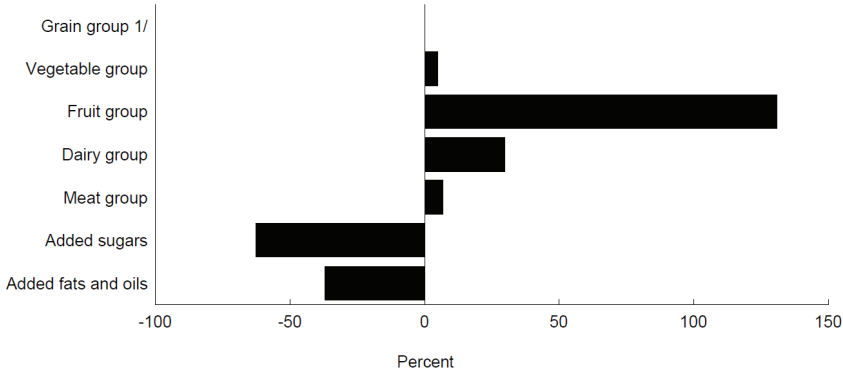


FIGURE 3-5 Change in food supply servings needed to meet recommendations. 1/Grain group servings meet the recommendation for a 2,200-calorie diet.
SOURCE: Kantor (1998).

that involved NHANES data as well as food supply data. By projecting dietary gaps out 20 years based on Census Bureau population projections, the study estimated that at the time, there needed to be more than one-and-a-half times the fruit supply, 50 percent more total low-fat dairy supplies, 15 percent more lean meat supplies, and a dramatic change in the composition of vegetables. Availability of dark green and deep yellow vegetables, and dried beans and peas would need to triple, while supplies of white potatoes and other starchy vegetables would need to be halved. She said the analysis also showed that huge decreases would be needed

in caloric sweeteners and added fats. This analysis highlighted the imbalances in several of the food groups.

Krebs-Smith pointed to Young and Kantor (1999), calling it another classic use of the loss-adjusted data. She said this report was the first analysis of the implications on U.S. agriculture if the population were to meet dietary recommendations, with the analysis updated in Buzby, Wells, and Vocke (2006) for selected food groups. This updated analysis found that consumption or production of fruit would need to increase by 132 percent, and the land area harvested would need to more than double. Because of the constraints of quality land, labor, and climate, this would probably result in more imports.

To evaluate dietary patterns, Krebs-Smith said a question is whether the food supply is consistent with the pattern of recommended diets and referred to her research (Krebs-Smith, Reedy, and Bosire, 2010) and to Reedy, Krebs-Smith, and Bosire (2010). The Healthy Eating Index (HEI), a multicomponent index that captures diet in multiple dimensions, has been used to assess dietary patterns. The LAFA data, nutrient availability data, and salt availability data from the U.S. Salt Institute[9] were used in this analysis, she explained.

The HEI gives a score between 0 and 100. A plot of the score from 1970 to 2010 shows that it is approximately flat, with a score of about 50, which she characterized as mediocre at best. She said it is also possible to look at the index for its component parts and to examine total energy that comes from different sources. She said that Miller et al. (2014) illustrate the percentage of total calories over time that comes from sugar, solid fats, and alcohol, which represent what are considered to be empty calories.

Krebs-Smith reminded the audience that the LA and LAFA data represent foods available that enter distribution channels. She suggested thinking of them as headwaters of the food stream, rather than a proxy for consumption. Even though analysts sometimes think of them as separate measures of the same construct, she said they are different and it is better if there are metrics all along the food supply chain.

She observed that the nutrient estimates are only as good as the nutrient composition data that are applied. As discussed earlier (see Chapter 2), she said there is room for improvement in the food waste and loss estimates, pointing to a few such areas. First, she said, food availability data, even nutrient availability, do not capture all the sodium that enters the food stream as the commodity of salt, an issue because sodium is a nutrient of concern. She suggested better data would also be helpful about whole grains, another issue of concern in diet and health. Finally,

[9]Krebs-Smith observed that since sodium is of concern, the FADS data might benefit from incorporation of salt, even though it is not an agricultural product.

fats and oils are not exactly captured by the food supply data in a way that is compatible with dietary recommendations. She observed that analysts need to impute the amount of fat that is trimmable from meat, and the loss of fats and oils can be substantial. She stated that these estimates need more careful examination.

In closing, Krebs-Smith stated that the FA and LAFA data are an important and useful resource for assessing the country's ability to provide healthy diets to all, and for evaluating policy changes and interventions aimed at improving diets. To her, the accuracy and precision of the waste and loss factors are important because they affect the conclusions that can be drawn, and she commended ERS for continuing to try to improve the quality of the data. She said nutrient data are also useful, but suggested that they might be more useful if applied to the LAFA data.

STATEMENT OF TABITHA RICH
AN OVERVIEW OF CANADIAN FOOD AVAILABILITY ESTIMATES

Rich explained that Statistics Canada is Canada's centralized statistical agency, and FA and LAFA data are part of the agency's agricultural statistics program. She noted that data development is different in Canada compared to the United States, because a department like hers, the DAAF, is often called upon to help Statistics Canada by providing subject matter expertise for data development. Her department has been filling this role for the Canadian equivalent of FADS for many years and has been a partner in Canada's food availability data system since the system began in about 1956. For the first few years, only basic data on food supply per capita were published. Beginning in about 1960, Statistics Canada began publishing complete supply and disposition tables.

By the early 2000s, Canada reached out to ERS to pursue an interest in estimating loss-adjusted food availability. DAAF and Statistics Canada worked with researchers at ERS to evaluate adoption of the U.S measures. She said that analysts compared food consumption patterns in Canada and the United States, determining that the patterns were similar enough that U.S. loss estimates could be used in the Canadian system. Canada has used many U.S. loss estimates ever since.

Like many countries, she continued, Canada produces its FA estimates along the same lines as the Food and Agriculture Organization (FAO) balance sheet, starting with sources of food supply and then subtracting all nonfood uses. The difference, a residual estimate, is called disappearance, net supply, or food available, and it is considered a proxy for consumption.

She noted the Canadian methodology includes a series on waste within the supply and disposition part of the spreadsheet. A nonfood use

category represents storage and transport losses. For example, Canadian data on storage and transportation losses are available for fresh fruits and vegetables, eggs, most grains, and several other commodities. This is different from the LAFA series, she noted, where these losses appear as a conversion factor between the primary and retail levels. Both the U.S. and Canadian systems report per capita food availability at the retail level as the proxy for consumption. For some commodities, where data on storage and transportation losses are not available, Canada uses the USDA factor to adjust between the primary and retail levels.

Rich gave two examples. First, for butter, the primary weight and retail weight are the same, meaning there are no storage and transportation losses. Canada uses the USDA retail loss factor of 7 percent and the consumer loss of 35 percent to get at the equivalent of loss-adjusted food availability for butter. For eggs, Canada has loss data from storage and transportation. The loss due to leaker and reject eggs is about 2.2 percent. In FADS, the loss from primary to retail is 1.5 percent. Canada uses the USDA losses of 9 percent at the retail level and 23 percent at the consumer level[10] to get at the loss-adjusted food availability for eggs.

Rich compared the LAFA losses at the retail and consumer level to the equivalent losses from the Canadian system for a variety of groups of commodities. Though there may be some differences due to commodities appearing in different groups, the data are very similar, she said. The largest differences[11] in total loss were 5.1 percent for vegetables and 4.7 percent for fruits (with Canadian losses higher) and 5.8 percent for added sugars and syrups (with U.S. losses higher).

According to Rich, the results may indicate differences in consumption, as well as simply measurement differences. For example, as noted above, the data indicate Canadians may have higher consumption of fresh fruits and vegetables, and they also indicate that Canadians wasted about 31 percent of the food supply in 2010, very similar to U.S. results.

Rich said her department is interested in gaining a better understanding of food loss and food waste, and pointed to some of the same limitations as in the U.S. system. The approach likely underestimates food loss and waste, and food availability is generally calculated as a residual, so accuracy is sensitive to inaccuracies in all of the component data series. She noted Canada, too, has lost some input data series, particularly some manufacturing data sources. Canada has also considered using retail

[10]The factor 23 percent is for other consumer losses in the U.S system. Nonedible consumer losses in the U.S. system are 12 percent and do not appear to be included in the Canadian system.

[11]Computed as the absolute value of the difference between the Canadian loss in percentage and the U.S. loss in percentage.

scanner data, and has found that these data may be useful for a few processed fruits and vegetables. However, if scanner data are used as the proxy for consumption, the impact is that the supply and disposition balance sheet is no longer complete—so results cannot be aggregated at all levels of the balance sheet and used for other purposes.

She observed that one difference between the Canadian and U.S. systems is where inedible waste is accounted for. The Canadian system accounts for it between the primary and retail levels, while the U.S system considers it a consumer loss. For example, for eggs, the loss from primary to retail (leaker and reject eggs) was likely to be inedible. For fresh vegetables, it is less clear whether the loss between primary and retail was edible or not. She noted that these ambiguities would benefit from additional research, and the rich underlying data used in the tables are worth discussing, debating, and improving.

OPEN DISCUSSION

Krebs-Smith asked Jensen about her point that few policy changes at the consumer level would have the same kind of impact as policy changes at the food production level, asking whether it relates to the point that food supply data show U.S. diets are not aligned with food dietary recommendations. Jensen said she did not mean to imply that policies for consumers concerning dietary guidance would have no effect. What she was indicating was that the kinds of policies under consideration in the Farm Bill are likely to have much greater effect, especially in an industrialized economy, on production and supply—the availability side. In contrast, she said, other factors, whether they be income or changes in education that could be tracked over time, would have more of an effect at the consumer level in lower-income countries.

Josef Schmidhuber asked about Jensen's result that it would take a 42 percent tax on sugar to reduce sugar consumption by 10 percent. Jensen replied that her result was for aggregate sweetener consumption, including high-fructose corn syrup. Schmidhuber said based on his work on similar issues, sweeteners might be one area where a tax makes sense. If the goal is to collect revenue, a tax makes sense because demand is inelastic. Consumption might not change, but at least revenue would increase. However, sweeteners present two options: sugar and high-fructose corn syrup. When there is a healthier substitute, a small tax may be sufficient to move from an unhealthy to a healthy substitute in production. Jensen explained that her result has to do with the fact that many different kinds of foods contain either high-fructose corn syrup or sugar sweeteners. The result of applying a tax will hit a product differ-

ently depending on the demand elasticities for the products and the share of sweetener in the products.

In answer to a question from Mary Muth, Krebs-Smith said the HEI was computed using both NHANES and FADS data; they were found to be very similar on the overall scale, within a few points of each other. Some of the components were a bit different, she noted, which would provide a reason to look at those components more carefully. She said it is not clear they differ because of loss adjustment factors or underreporting in NHANES. Measurement errors exist in both datasets, and the HEI might be an interesting tool for comparing the two series, she suggested.

Unnevehr asked about the USDA's Center for Nutrition Policy and Promotion (CNPP) estimates of nutrient availability based on FA and not LAFA data. She asked Krebs-Smith whether anyone has looked at how the nutrient availability would change if the LAFA data were used as the starting point. Krebs-Smith conjectured that the overall quantity of nutrients would go down, with some relative differences with different nutrients. Jean Buzby pointed out that ERS has a chart that compares the calories from the nutrient availability data[12] versus the calories from the LAFA data. ERS and CNPP have discussed the possibility of CNPP adopting the LAFA series as the foundation of its nutrient series, like ERS does, she added. Krebs-Smith noted having both would be valuable and that the LAFA data have been applied to the Healthy Eating Index. The nutrient breakdown is designed to be applied to the LAFA data, and in her work, they did a calibration on calories along with a proportional adjustment.

Jensen commented on a graphic from Miller et al. (2014) presented by Krebs-Smith, pointing to the decrease from about 13 percent of energy from solid fats in 2005 to a little over 8 percent in 2009 with a small uptick in 2010. She asked whether the decrease might be attributed to changes in the adjustment factors, such as those that accounted for closer trimming of meat in the 1980s, or whether Americans have improved their diets, and whether the recent uptick is due to the consumption of more trans fats. Krebs-Smith said she did not have a reason for the decline.

Connie Citro (National Academy of Sciences) observed that the FA and LAFA data are prepared in an accounting framework. She asked whether any analysis has incorporated variability, perhaps as part of a sensitivity analysis. She noted in a survey context, estimates of variability are expected, and there are sources of bias and variability in each of the entries in the supply and disposition spreadsheet. Krebs-Smith responded

[12]Portions of the CNPP's Nutrient Content of the U.S. Food Supply Data are provided in tables on the ERS website in the Nutrient Availability data. Available: http://www.cnpp.usda.gov/USFoodSupply.htm [July 2014].

that with the HEI, she and her colleagues did some sensitivity analyses for sodium, because it was from an external data source of unknown quality. They used varying estimates of what the waste or loss of sodium might be, because salt is used in processes such as pickling, where much of it could be thrown out with the juice. In testing the sensitivity of the HEI in relation to variability in salt, they found that even if the assumption was that half of the sodium would be lost, sodium scores were low (meaning the sodium content was in excess of recommendations).

Citro also asked about possibilities for improving timeliness, and if there are bottlenecks that might be addressed. Mark Jekanowski noted that the FA data being released at the time of the workshop were for 2012.[13] Internally, he said, ERS updates the data as new estimates become available. However, updated FA data are not posted until all of the input data have been finalized; this takes about 18 months from the close of the year of the data. Buzby added that ERS does one annual update of the FA and LAFA data. Nusser asked whether any preliminary data might be useful to release sooner. Buzby said ERS has considered more frequent updates, but decided ERS resources are best spent on the annual update.

Muth asked about Rich's statement that loss for fruits and vegetables is higher in Canada than the United States. She asked whether that is because of differences in the loss estimates or because the losses are applied to a larger amount of fruits and vegetables available for consumption. Rich replied that per capita availability of fruits and vegetables at the retail level is higher in Canada, and thus losses are higher.

Muth also asked if Canada has any qualitative information and asked whether it might be an artifact of the accounting approach. Rich observed that Canada has not done much to find anecdotal evidence. She said that Gooch, Felfel, and Marenick (2010) looked at food waste in the middle part of the food chain in Canada. In addition, the Canadian Community Health Survey—Nutrition Module collected food consumption data via a food diary, but it did not collect information about food waste and has not been conducted since 2004. Finally, she noted that Gooch et al. (2013) focused on consultation with industry, some retailers, and a few food processors to gauge qualitatively what the waste is at those levels.

Mary Bohman (ERS) asked the speakers to speculate about the most valuable additions that ERS could make to the FADS data. Krebs-Smith suggested a thorough assessment of the waste and loss adjustment factors. She commended ERS on what they have done to improve and update these factors, but said there are more food groups and levels to examine. Jensen agreed it is important to evaluate the factors and to keep them up to date to capture the impact of technological changes, particularly in

[13]This was also the case for the LAFA data.

processing. She said a processor has a much greater ability to control food waste than a retailer has. Unnevehr echoed Jensen's point about processed foods, noting more and more of the food supply is in processed products. She pointed to a previous analysis by David Klurfeld of the Agricultural Research Service (ARS)[14] that tried to estimate the amount of trans fats in foods (unhealthy and added during a hydrogenation process). Unnevehr added that a review of the extent to which processing wastes and conversions are reflected in the data would be useful.

Rich agreed about the importance of the conversion factors and the other parts of the food chain. She reiterated her point about ambiguity in definitions. For example, Canada has estimates for fruits and vegetables lost in storage and transportation. She said if these losses are food that was edible and intended to be consumed, they represent waste rather than loss. She suggested striving for consistency in the application of the definitions used in the food supply and disposition tables.

Krebs-Smith suggested that adding data on whole grains would be very useful. More information on sodium would be useful as well, although she recognized that this may be more relevant for the nutrient availability data system because sodium is not an agricultural commodity. She also expressed interest in more information on fats and oils.

Nusser stated that, as someone without extensive knowledge of FADS before this workshop, she found the waste and loss factors sound somewhat ad hoc. She asked whether a taxonomy of loss could be used to map out the system. The goal would be to look at the elements of the system and identify existing surveys or other more rigorous ways to estimate the factors. She observed that the waste and loss estimates are a very important part of the system and suggested that a structured, methodological approach to evaluating the loss estimates might be useful.

Schmidhuber stated he compares estimates in his work, including loss factors (extraction rates) across countries. The nutrient conversion factors show little variability across countries, he said, but there is huge variability in the processing industry or technical conversion factors. For example, for grains such as millet or wheat, the factors range from 0.59 to 0.975. He noted variability in the basic data and in the methods underlying the basic data from country to country. For the international data, he said improving the basic data would be most productive, although this may not be the case in the United States. However, he observed, even in the United States, there is some variability from commodity to commodity in how estimates for waste for product used for feed or seed and for other items are compiled and presented.

[14]For additional information, see the PowerPoint presentation at http://www.heart.org/idc/groups/heart-public/@wcm/@global/documents/downloadable/ucm_301513.pdf [October 2014].

4

Alternative Approaches for Estimating Food Availability: International and Domestic

This chapter summarizes the third session of the workshop, which focused on alternative approaches for estimating international and domestic food availability. Jay Variyam (Economic Research Service [ERS]) moderated the session. The first speaker was Josef Schmidhuber (Food and Agriculture Organization [FAO]), who described FAO's approach for estimating food availability. Klaus Grünberger (FAO) then described FAO's approach to comparison and reconciliation of food consumption from household surveys and food balance sheets. Aylin Kumcu (ERS) described potential availability of alternative data sources, including scanner data. The fourth speaker, Alanna Moshfegh (Agricultural Research Service [ARS]), talked about her group's work to disaggregate food mixtures in nutrition data. The final sections in this chapter present a summary of open discussion between panelists and the audience, followed by a facilitated discussion conducted by steering committee chair Mary Muth.

STATEMENT OF JOSEF SCHMIDHUBER FAO'S APPROACH FOR ESTIMATING FOOD AVAILABILITY

Schmidhuber explained that the FAO food balance sheet system is currently in transition to update conversion factors and extraction rates and, importantly, to develop new imputation methods for all elements (variables) of its balances. In tandem, the questionnaires sent to FAO member countries are being improved and new technologies to ease data

collection, processing, and dissemination are being adopted to harness operating efficiencies and ultimately reduce costs.

He said FAO currently publishes comparable food balance sheets with data from 1961 to 2011 for 185 countries. The most recent estimates extend the series to 2011 and were published in May 2014; a new statistical working system will allow FAO to generate preliminary data up to 2013 by the end of 2014. He said FAO plans to provide open and easy access to the data. He noted some improvement in dissemination with the FAO's FAOSTAT version 3 website.[1] The food balance sheets database is a four-dimensional cube, and the new system pivots the data in ways that make them easy to access. He said FAO's key goal is to promote statistics for evidence-based policy making. FAO uses the food balance sheets to prepare food security indicators for prevalence of undernourishment, indicators of food adequacy, and so on. They have also established simple balance sheets for early warning purposes and worked on tracking dietary patterns.

He said FAO tries to serve the needs of its many internal and external clients. One key type of external client uses the data in economic models. For example, the International Food Policy Research Institute (IFPRI) uses the FAO commodity balances, including the food balance sheets, in its IMPACT model. The same holds for the FAO/OECD Aglink/Cosimo model,[2] and FAO's long-term projections to 2050 (FAO's global perspectives studies).[3]

FAO is pursuing a two-pronged approach to improve the balance sheets. One prong is to make sure countries have available the best possible data collection methods. FAO is moving into the next World Census on Agriculture (WCA), called the WCA2020 round, starting in 2015. The WCA2020 will make numerous recommendations to improve data coverage and quality and to help countries access new and efficient data collection methodologies. Other programs to improve data collection methods include the Global Strategy to Improve Rural and Agricultural Statistics (GS), Agricultural Market Information System (AMIS), and, in part, CountrySTAT.[4] Second, FAO is trying to improve imputation methods and plans to roll them out to member countries. He noted that much of the food utilization data that FAO requests from countries are not provided, forcing FAO to impute them.

[1]See http://faostat3.fao.org/faostat-gateway/go/to/home/E [July 2014].

[2]For information on the model, see http://www.oecd.org/site/oecd-faoagricultural outlook/oecd-faoagriculturaloutlook-tools.htm [July 2014].

[3]For information on these studies, see http://www.fao.org/waicent/faoinfo/economic/esd/gstudies.htm [July 2014].

[4]For more information, see http://www.fao.org/economic/ess/ess-capacity/countrystathome/en/ [July 2014].

Schmidhuber said FAO is also trying to tap into new technology for data collection. For example, FAO has an application programming interface (API) with the United Nations Statistics Division (UNSD) to get trade data automatically and seamlessly. FAO is trying to establish the same technology with member countries, even though there is greater reluctance to engage in such automated processes at the level of individual countries. Schmidhuber noted that FAO does not generally collect data directly within a country, instead relying on data already collected by the country. The only notable exception is a cooperative agreement with Gallup called Voices of the Hungry.[5]

Because of this reliance on secondary data, FAO is trying to work with countries to improve their data collection methodologies through a number of efforts, including, as noted above, GS, WCA, AMIS, and, in part, CountrySTAT. Such efforts also include work on experimental designs to measure food waste at different stages of the value chain.

Another FAO effort, he said, has been to ensure that member countries use internationally accepted standards to report their data, using classifications such as the Harmonized System (HS) or the Central Product Classification (CPC). FAO also tries to make sure member countries compile data in a comparable manner so the agency can be assured that it has comparable food balance sheets. Before overwriting official data, FAO goes back to member countries, asking them to verify their submissions. FAO undertakes extensive quality checks to ensure there are no logical errors, transcription errors, or shifts in decimal points.

He noted the generic FAO balance system is similar to that described earlier for the Food Availability Data System (FADS). For grains, however, FAO includes use for food, feed, seed, waste, and other uses in separate columns, whereas a U.S. commodity spreadsheet typically has fewer end-use columns. Like the U.S. system, the FAO system is set up to ensure that domestic supply is equal to domestic utilization, and total supply is equal to total utilization. He noted that few countries report all end-uses. Most countries report trade and production, some also report stocks, but all are estimates with varying levels of accuracy. This means that there is a considerable need to impute missing data, he explained.

FAO is currently reviewing and revising their imputation approaches, which Schmidhuber highlighted, starting with a description of the new feed use imputation system. He explained that few countries have official feed use estimates based on feed surveys; instead, most countries, including the United States, compute the estimate as a residual. The new FAO feed use imputation method links feed use estimates to four fac-

[5]For more information, see http://www.fao.org/economic/ess/ess-fs/voices/en/ [July 2014].

tors: number of livestock, composition of the herd, feeding intensity (the share of compounding concentrate feed and the total ration), and feeding efficiency.

Schmidhuber said many developing countries are moving from a backyard livestock system to a family-based livestock system, and eventually to an industrialized system. To capture this, the FAO model estimates the amount of feed needed to support the food requirements of a country's herd. This estimate is then mapped into feed availability and allocated to livestock based on country-specific feeding practices, which allows for a number of consistency checks. For example, it is possible to ensure that grain use is consistent with changes in feeding intensity, as well as the number and types of animals to be fed.

He observed that industrial use of agricultural products was fairly small when oil was cheap, but this situation changed dramatically with higher oil prices. FAO has observed that more vegetable oils and cereals are used either for biodiesel production or ethanol and that more agricultural products are used to produce paints, detergents, and starch-based products. Higher energy prices not only made agricultural products competitive for the biofuels market (not ignoring the help of subsidies, he noted), but also traditional or nonexisting industrial use became competitive as agricultural raw materials became more competitive with traditional sources of energy and synthetic raw material. FAO is trying to collect as much information as possible on these new uses from its member countries. Many countries provide information on production of biofuels, and some have information on paints, detergents, and starches. For the rest, FAO imputes based on an economic model.

Schmidhuber said FAO is also reviewing and updating its classification system. In the old approach, the food balance sheets were classified using the FAOSTAT Commodity List (FCL) that was developed decades ago. However, the FCL largely remained static, so few countries use it today. One of the consequences has been a sometime arbitrary conversion process between data provided by countries and the FAO classification system. In the future, the FCL will be replaced with the UN CPC Version 2.1, expanded and the HS 2012, where available.[6] The CPC and HS have a high level of communicability, he said, allowing complete one-to-one

[6]These classification systems and their evolution are described at http://www.fao.org/fileadmin/templates/ess/ess_test_folder/Workshops_Events/APCAS_24/Documents_and_ppt/APCAS-12-INF5-International_Classification_of_Agri_Commodities.pdf. This is a summary of a meeting to discuss classification systems that was held in October 2012. It also lists other FAO websites such as the page on classifications and standards: see http://www.fao.org/economic/ess/ess-standards/en/ [September 2014] and the page on FAOSTAT commodities and inputs, see http://www.fao.org/economic/ess/ess-standards/commodity/en/ [September 2014].

commodity mapping between the two systems. This will eliminate mapping errors, reduce the country response burden, and increase international comparability.

FAO publishes balances for more than 80 primary commodities plus 10 commodity groups. Underlying these primary product balances is a vast array of processed products, which are converted into primary equivalents using extraction rates, conversion factors, and a detailed structure of the processing chain. The conversion and aggregation process is referred to as "standardization." FAO has developed standardization commodity trees, flow diagrams that trace the flow of a primary agricultural commodity along the value chain from raw agricultural commodity to processed products, to facilitate this process. Commodity trees for many commodities can be found on the FAO website.[7] For example, he stated that quantifying wheat supply is quite complex, because wheat is processed into flour, bran, and germ. He noted one of the key wheat products is bran and it goes into many other products such as breakfast cereals and feed. In addition, wheat flour can go into cereal, bread, pasta, pastry, or starch and gluten. There may be subsequent processing levels as well. FAO estimates the amounts of wheat included in imports and exports of processed products and includes them in the wheat balance sheets. FAO has mapped these multi-ingredient products back into primary products via commodity trees.

Schmidhuber provided a detailed illustration of the standardization process using millet, a product with one of the simplest commodity trees because millet is not consumed directly and is used for human consumption only as millet flour and bran. He described an FAO balance sheet for Niger in 1981, illustrated in Figure 4-1. Like FADS, FAO starts with the basic supply and disposition balance in primary products. In the first row of Figure 4-1 labeled millet, the columns show raw millet grain production (P), imports (I), exports (X), and stock change (dSt) as well as estimates for amounts used for feed, for seed, waste, and other uses (O_Use). The column showing millet processed into food (Food Proc.) is the residual.

In the line in Figure 4-1 for flour, FAO uses an exogenous extraction rate—in this case, 0.7—to estimate the fraction of millet flour that is extracted from millet grain. Thirty percent is bran or is lost in the milling process. The product of the amount of millet grain used for food and 0.7 is an estimate for the amount of millet flour produced as shown in red in the row labeled flour. In the third line, FAO shows imports of millet flour, and in the fourth line, in green, shows the negative of exports of

[7]See http://www.fao.org/fileadmin/templates/ess/documents/methodology/tcf.pdf [September 2014].

1	Primary	P	I	X	dSt		=	Food Proc.	Feed	Seed	Waste	O_Use	Calories
	Millet	1313900	1607	40000	-125000			814838	157861	46257	131551	0	
						Extr. Rate				cal/kg			
2	Flour	814838		*		7000	=	570387	*	3520	=		2007762
3		+	708					708	*	3520	=		+2492
4		-		-31					*	3520	=		-109
5								570387					2010145
Conversion back to primary millet, (/0.7) aggregation, rounding			1011	-44				816	158	46		132	
FBS		1,314	3	40	125			816	158	46	132		

FIGURE 4-1 Example of Food and Agriculture Organization (FAO) balance sheet for millet in Niger, 1981.
NOTE: dSt = stock change, Food Proc. = processed into food, I = imports, O_Use = other uses, P = production, X = exports.
SOURCE: Prepared by J. Schmidhuber for presentation at the workshop. Based on FAO food balance sheet (FBS).

millet flour, also in green, to get the total amount of millet flour available for consumption. Creating a sub-balance at the level of millet flour offers the possibility of using a commonly available, region-specific calorie conversion factor for millet flour (3.52) to estimate the calorie content of the flour produced, imported and exported. These estimates are shown in the column labeled Calories, with the last row of that column showing the calorie content of the flour that was available for consumption. Calorie conversion factors are seldom reliably available for commodities such as millet grain.

For purposes of presentation in the food balance sheet (FBS), the results for millet flour imports and exports are converted back to units of raw millet by dividing by 0.7 (as shown in the row *conversion back to primary millet*). The last two rows of Figure 4-1 show the standardized FBS for millet that includes imports and exports of both millet grain and its primary product, millet flour.

STATEMENT OF KLAUS GRUNBERGER COMPARING AND RECONCILING FOOD CONSUMPTION FROM HOUSEHOLD SURVEYS AND FOOD BALANCE SHEETS

Grünberger described his current project at FAO to develop an approach for using food consumption results from household surveys to improve food balance sheets, pointing to Conforti and Grünberger (forthcoming) for additional details. FAO developed a model that adjusts the food group shares in the food balance sheets by reconciling them with the information gathered from survey data.

He noted food balance sheets look at food at the macro level, while household surveys provide micro data. These two types of estimates are not perfectly comparable because household surveys usually measure consumption by considering incremental expenditures. For the most part, the surveys provide estimates of the economic value of food that needs to be transformed into calories obtained from purchases. An additional challenge faced by FAO, he said, is that household surveys in different countries are quite heterogeneous, with differences in timing and content. Some surveys have a recall period of seven days while others have a recall period of one month.

In contrast, the food balance sheets are homogenous because they are an FAO product. He described the challenges with using household survey data. FAO has processed 64 household surveys from 52 countries, primarily low- and middle-income countries. They calculated average consumption from the survey data and categorized the food items into 17 food groups. Then, they compared the consumption pattern indicated by the surveys and by the food balance sheet.

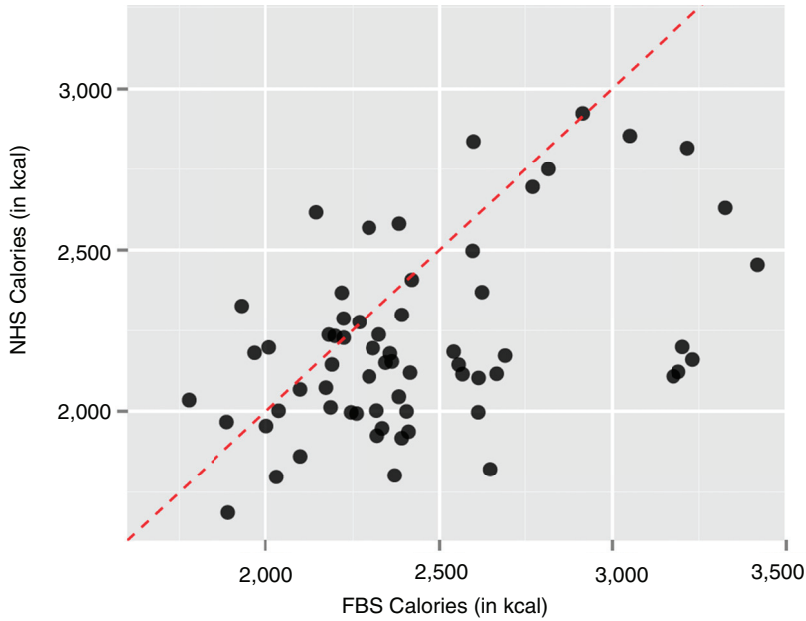


FIGURE 4-2 Total calories in national household surveys and food balance sheets.
NOTE: FBS = food balance sheets, NHS = national household surveys.
SOURCE: Prepared by K. Grünberger for presentation at the workshop. Based on Food and Agriculture Organization data.

He showed a comparison of the total calorie consumption levels from the two sources (see Figure 4-2). On the Y axis is the calorie consumption level from the household surveys, and on the X axis is the calorie availability from the food balance sheets. The dotted line is the equality line. There is a correlation, he said, but also a lot of variability, pointing to an interesting pattern that with increasing food balance sheet calories, the household survey calories are lower. This is consistent with older studies that showed that this difference is significantly correlated with income.

Grünberger then showed Figure 4-3 to illustrate the relative difference between calories measured from household surveys and calories measured from food balance sheets against gross domestic product (GDP) per capita. This graph shows that the difference is not significant in low-income countries. However, with increasing income, the differences increase. He noted even after controlling for some confounding factors, such as the ratio of foods consumed away from home, correlated with GDP, the negative correlation still holds. The difference may be because food balance sheets are too high or because household surveys are too

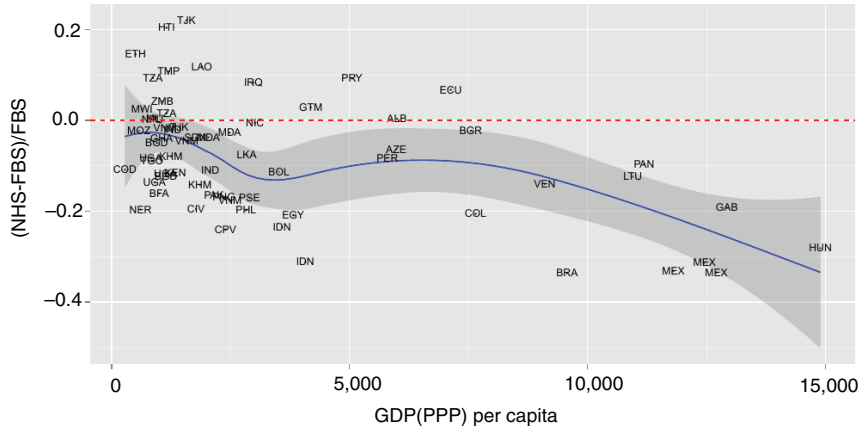


FIGURE 4-3 Differences in calorie measurements against gross domestic product per capita.
FBS = food balance sheets, NHS = national household surveys.
SOURCE: Prepared by K. Grünberger for presentation at the workshop. Based on Food and Agriculture Organization data.

low. For example, it is difficult to assess food away from home because food type and quantity are rarely specified in the surveys, but measured only with economic value.

Although the data tend to indicate that food balance sheets might overestimate food availability, such as due to underestimation of losses at the retail level, household surveys may underestimate food processed in the hospitality sector, he said. Food wasted in restaurant kitchens, for example, is not included in the household surveys that only include already-prepared dishes. He pointed to a systematic pattern in the differences.

Terming the data noisy, Grünberger said he switched to an analysis of consumption patterns. To do this, he calculated the caloric shares of the food items and calculated the contribution of food groups to the total consumption. He said categorization of the household surveys and the food balance sheet is quite similar, so they were easy to match. Seventeen food groups were developed for comparison.

He displayed Figure 4-4, with 16 plots (for descriptive purposes, tree nuts are combined with oil crops in a single-item group) showing the calorie share from household surveys to the calorie share from the food balance sheets for each food group. He noted a correlation for cereal that does not show up for all other products. For stimulants, there is no apparent correlation. There are some items that might be biased in household survey data such as alcoholic beverages, stimulants, and spices, but these

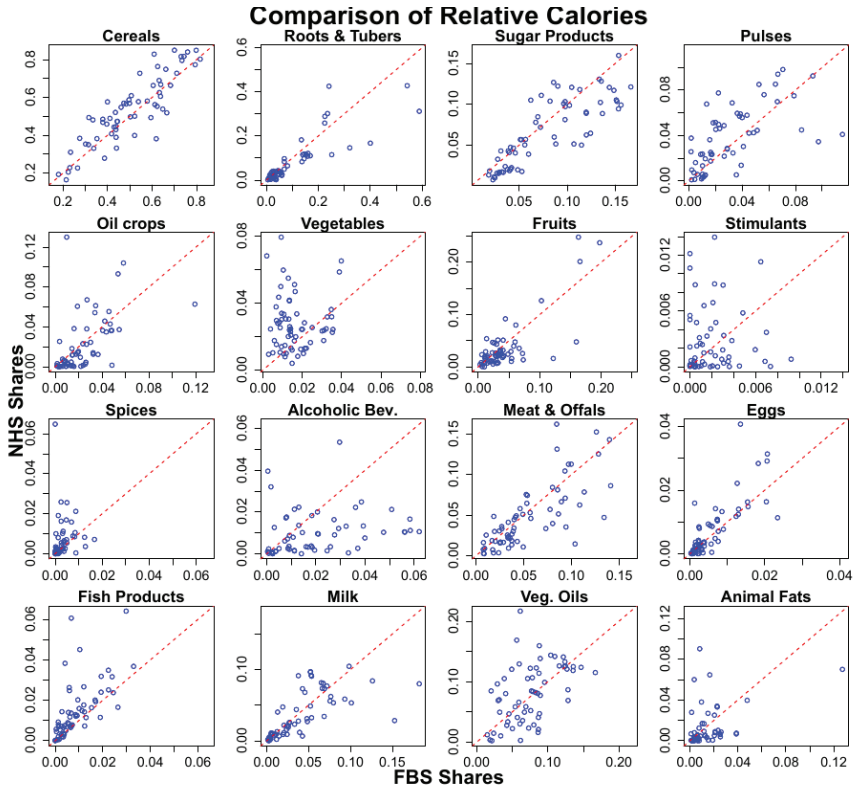


FIGURE 4-4 Calorie shares by food group.
NOTE: Tree nuts are combined with oil crops in a single-item group. FBS = food balance sheets, NHS = national household surveys.
SOURCE: Prepared by K. Grünberger for presentation at the workshop. Based on Food and Agriculture Organization data.

three groups are of minor importance in terms of their contribution to total calories. Seven food groups were excluded from the analysis: alcoholic beverages, animal fats, miscellaneous food, oil crops and tree nuts, spices, stimulants, and vegetable oils.

He then described the model used to adjust the food group shares of the balance sheet data using the household survey data. Box 4-1 shows the important part of the model, he said. Its objective function was the Kullback-Leibler divergence, a cross-entropy measure that allows for measurement errors in both data sources. It is a divergence measure between old and new shares, where the new shares are better in line with household survey shares. The objective function was minimized subject to stochastic constraints. The error term was added to incorporate the

BOX 4-1
Model Specification

Model to adjust food group shares of balance sheet data using household survey data.

Minimize the objective function (Kullback-Leibler divergence)

$$\min_{F,w} \sum_{i}^{N} F_i \ln\left(\frac{F_i}{\tilde{F}_i}\right) + \sum_{i,l}^{N\times L} w_{i,l} \ln\left(\frac{w_{i,l}}{\tilde{w}_{i,l}}\right)$$

subject to the stochastic constraint

$$\text{s.t.} \quad F_i = N_i + \varepsilon_i, \quad \forall_i$$

$$\text{with } \varepsilon_i = \sum_{l}^{L} w_{i,l} \overline{v}_{i,l}$$

where the variables F_i, $\tilde{F}_i$ and N_i are the shares of food group *i* of the updated FBS, the old FBS and the NHS, respectively

ε_i is an error term with a discrete $\overline{v}_{i,l}$ of L dimensions and respective probabilities $w_{i,l}$. Probabilities are going to be updated as well.

The model finds updated FBS food group shares that meet the stochastic constraint (2), and at the same time are 'close' to the old FBS.

SOURCE: Prepared by K. Grünberger for presentation at the workshop.

known noise in the household surveys, and it was developed as a discrete distribution based on the error structure of the differences between the food balance sheet and household data that were shown in the correlation plots.

According to Grünberger, the objective function can be viewed as a penalty function that searches for updated shares that are close to the old food balance sheets and simultaneously meet the stochastic constraint, which is defined by the household survey shares and the error term. The noise term determines whether household survey shares or food balance sheet shares are favored. If the household survey is regarded as reliable, the result will be closer to the household survey share.

Grünberger next displayed Figure 4-5 to summarize the results of the comparisons and reconciliations. The approach does not change total food balance sheet (FBS) overall calories. Instead, changes were made to the shares of the food groups to bring them more in line with those from the national household surveys (NHS). For each food group, the

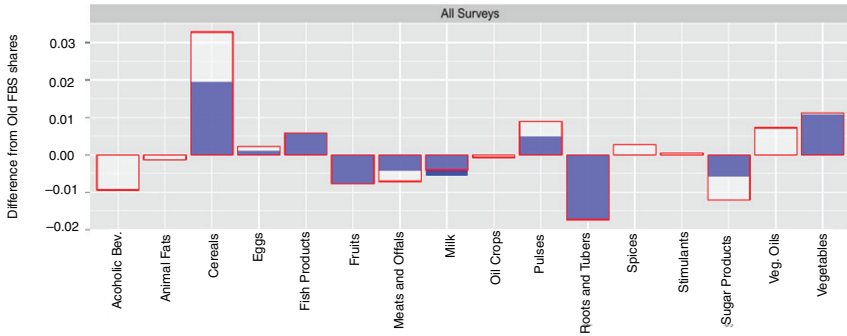


FIGURE 4-5 Mean differences between shares of the updated FBS/NHS and old FBS. (See text for explanation of boxes.)
NOTE: FBS = food balance sheets, NHS = national household surveys.
SOURCE: Prepared by K. Grünberger for presentation at the workshop. Based on Food and Agriculture Organization data.

height of the overall box shows the mean difference across countries between NHS and FBS, while the height of the dark box shows the mean difference across countries between the adjusted balance sheet and the original balance sheet. Figure 4-5 shows the adjusted share is between the household survey share and the food balance share for cereals, meat and offal, sugar products, and eggs. For these products, the approach is like a compromise. For roots and tubers, fruits, and vegetables, the adjusted share is close to the household survey share. Shares of cereals increased, while shares of roots and tubers decreased. Shares of vegetables increased, while shares of fruits decreased.

Grünberger called the approach promising, although it has limitations and could be improved. The procedure provides one way to inform the pattern of consumption in food balance sheets using information from household surveys. The analysis can be used to cross-validate household surveys and the food balance sheet, and to detect potential errors. Ultimately, he said, FAO hopes that the approach could be a tool to improve data for the measurement of undernourishment and to show why it is important, at both the level of consumption and distribution.

STATEMENT OF AYLIN KUMCU
POTENTIAL USES OF SCANNER DATA AND OTHER DATA RESOURCES

Kumcu described four data sources that might be considered to improve FADS. The first series is data on food expenditures from the

Census Bureau and published by ERS. Annual data are currently available from 1928 to 2011. The second series is data from Information Resources Incorporated (IRI) that includes retail scanner data as well as household survey data. Both datasets are available from 2008 to 2011. Third, she noted the Food Acquisition and Purchase Survey (FoodAPS) has recently been released by ERS for 2012. The data are based on a household survey. Finally, the Census Bureau's Economic Census of Manufacturers has been done every 5 years, with the most recent in 2012.

She explained that the ERS food expenditure series[8] measures the total value of all food and beverages purchased by consumers in the United States. It is supposed to measure the expenditures both for consumption at home and away from home. The data represent the entire population, including the institutionalized population, as well as taxes, tips, and so on. The data are available in total, with no breakdown by commodity, although some detail is provided through tables. She suggested that the tables of greatest interest might be total expenditures for alcoholic beverages; food expenditures by source of funds (consumers, home production, government, business); per capita food expenditures; sales of food away from home by type of outlet; and sales of meals and snacks away from home by type of outlet.

Next, she explained that the proprietary IRI data include weekly retail scanner data[9] that come from selected retailers across the United States (not all food retailers), including grocery stores, supercenters, and convenience stores. Data are available by store, Uniform Product Code[10] (UPC), sales quantities, and cost. Not all variables are available for all retailers. She noted the IRI retail data have advantages and disadvantages. The data include all sales, not just to consumers. Some types of outlets are not included, nor are all U.S. retailers included. Some chains are missing, and there are no private-label data for some retailers. She said one of the advantages of the 2012 data is that they include random weight information, for example, for fruits and vegetables sold in bulk.

A second source from IRI is the consumer network,[11] similar to the Nielsen Homescan approach. IRI has a sample of more than 60,000 U.S.

[8]For more information, see http://www.ers.usda.gov/data-products/food-expenditures.aspx [July 2014].

[9]For more information, see http://www.iriworldwide.com/SolutionsandServices/Detail.aspx?ProductID=181 [July 2014].

[10]The UPC provides information on nutrition facts from the label and random weight. For UPC-coded perishable products, it includes weight/volume. With the UPC information, ERS can break out information about products to get down to the commodities. For prepared food and some canned food, more work would be needed to use the information.

[11]See http://www.iriworldwide.com/SolutionsandServices/Detail.aspx?ProductID=180 [July 2014.]

TABLE 4-1 Summary of Pros and Cons of Selected Data Sources

Data Source	Pros	Cons
ERS Food Expenditure Series (1929-2011+)	• Nationally representative • FAH and FAFH • Entire food system: retail, household, gov, business, etc.	• No quantities • No commodity detail
IRI InfoScan: Retail (2008-2012+)	• Includes quantity • Detailed food groups	• Not nationally representative • FAH only; retail only • Some limits to PL, RW
IRI Consumer Network: HH (2008-2012+)	• Nationally representative • Includes quantity • Detailed food groups	• FAH only • No quantities for RW • Consumers only
USDA (ERS) FoodAPS (2012)	• Nationally representative • FAH and FAFH • Includes quantity • Detailed food groups	• Consumers only • Coverage: 50 PSUs
Economic Census 1902-2012+	• Nationally representative • FAH and FAFH • Some food groups, FAH	• No quantities • No commodity detail, FAFH • Not annual (every 5 years)

NOTE: FAH = food at home, FAFH = food away from home, IRI = Information Resources Incorporated, PL = private label, RW = random weight, PSU = primary sampling units.
SOURCE: Prepared by A. Kumcu for presentation at the workshop.

households that scan all their food purchases. Projection factors allow aggregation to the U.S. level. Data are available daily, by UPC, price, and quantity. The advantage is that the data can be weighted up to be representative of food consumption at home for the United States.

The third data source described by Kumcu is USDA's FoodAPS National Household Food Acquisition and Purchase Survey.[12] It was a nationally representative sample survey conducted in 2012, with oversampling of Supplemental Nutrition Assistance Program (SNAP) and low-income households, and a sample size of almost 5,000 households. The data were collected using a seven-day recall by day for all food con-

[12]See http://www.ers.usda.gov/data-products/foodaps-national-household-food-acquisition-and-purchase-survey.aspx [July 2014.]

TABLE 4-2 Summary of Food Group Availability in Selected Data Sources

Food Groups	ERS Food Expenditures	IRS InfoScan	IRI Consumer Network	ERS FoodAPS	Economic Census
Meat, poultry, and fish	No	Yes	No RW	Yes	FAH, no FAFH
Dairy products	No	Yes	Yes	Yes	FAH, no FAFH
Eggs	No	Yes	Yes	Yes	No
Fats and oils	No	Yes	Yes	Yes	No
Fruits	No	Yes	No RW	Yes	No
Citrus	No	Yes	No RW	Yes	No
Noncitrus	No	Yes	No RW	Yes	No
Legumes, nuts, and soy	No	Yes	No RW	Yes	No
Vegetables	No	Yes	No RW	Yes	No
White potatoes	No	Yes	No RW	Yes	No
Dark green, deep yellow	No	Yes	No RW	Yes	No
Other vegetables	No	Yes	No RW	Yes	No
Grain products	No	Yes	Yes	Yes	Some FAH
Sugars and sweeteners	No	Yes	Yes	Yes	Some FAH
Miscellaneous	No	Yes	Yes	Yes	Some FAH

NOTE: FAFH = food away from home, FAH = food at home, IRI = Information Resources Incorporated, RW = random weight.
SOURCE: Prepared by A. Kumcu for presentation at the workshop.

sumed at home (UPC/food product detail) and away from home for all members of the household.

One advantage of FoodAPS, she said, is that it includes food away from home, as well as food that households produced themselves in gardens. It includes UPC-level information for purchased food so it could be

used to break out commodity groups; it also has receipts for food away from home.

The fourth source of data Kumcu described was the Census Bureau's Economic Census,[13] collected every 5 years since about 1902. It provides information about sales of food by category at supermarkets and warehouse clubs and supercenters. The Economic Census provides information about the composition of food used at home, though it might also include sales that were not for direct consumption. Sales categories include groceries and other food for consumption off premises;[14] meals, snacks, and nonalcoholic beverages prepared for immediate consumption; and meals, snacks, and nonalcoholic beverages prepared for catered events.

The Economic Census also provides information about sales by full-service restaurants. While there is no information by commodity, it includes meals and snacks for immediate consumption off the premises; groceries and other food for consumption off the premises; meals and snacks served at a table by a server; meals and snacks dispensed without table service for consumption on the premises; and meals and snacks dispensed through drive-in service.

Kumcu summarized highlights of the pros and cons of the four data sources and their possible relevance for FADS (see Table 4-1). She noted it is unlikely any of these sources would provide comprehensive information, but they may be useful. She also provided Table 4-2 as a summary of whether each source has information by food group.

STATEMENT OF ALANNA MOSHFEGH
DISAGGREGATION OF FOOD MIXTURES IN NUTRITION DATA

Moshfegh described special databases developed to go from individual consumption of processed food back to the food supply in terms of commodities. In particular, this requires use of a disaggregation process for foods and beverages.

First, Moshfegh described the dietary intake portion of the National Health and Nutrition Examination Survey (NHANES), which is the basis of the two special purpose databases described later in her presentation. NHANES is a nationally representative sample of about 5,000 individuals of all ages, conducted annually beginning in 1999. Interviews are conducted every day of the week, with two 24-hour dietary recalls. The first

[13]See http://www.census.gov/econ/census [July 2014].

[14]Meat, fish, seafood, and poultry, including prepackaged meats; produce, including fresh and packaged fruits and vegetables; frozen foods; dairy products; bakery products baked on premises; bakery products not baked on the premises; delicatessen items; soft drinks; candy.

is administered by an in-person interview, the second by telephone 3 to 10 days later. The data from 2011-2012 were released in 2014.

Moshfegh said the USDA's automated multiple-pass method is used for collecting the data. The questionnaire goes through a series of steps to elicit information about the foods and beverages that Americans eat. She said many items are mixture foods or multi-ingredient items, and that is how the data are collected. For example, NHANES would find out a respondent ate a slice of pepperoni pizza, then whether it was thick or thin, whether it contained extra cheese—with a probe for the size of the slice. She noted because the majority of the foods people eat are mixture items, ARS needs to convert them back to nutrient and commodity levels.

ARS developed the Food and Nutrient Database for Dietary Studies (FNDDS) to identify the nutrient profile for 8,000 foods/beverages. The USDA National Nutrient Database for Standard Reference is the basis of the 65 nutrient/component values. This database is defined to support specialized research and policy needs and has been funded by other federal agencies.

Moshfegh said that, in the FNDDS, about one-third of the items are simple, single-ingredient foods, such as types of milks by fat level and flavorings, apples, and so on. However, two-thirds of the items in the database are mixture foods. Examples of commodities and some of the multi-ingredient foods that contain them include apples in pies and apple jacks, tuna filet in tuna salad and tuna casserole, and eggs in cake and cookies. ARS releases the FNDDS every 2 years in concert with the 2-year releases of NHANES data in What We Eat in America (WWEIA). ARS is continuing to expand the number of food items in the database to reflect differences in foods that are being consumed.

She then discussed two special purpose databases developed primarily in support of other agencies. The Food Intakes Converted to Retail Commodities Database (FICRCD) is designed to translate the foods and beverages in FNDDS into 65 food commodities at the retail level, as defined by ERS. Two versions of the database have been prepared, one based on the 1994-1998 NHANES, the other based on the 1999-2008 NHANES. FICRCD translates all of the items in FNDDS into its 65 food commodities, and ARS worked in collaboration with ERS to develop the list.

Moshfegh showed Box 4-2, which lists food categories on the far left and the 65 commodities within those categories. ARS used foods as reported and converted them to the retail amount of a commodity. This provides the capability to look at consumption of commodities that appear in multi-ingredient foods by individuals. She said, for example, one category is apples from fruit. Another is apples from juice. ARS disaggregated all of the different sources of foods that have apples in them.

BOX 4-2
Food Intakes Converted to Retail Commodities Database (FICRCD) Commodities by Category, 2003-2008

FICRCD Commodities by Category

Category (no. of commodities)	Commodities	
Dairy Products (10)	Total dairy products	Fluid skim milk
	Total fluid milk	Butter
	Fluid whole milk	Cheese
	Fluid 2% milk	Yogurt
	Fluid 1% milk	Other dairy products
Fats and Oils (5)	Total fats and oils	Shortening (includes industrial shortenings)
	Margarine	
	Salad & cooking oils	Other oils
Fruits (14)	Total fruit	Melons
	Total apples	Total oranges
	Apples from fruit	Oranges from fruit
	Apples from juice	Oranges from juice
	Bananas	Other citrus fruits
	Berries	Stone fruits
	Grapes	Tropical fruits
Grains (5)	Total grains	Rice (dry or uncooked)
	Corn flour & meal	Wheat flour
	Oats & oat flour	
Meat, Poultry, Fish & Eggs (10)	Total meat, poultry, & fish	Chicken
	Total meat	Turkey
	Beef	Finfish & shellfish
	Pork	Eggs, shell included
	Total poultry	Eggs, without shell
Nuts (tree nuts & peanuts) (3)	Total nuts	Tree nuts
	Peanuts	
Sweeteners, caloric (1)	Total caloric sweeteners	
Vegetables, Dry Beans & Legumes (17)	Total vegetables	Onions
	Total brassica (cruciferous) vegetables	Peppers (bell & non-bell)
	Broccoli & cauliflower	Tomatoes
	Carrots	Sweet corn
	Celery	Total roots & tubers
	Cucumbers	Potatoes
	Green peas	Snap beans (string beans)
	Total leafy vegetables	Dry beans and peas (legumes)
	Lettuce (head & leaf)	

SOURCE: Available: http://www.ars.usda.gov/SP2UserFiles/Place/12355000/pdf/ficrcd/FICRCD_2003_08_factsheet.pdf [September 2014].

Moshfegh described the process of preparing the disaggregation, starting from the food category and a determination of whether the category needed disaggregation. ARS has compiled recipes for foods in each category. Recipes may be within FNDDS, from Internet sites, product labels, or the profile of the ingredients from similar foods and beverages. The recipes are used to determine ingredients (commodities) as well as their amounts and proportions. She said conversion factors are applied, if necessary. Food/beverage ingredients are characterized by predefined characteristics/criteria.

She gave the disaggregation for a tuna noodle casserole as an example. Their recipe calls for light tuna fish canned in oil (drained), egg noodles (cooked), fluid milk, margarine (80 percent fat), and white flour. Further disaggregation would be for the tuna into tuna fish, soybean oil, and salt, and the egg noodles into egg noodles (dry), and further into the amount of whole eggs and raw wheat flour.

She noted some foods and beverages may appear simple, but still need to be disaggregated. As examples, canned pineapple in pineapple juice needs to be disaggregated into the amount of pineapple and amount of juice, while buttered popcorn needs to be disaggregated into popcorn and butter.

She described the second special purpose database, the Food Patterns Equivalents Database (FPED),[15] which is available for 2005-2006, 2007-2008, and 2009-2010. It is developed using the same translation process for the foods and beverages in FNDDS, but it uses a different criteria. FPED translates foods and beverages into the 32 USDA food pattern groups that have been defined by USDA's Center for Nutrition Policy and Promotion (CNPP) based on the 2010 Dietary Guidelines for Americans. She acknowledged the efforts of Susan Krebs-Smith, whom Moshfegh said served as their champion in developing the FPED. Moshfegh noted some of the 37 food pattern components of FPED (see Box 4-3) are similar to those in FICRCD, but in FPED, none was taken back to the retail level. She pointed out that the last items on the list are oils, solid fats, added sugar, and alcoholic drinks.

Moshfegh described another new product based on WWEIA that groups the 8,000 food and beverages in FNDDS into 150 unique categories. These are called the WWEIA food categories. It is to be used for analyzing consumed foods and beverages. There is no disaggregation, but, for example, one can look at milk and how it is consumed separately by fat content and flavorings.

She closed by noting all the ARS databases, including FICRCD and

[15]The Food Patterns Equivalents Ingredient Database (FPID) is provided by ARS as part of the FPED release.

BOX 4-3
Food Patterns Components in the Food Patterns Equivalents Ingredient Database (FPID) and the Food Patterns Equivalents Database (FPED)

37 Food Patterns Components in FPID and FPED

Main Components	FPID/FPED Components
Fruit	1 Total fruit
	2 Citrus, melons, and berries
	3 Other fruits
	4 Fruit juice
Vegetables	5 Total vegetables
	6 Dark green vegetables
	7 Total red and orange vegetables
	8 Tomatoes
	9 Other red and orange vegetables (excludes tomatoes)
	10 Total starchy vegetables
	11 Potatoes (white potatoes)
	12 Other starchy vegetables (excludes white potatoes)
	13 Other vegetables
	14 Beans and peas computed as vegetables
Grains	15 Total grains
	16 Whole grains
	17 Refined grains
Protein Foods	18 Total protein foods
	19 Total meat, poultry, and seafood
	20 Meat (beef, veal, pork, lamb, game)
	21 Cured meat (frankfurters, sausage, corned beef, and luncheon meat made from beef, pork, poultry)
	22 Organ meat (from beef, veal, pork, lamb, game, poultry)
	23 Poultry (chicken, turkey, other fowl)
	24 Seafood high in *n*-3 fatty acids
	25 Seafood low in *n*-3 fatty acids
	26 Eggs
	27 Soybean products (excludes calcium-fortified soy milk and immature soybeans)
	28 Nuts and seeds
	29 Beans and peas computed as protein foods
Dairy	30 Total dairy (milk, yogurt, cheese, whey)
	31 Milk (includes calcium-fortified soy milk)
	32 Yogurt
	33 Cheese
Oils	34 Oils
Solid Fats	35 Solid fats
Added Sugars	36 Added sugars
Alcoholic Drinks	37 Alcoholic drinks

SOURCE: Available: http://www.ars.usda.gov/SP2UserFiles/Place/12355000/pdf/fped/FPED_2009_10_Fact_Sheet.pdf [September 2014].

FPED, as well as documentation for them, are available on the ARS website.[16]

OPEN DISCUSSION

Laurian Unnevehr asked Grünberger about Figure 4-3. She said the graph shows the relative difference between the food balance sheet and the household survey data gets larger as GDP increases, in accordance with expectations. She asked whether his analysis would be feasible in a country like the United States and whether a similar analysis might be done comparing NHANES versus the food balance sheet over multiple years. She asked whether the analysis might provide some insights into U.S. loss and waste estimates. Grünberger agreed it would be an interesting strategy for estimating food waste at the household level.

Unnevehr further questioned whether the analysis would hold since the gap is likely to be larger for the United States. Grünberger replied the challenge associated with the gap is not related to the analysis of shares. He said the reason he moved away from analyzing levels to analyzing shares is that shares are robust to differences in levels, and the data in shares were more correlated than the data in levels. While an analyst would need to consider these issues, he said, the suggestion to use the U.S. data to estimate waste is excellent. The Statistics Division of FAO is primarily focusing on losses before food reaches households, he said, because food balance sheets do not consider consumer waste, and the division is currently producing updated estimates of preconsumption food losses. Once the latter are updated, he said, the division may want to focus on waste at consumption by using nutrition surveys.

Suzanne Thornsbury (ERS) asked Grünberger to comment on the observation that while differences are getting larger for higher-income countries, they are also becoming more variable. Grünberger pointed to Figure 4-3, observing variability is also high for low-income countries. This contradicts the intuitive assumption that suggests variability is larger in richer countries where the production chain is more complex. He observed that FAO did not use the data in levels because the data were so noisy. He said one step forward might be to categorize surveys to see if that would help in explaining differences, then decide whether differences are due to loss or lack of information on foods consumed away from home.

Krebs-Smith noted that Moshfegh's presentation about the FICRCD database is particularly relevant because it illustrates a way to draw link-

[16]See http://www.ars.usda.gov/ba/bhnrc/fsrg [July 2014] for links to all databases and documentation.

ages between the survey data and the balance sheet data, or using one data source to cross-check the other. She suggested the disaggregation approach Moshfegh described for the FICRCD might be useful in dealing with imports and exports of composite foods in the FADS data.

Kai Robertson (World Resources Institute) asked Schmidhuber about the waste column in Figure 4-1. Schmidhuber responded that the column covers waste only at the primary level. It might be useful, he said, to identify losses at the primary level, the retail level, and the consumer level. He explained that the conversion factor in Figure 4-1 is just the primary extraction rate and has nothing to do with losses. Robertson asked whether waste is a function of the conversion factors. Schmidhuber responded in the negative, saying that the 0.7 is a technical conversion factor: one kilogram of millet typically has 70 percent flour, and the rest is bran and germ.

Morvarid Bagherzadeh asked how optimistic others are that the discrepancies between the food balances and the household surveys can be explained. She asked whether it might be possible to generalize to a country from modeled comparisons of survey and balance sheet results in other countries, suggesting maybe there are categories of countries for which this is possible. She observed that household surveys are resource-intensive and are difficult for many developing countries. Grünberger responded that the model is country-specific at the moment, and he has not thought about the proposed generalization. Countries are used in the analysis only if they have both balance sheet and survey information, and only low- and middle-income countries are included. He noted it would be interesting to extend this research to developed countries, to see how the relationship with GDP changes.

Schmidhuber stated one of the purposes of the analysis was to have a comparison between household surveys and food balance sheets and to use it to calibrate the food balance sheets. The calibration would be used in updated balance sheets until such time as additional household survey data become available. He said FAO is looking at the comparison commodity by commodity and item by item. In some cases, country-specific information is important; in other cases, some generalizations are possible. As an example of a country-specific result, he said, in Cambodia, 8 kilos of sugar are available in the food balance sheet and 4 kilos in the household surveys. In this case, the household surveys would not be used for calibration because the food balance sheets appear to be more accurate. Cambodia imports nearly all of its sugar. The household survey reports sugar consumed as sugar, but does not include sugar consumed in the form of processed products. In other cases, such as Mexico for maize (corn), the household surveys could be used to recalibrate the food bal-

ance sheets because there is reason to believe that the household surveys are the more accurate information.

FACILITATED DISCUSSION WITH PANELISTS AND AUDIENCE

Muth next moderated the discussion, asking the panel members and audience to consider this session in light of the question posed earlier by ERS Administrator Mary Bohman (see the open discussion in Chapter 2) in which she asked participants to identify high-priority improvements for ERS data. Muth asked panelists to consider how ERS might use the data and approaches they presented to improve the food availability (FA) data. (She noted that the loss-adjusted food availability [LAFA] data would be discussed in the next workshop session.) She also asked panelists and the audience to suggest their personal one or two highest priority research ideas for ERS to consider for the FA data.

Sarah Nusser noted that the FAO analysis calibrating the food balance sheet and the survey data together was interesting, and asked about any promise for that approach within ERS. Jay Variyam (ERS) questioned whether the different purposes of the FAO and ERS balance sheets have an impact on methods that might be used. He stated that FADS has been used for meta-analysis and other purposes, while the FAO data are used to understand food safety and availability in many countries. He stated that, to the extent the FAO data are based on models, he thinks their use is limited, while the U.S. FA data come from balance sheets and represent production estimates and, hence, can be used in forward modeling. He expressed a need for caution in adopting the use of models.

Nusser observed that she views a balance sheet as a model about how the system works, and it is perfectly closed. She asked whether Variyam is concerned about imputed values in the balance sheet and how that might impact further analysis. Variyam said he disagreed that a balance sheet is a model. Mark Jekanowski stated he also thinks a balance sheet is not a model, but acknowledged this may be a semantic difference. He said he views a balance sheet more as an accounting framework, one that accounts for all of the different types of supply and use. To him, this differs from a modeling approach to estimating food availability directly from other sources, which he acknowledged may be a subtle difference. Nusser agreed that a balance sheet is an integrative framework with a set of constraints, which is why she thinks of it as a model. It is expected that production, imports, and beginning stocks add to supply, and, in theory, they do. However, estimates are needed in all the cells, some are more accurate than others, and key items are calculated as residuals. She said she views balance sheets as incorporating model assumptions.

Mark Denbaly (ERS) asked whether the underlying data for balance

sheets are survey-based. Jekanowski replied that the underlying data come from NASS and Census Bureau surveys and are estimates. Denbaly went on to say when estimates are added up, the result is a variable that has some probability distribution. Jekanowski again agreed, saying that in reality, the estimates might not add up perfectly. He added that there is potential for the data to be measuring things that are slightly different than assumed. However, they are the best data available and are put in a common framework with assumptions.

Muth reminded the audience about the interest in being able to break out food at home and food away from home in the LAFA data. She wondered whether the other data sources discussed might be used to come up with a disaggregation at the commodity level that could be used to estimate food at home and food away from home. Moshfegh replied that the FICRCD is linked to the data from NHANES. For every food and beverage reported in NHANES, a lot of information is available. Data are available for the time the individual started eating, whether the food was consumed at home or away from home, and the source of the food. This level of detail might be useful to estimate amounts of food consumed at home versus amounts of food consumed away from home.

Muth asked how the 65 commodities in FICRCD map to the 200 or so commodities in FADS. Moshfegh replied some are mapped very cleanly, some less so. Denbaly added that when the project with ARS started, ERS asked for the 200 commodities that are in FADS. Unfortunately, data were limited, but he is not sure why only 65 categories were chosen. Moshfegh explained that some of the commodities are not frequently consumed, according to the survey data. The commodity-level detail in FADS is food available for the whole country. NHANES surveys 5,000 people in a year in a country with a population of about 315 million. For that reason, ARS did not think that the data were robust enough to drill down to all of the smaller commodities.

Kumcu noted that other efforts might fill in some data gaps. For example, different groups have been working with ERS and the Food and Nutrition Service (FNS) of USDA to map UPC products to the FNDDS groups or the MyPyramid equivalents.

Muth asked whether the FoodAPS data will provide estimates for food acquisition at home versus away from home, saying those estimates might support an estimate in the FADS system. Denbaly replied that FoodAPS does have the designation of at home versus away from home. He observed, however, that measuring quantities of food away from home is difficult, although they are trying to do so.

Krebs-Smith asked about mapping of UPC codes to some commodities or the food pattern equivalents. Denbaly stated that CNPP, ERS, and ARS will meet to launch a project to link up the IRI data to FNDDS, which

would result in obtaining more information on price and quantity measures for food availability. He went on to say that theoretically speaking, it could also be done for FoodAPS, but this is not currently planned. Krebs-Smith asked about plans to link a commercially available database to FNDDS. She noted that a branded foods database is planned to be available soon. Denbaly expressed hope that this will also be part of the effort.

Schmidhuber stated that FAO is interested in continuing work comparing household surveys with food balance sheets. FAO is going through the comparison commodity by commodity to understand the strengths and weaknesses of the two data sources. He said the question is when it is better to use household surveys versus food balance sheets, noting the answer can be country-specific. More generally, he said, it is important to do comparisons. He asked whether the various U.S. sources support a total calorie availability comparison, calling it a useful benchmark. He said he would like to see a comparison of the U.S. balance sheets with household surveys.

He noted that most of the surveys available to FAO are household income and expenditure surveys representing food available at the retail level. Food consumption surveys would permit a much better evaluation of waste, he said, as the difference between food purchased and food consumed would be waste or loss. He noted that an international effort to sponsor more food consumption surveys is something FAO could support.

FAO has been using the National Nutrient Database for Standard Reference, he said. However, one of its limitations for FAO use is its inclusion of fortified food. When FAO used it on aggregated commodity balances at the process level, they noticed that micronutrient deficiencies in developing countries went away, which was an artifact of applying the nutrient content of fortified foods. He suggested a similar database, but without fortification, because it would serve as a default database for nutrient factors where they do not have country-specific nutrient tables.

Muth related a question that came in through the workshop webcast from Lisa Johnson (North Carolina State University) about whether supply and availability data would change drastically by including the portion that is unharvested, especially for the fruit and vegetable commodities. Unharvested amounts are estimated to be enormous, Johnson said; since growers report what leaves the farm to NASS, they could perhaps also report what is left. Jekanowski replied that for many commodities, NASS reports both planted and harvested acreage, and abandonment estimates are available for these commodities. However, no reason is given for that abandonment, and it is not clear whether it is appropriate to consider abandonment as a loss. Thornsbury said planted and harvested acres and a production number are typically reported on NASS surveys

for fruits and vegetables. The production quantities are used in the food balance sheets. NASS has national surveys that provide the production estimates, which are calibrated to the Census of Agriculture every five years. NASS does not collect data about abandonment in the field.

Muth noted one reason for abandonment might be a crop failure. She said the difference between planted and harvested acres could give an upper-bound estimate of farm loss. Thornsbury agreed, but also suggested other reasons for abandonment. For fruits and vegetables, it could also be economic abandonment. If too much product is available, prices are driven down, and there may not be enough value in the crop to pay for the harvest. Jekanowski noted one other complication: if not harvested, the yield is unknown. Assumptions would be needed to come up with loss estimates.

Helen Jensen said some abandonment has to do with food safety. Farmers may find a part of their fields has contamination, so they rope it off and do not harvest it. She said she was not sure whether that would be considered loss. Thornsbury elaborated that now, if a crop is not harvested, it is not captured in the supply and use table. There are many reasons why food might not be harvested, but none is captured in the supply and use tables.

Muth asked the audience about their ideas concerning high-priority projects for improving the FA data.

Krebs-Smith suggested the notion of abandonment and the reasons for abandonment might be good to capture. She said data that illuminate any unknowns along the way would be helpful for various types of analyses, especially at a time of concern about sustainability and feeding a hungry world, where food waste is a big issue.

Moshfegh suggested another type of data that may be of interest for international uses is food loss in transportation across countries. Inside a country, there are ways to capture transportation losses. However, for international trade, there seems to be no information at all, although perhaps insurance companies have data. Schmidhuber responded that trade statistics databases may provide the information because they include the exports of reporting countries and the imports of partner countries. Combining these quantities and values may provide an estimate of loss. He noted, however, that there is a lot of noise in the data, and the trade data are more reliable for developed than developing countries.

5

Alternative Approaches for Estimating Food Loss: International and Domestic

This chapter summarizes the fourth session of the workshop on alternative approaches for estimating food loss, moderated by Josef Schmidhuber (Food and Agriculture Organization [FAO]). Kai Robertson (World Resources Institute [WRI]) described the Food Loss and Waste Protocol currently under development, as highlighted in the first section of the chapter. The second section reports on the questions and answers after her talk. The third section summarizes the presentation by Klaus Grünberger (FAO) about a model for imputing food losses in food balance sheets, followed by a summary of the questions and answers that resulted. The fifth section is a summary of the presentation by Morvarid Bagherzadeh (OECD), who described a project to assess the availability and quality of data on food waste in OECD countries and how policy objectives have shaped data production. Shelly Schneider (Franklin Associates) then described methods for developing estimates of waste—both sample-based and food availability-based—used by the U.S. Environmental Protection Agency (EPA). The last section is a summary of the discussion with panelists and the audience, facilitated by Jean Schwab (EPA), which centered on possible ideas to improve Economic Research Service (ERS) estimates of food waste and loss.

STATEMENT OF KAI ROBERTSON FOOD LOSS AND WASTE PROTOCOL

Robertson said that she was representing WRI, which serves as secretariat for developing the Food Loss and Waste Protocol in collaboration with many other stakeholders. The Food Loss and Waste Protocol is a new effort, just getting under way at the time of the workshop, intended to produce a global standard with guidance for measuring food loss and waste. If successful, it would enable a wide swath of users, including countries, companies, and other organizations, to measure and estimate how much food is lost and wasted in a credible, practical, and consistent manner, and would support identification of where loss and waste occur.

She said the long-term vision of the stakeholders is that the wide use of the protocol and its measurement standards will empower the world to minimize food loss and waste. One benefit, she said, would be enhanced food security, because food that would be wasted or lost could be used to feed people in need. Another benefit would be to encourage economic growth by raising the incomes of farmers who would receive more value from crops currently being "lost" and by saving resources now used to grow, transport, and process food that is not used for its intended purpose. An environmental benefit would accrue by reducing the amount of methane produced from decomposing food, she said.

Robertson noted that WRI publishes *World Resources Reports*, each focused on a major global issue and the issue's intersection with the environment and development. The 2013/2014 *World Resources Report*[1] focuses on how the world will feed nine billion people by 2050 in a manner that ensures that agriculture contributes in a positive way and adverse impacts are minimized. She pointed to Lipinski et al. (2013), one of the many working papers developed in support of the report, which was a collaborative effort with the UN Environment Programme (UNEP), FAO, the Waste and Resources Action Programme[2] (WRAP), and the Postharvest Education Foundation. The paper's first recommendation was to develop a global Food Loss and Waste Protocol, with the premise that "what gets measured gets managed." She stated it is very difficult to adequately manage food loss and food waste if there is no consistent way to measure them, referring to the earlier workshop session (see Chapter 2) about the challenges associated with measuring food availability, loss, and waste. She identified three challenges to the multidimensional topic of food loss and waste: definitions, data, and diverse methods.

Robertson observed that there are different definitions of what con-

[1]For information about the report, see http://www.wri.org/our-work/project/world-resources-report [July 2014].

[2]For more information about WRAP, see http://www.WRAP.uk.org [July 2014].

stitutes food loss and waste. ERS, FAO, and others have collected data, but the quantifiable data on loss and waste are sparse, inconsistent, or nonexistent. The diverse methods for gathering the data result in a lack of comparability and consistency, and they risk confusion and potential multiple reinventions of the wheel, she said.

As Robertson explained, the Food Loss and Waste Protocol will address the definition and diverse method components of the challenge. It will not collect data, but is intended to enable data collection. As a precedent, WRI partnered with the World Business Council on Sustainable Development (WBCSD) in launching a Greenhouse Gas Protocol in 1998. At that time, she said, there was a similar concern about lack of a consistent, standard, agreed-upon way to measure and monitor greenhouse gas emissions. WRI and WBCSD convened a multistakeholder process to develop the Greenhouse Gas Protocol,[3] which she said is now seen as the standard for measuring greenhouse gas emissions.

Development of the Food Loss and Waste Protocol is drawing from the lessons learned during the development of the Greenhouse Gas Protocol, Robertson noted. It will have standard language to specify requirements and recommendations, and its development will rely on the same guiding principles that underpinned the Greenhouse Gas Protocol. These guiding principles point to the need for a multistakeholder process in order to be inclusive and global, including public- and private-sector organizations from around the world. The guiding principles also point to building on existing initiatives, so data collection efforts on food loss and food waste by USDA, EPA, FAO, and others will be examined. She said WRI wants to build on these measurement methods.

WRI is trying to keep the scope broad, Robertson explained, looking from farm to fork to see where food loss and waste might occur. The protocol will be designed for multiple audiences and uses, and it will be modular. A key component of meeting diverse users' needs is to be practical and have low barriers for use. Hence, she said, "modular" means that the protocol will define the possible components of food loss and waste, so users may select those components that best satisfy their needs and objectives. Another key guideline is to "avoid letting the perfect become the enemy of the good," she said. It is not necessary to have complete, precise information about food loss and waste to be able to take action. This is one way in which the Food Loss and Waste Protocol differs slightly from the Greenhouse Gas Protocol, she pointed out, as greenhouse gases can be measured much more precisely than food loss and waste.

Robertson said that in developing the Food Loss and Waste Protocol, WRI is cognizant of being amenable to differences. This is a global effort

[3]For more information on the protocol, see http://www.ghgprotocol.org/ [July 2014].

and an issue for both developing countries and developed countries, so availability of resources and data measurement capabilities will differ widely. The protocol will address this by providing tiered guidance. For example, there will be guidance for collecting the most reliable and comprehensive data, and it is hoped that entities might aspire to this. But there will also be guidance on lower cost, less resource-intensive options for entities with fewer capabilities.

Robertson said WRI is planning on a 2-year process to develop the Food Loss and Waste Protocol. Over the last several months, the team has been developing a governance strategy and mapping out the overall structure of the protocol. Public- and private-sector entities have been invited to join the effort. For the next few months, technical working groups, in coordination with an external review group, will develop measurement standards and draft content, with the intent to have a draft by the end of 2014 that can be pilot-tested in early 2015. The protocol will be edited based on reviews and published by September 2015. She acknowledged the due date is "somewhat aspirational," but it is driven by the fact that the UN General Assembly will meet then and it is expected that food loss will be on the agenda. She noted that there will be public updates during the process.

She said that the first protocol will be titled version 1.0. It is expected that as the protocol is used over time, there will be advances in methods and data, and user needs may change. Similar to the Greenhouse Gas Protocol, additional versions are likely. The organizations currently directly involved in developing the protocol include WRI as secretariat, as well as six other leading organizations: (1) Consumer Goods Forum (CGF), a network for CEOs of leading manufacturers and retailers from around the world representing trillions of dollars in sales; (2) FAO, which works on postharvest losses and has launched an initiative called Save Food; (3) Food Use for Social Innovation by Optimizing Waste Prevention Strategies (FUSIONS), a multistakeholder project working toward achieving a more resource-efficient Europe and on providing guidance on defining food loss and waste for the European Union; (4) UNEP, which has launched a food loss campaign called Think, Eat, Save, Reduce Your Foodprint; (5) WBCSD, a CEO-led organization of companies focused on sustainable development; and (6) WRAP, a UK-based organization with a focus on food waste and packaging issues. The group has deep technical expertise, she pointed out, and while the organizations are based in the developed world, a number of them have deep and broad reaches globally.

The organizational structure includes the secretariat, steering committee, technical working groups, and an external review group. The technical working groups will develop content in two phases: review

and analysis, and writing and revising. There are two subgroups because approaches to measuring food loss and waste are different upstream and downstream. The upstream group will focus on losses at harvest up to the point of processing, and the downstream group will focus on the processing point forward to consumption. The external review group will provide independent perspectives on the Food Loss and Waste Protocol, particularly feedback on the draft guidance. It will be more informally involved to review draft products. A group of pilot testers will be drawn from these groups. The pilot testers will be engaged at the end of 2014 when the draft protocol is ready for testing. They will provide feedback, and case studies will be developed.

Robertson invited workshop participants to join any of these groups. She noted the benefits of participating are to shape the guidance of what comes out at the end of the process and to exchange experiences with experts from around the world. WRI will also provide recognition for everyone who contributes to the process.

She described what the report might contain and said project updates will be available on the WRI website.[4] The report will focus on the standards and guidance for how to measure, with supplementary material to help users. These might be developed from case studies, references, or tools and other information.

QUESTIONS AND ANSWERS: KAI ROBERTSON

Laurian Unnevehr asked whether the WRI effort is planned to include loss at the consumer level. Robertson replied that the protocol will go through consumption, both at home and away from home. She noted that WRAP has done a lot of work on household food and drink surveys and since the Consumer Goods Forum is composed of retailers, the consumption part is critical in their view.

Susan Krebs-Smith asked Schmidhuber whether FAO is involved with the WRI effort, and if so, whether FAO would apply the protocol to their food balance sheets. Schmidhuber responded that the FAO Agriculture, Industry, and Services Division is involved, but not the Statistics Division. However, he said, FAO is open to a protocol that makes sense and can be populated with data. Such a protocol would be adopted into the FAO system because it is consistent with what FAO has been trying to do to define waste and loss at various stages. The big question for him, he said, is whether FAO could mobilize the resources to populate the system with data.

Robertson added that the protocol is intended to enable data collec-

[4]For updates, see http://www.wri.org/food/protocol [July 2014].

tion, but a lot of data do not yet exist. Hence, she said, the protocol will provide a framework for consistent discussion about the terms and what is actually included in specific components.

Sarah Nusser asked if the Global Strategy to Improve Rural and Agricultural Statistics is involved with the development of the protocol. Schmidhuber responded that FAO has already started that collaboration with the World Bank and the Global Strategy. He said FAO is collaborating on setting up an experimental design to measure waste at different stages of the value chain for four or five representative systems. The hope, he said, is to be able to draw inferences from one representative country within a food chain to other countries that have similar food chains.

STATEMENT OF KLAUS GRUNBERGER A MODEL FOR IMPUTING FOOD LOSSES IN FOOD BALANCE SHEETS

Grünberger described an analytical effort to use existing data to impute food losses to countries and commodities for which FAO does not have data. The analysis is documented in Grünberger (2013). He reminded the audience that the food balance sheet has about 100 crops or commodities and more than 180 countries or territories, though not all commodities are produced or consumed in every country. He said that there are thousands of loss figures in the spreadsheet for which data are needed but not available. He described an approach for imputing, or estimating, this missing data.

In the present FAO system, like the U.S. system, losses are computed using loss ratios, he explained. For example, as shown in Figure 2-4 (see Chapter 2), in the United States, the loss ratio for carrots to retail is 3 percent. In the FAO system, fixed ratios are used for all countries and years. Losses at a given time are computed as the product of the loss ratio for that country and commodity times net supply (production plus net imports plus stock withdrawals) for that country and commodity for the given time period.[5] These loss ratios have not been updated in some time. The purpose of the project he described in his presentation is to provide a way to update the loss ratios.

Grünberger said the data used in the analysis were selected from loss data provided to FAO by national statistical offices and by ministries of agriculture. FAO considers these to be official. These loss data were divided by net supply to yield a loss ratio. There is one loss ratio computed from official data for primary commodities for each country that had such data, and for as many years as possible from 1970 to 2012. The

[5]The FBS Handbook (Food and Agriculture Organization, 2001) provides further information.

intention was to have a dataset with some observations in most parts of the world, and for different commodities or food groups. Since there were not enough data for sub-Saharan Africa, additional research revealed some data from national food balance sheets that were included in the sample.

Grünberger showed Table 5-1 to illustrate the sample, regions, and commodity groups covered. For some regions, no data of certain food groups are available: for example, in Northern Africa and the Middle East, there is no information on pulses (legumes). He pointed out that within the body of the table, each country and commodity observation is counted once. However, several of the countries repeated their observations over time, as shown in the last row and the last column of Table 5-1. This repeated information was generally very stable over time, he explained. For example, if a country reported loss ratios for 1990 and 2000, it was likely that the same value was reported in both years. He said the data had probably not been updated, so they could not be viewed as panel data. As a result, for analytical purposes, the information was considered to be a cross-sectional dataset with repeated observations.

Grünberger described a regression model that related the log of the loss percentage to several factors (see Box 5-1). The model includes a time trend, dummy variables for regions and subregions, a dummy variable for a commodity, an interaction term between commodity group and the percentage of paved roads in a country,[6] and an interaction term between the commodity group and the per capita gross domestic product (GDP) of a country. He said the interaction term between commodity group and percentage of paved roads was included because of the potential differential impact by product. For example, bad roads will result in more damage in transporting tomatoes than cereals. Similarly, GDP may be a proxy for storage quality (for example, the availability of cold storage), which, too, is more important for some food groups than others.

He said one variable not included in the model is climate. Although an initial analysis included average rainfall and temperature by country, their analysis found inclusion of these variables created extreme outliers in predicted values. Another issue was this simple model has no way to capture weather variability: Average rainfall, for example, is likely to be less important than whether it is consistent over the year or seasonal. Another potential factor to include is excess production. One might imagine greater losses may occur in a year with very high production because storage facilities are full, Grünberger observed.

Grünberger stressed that the model is intended only for prediction of loss ratios. He showed Figure 5-1 to illustrate the predicted loss values

[6]To reflect the transportation infrastructure.

TABLE 5-1 Sample Size by Food Group and Subregion

Food Group	SSA	Northern Africa and Middle East	Latin America	Western Industrialized Countries
Cereals	24	29	37	140
Roots and tubers	13	5	17	19
Sugar crops		2	2	3
Pulses	5		17	9
Tree nuts			4	4
Oil crops	7	3	14	14
Vegetables	5	2	29	49
Fruits	10	9	61	46
Stimulants and spices			8	
Milk	2	2	3	14
Eggs	2	3	3	15
Meat	10	5	16	4
Total	78	60	211	317
Incl. repeated obs.	164	584	3,418	4,778

NOTE: Sub-Saharan Africa (SSA). Data are treated as cross-sectional with repeated observations. Totals include countries not classified by subregion.
SOURCE: Prepared by K. Grünberger for presentation at the workshop. Based on Food and Agriculture Organization data.

versus the input loss ratios. He observed that the fit is modest, most likely because of noise in the input data. The predicted mean loss ratio, however, may provide a reasonable estimate for the actual loss ratio.

He showed Table 5-2, illustrating the predicted losses for six subregions and 12 item groups. He pointed out that the mean loss ratio is about 8 percent, and the highest ratios are for fruits, vegetables, and tree nuts in Latin America and in sub-Saharan Africa, where loss ratios are quite high. Next, he used Table 5-3 to illustrate the difference between the loss ratios predicted by the model and those used in the balance sheets. Overall, the model results are about 0.5 percent higher than the food balance sheets; for several item groups and subregions, the differences are quite dramatic. Overall in Latin America, the model results are 4.5 percent greater than food balance sheet losses. Breaking this down further, he noted that the current food balance sheet losses might be too low in Latin America for vegetables (by 9.8 percent) and fruits (by 4.5 percent). He went on to say his group knows there is measurement error in the loss ratio data and will carefully review the actual loss rates versus the model-based results

Eastern Europe and Central Asia	Asia and Pacific	Total	Incl. Repeated Observations
41	29	313	4,233
10	14	80	1,228
4		11	66
2	2	36	470
2	2	12	224
6	8	52	573
19	3	108	1,421
23	3	154	2,031
	2	10	108
6	2	29	340
7	2	32	427
7		42	651
127	67	879	
1,557	920		11,772

as part of their evaluation. He also noted that if the mean of the measurement error is different from 0, predictions are biased.

He closed by saying this approach is an efficient way to estimate losses given the poor-quality data that are available. He stated FAO is considering extending the model to incorporate additional data from regional or commodity-based surveys, although combining different types of data would have to be done carefully. They are also considering extending the model to represent losses at various stages of the value chain (commodity tree) described by Schmidhuber in an earlier session (see Chapter 4). He noted, however, a major challenge is that there are not enough data to populate the processing trees.

QUESTIONS AND ANSWERS: KLAUS GRUNBERGER

Jean Buzby asked for and received clarification that the United States is included in the analysis Grünberger presented. She stated that when she last looked at the commodities covered by FAO for the United States compared to those covered by the Food Availability Data System (FADS),

BOX 5-1
Model Specification for Food Loss Ratio (LR)

$$\ln(LR_{ijt}) = c + \alpha T_t + \beta RE_j + \delta C_i + \gamma_1 CG_i \times PR_{ij} + \gamma_2 CG_i \times GDP_{jt} + \mu_{ijt}$$

where T is a linear time trend
RE is the set of dummy variables for subregions
C is a set of dummies identifying the commodity
CG identifies the food group
PR is the percentage of paved roads in the country
GDP is the country's per capita GDP
Indexes i, j, t refer to the commodity, country, and year of observation, respectively

The model is estimated by OLS, clustering std. errors at commodity and country level. Logarithmic predictions are corrected for retransformation bias.

SOURCE: Prepared by L. Grünberger for presentation at the workshop.

she observed some differences. She asked whether FAO uses the method Grünberger described to impute commodities that are not in FADS.

Schmidhuber noted the model Grünberger described has not yet been applied. The current methods used by FAO are very similar to those used by ERS. FAO multiplies supply, the sum of production, net imports, and stock withdrawals, by a loss ratio. He said while there is nothing wrong with the methodology, FAO noticed the loss ratios have not changed for 30 years. The need for a process that can be updated with new data drove FAO to consider this new approach, and FAO is still collecting input about the new method. He suggested ERS may want to consider this new approach as well. He noted it is a stopgap measure because of discomfort with the existing approach, but FAO's ultimate goal is to have a measured approach developed with an experimental design and measurements through representative value chains that can be rolled out to all countries.

Rosanna Morrison (ERS) asked whether the model includes a term to account for civil or military disruptions, saying that if this could be done by country and time period, it might help with the model fit. Grünberger said the model does not capture extreme events, political or climatic. He said variability by country over time is so low that national statistical offices may not respond to such changes. If the data were of higher quality, he said, including extreme events would be a logical next step.

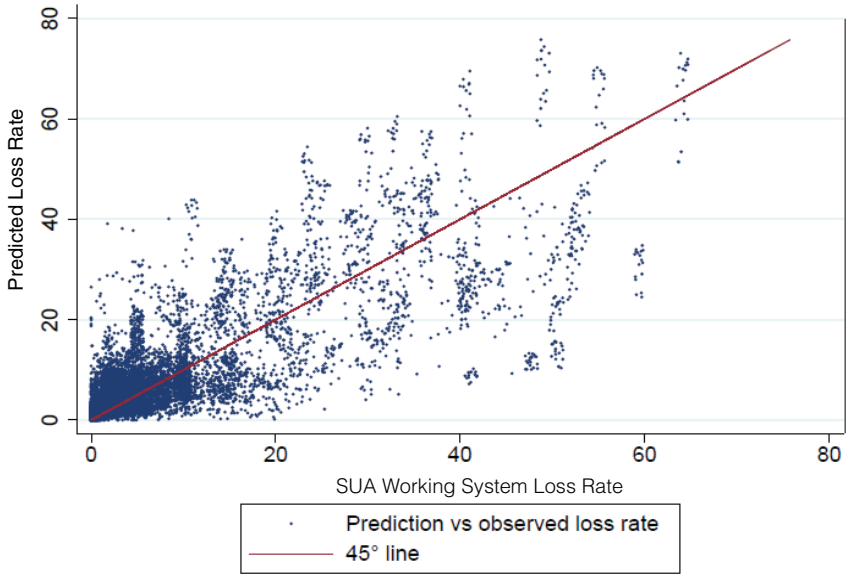


FIGURE 5-1 Validation: Scatterplot of predicted loss rates versus estimation in sample.
NOTE: SUA (supply and utilization accounts) is the statistical framework that provides data for food balance sheets.
SOURCE: Prepared by K. Grünberger for presentation at the workshop. Based on Food and Agriculture Organization data.

Mary Muth asked whether the loss estimated in Grünberger's analysis is the total cumulative loss from production through consumption. He replied it is cumulative loss up to the retail level. Muth asked whether it would be possible to split the available data on losses into those that are based on expert opinion and those based on measurement approaches and whether that could be controlled for in the model. Grünberger replied the goal was to update the loss ratios developed from expert judgment in the 1970s. He used one source of homogeneous data. He said if data from surveys were available, it would be important to control for the different typology of the data. Schmidhuber added that they do not have the metadata information that would allow them to distinguish expert opinion from official measurements because countries do not provide the information.

Suzanne Thornsbury asked how FAO plans to move forward. She observed that it is hoped that the model, a stopgap approach to updating the loss ratios, and the experimental design approach will provide

TABLE 5-2 Results: Predicted Loss Rates by Food Group and Subregion

Food Group	SSA	Northern Africa and Middle East	Latin America	Western Industrialized Countries	Eastern Europe and Central Asia	Asia and Pacific	Total
Cereals	7	4	8	3	4	5	5.20
Roots and tubers	7	6	11	6	4	6	6.80
Sugar crops	2	2	4	2	1	2	2.30
Pulses	5	3	5	2	2	3	3.50
Tree nuts	14	8	16	5	7	10	11.00
Oil crops	7	4	7	2	3	5	5.00
Vegetables	19	9	19	6	6	14	13.00
Fruits	15	7	15	5	5	11	11.00
Stimulants and spices	1	0	1	0	0	1	0.53
Milk	3	1	3	1	1	2	1.90
Eggs	3	1	4	1	1	2	2.10
Meat	11	6	15	4	3	8	8.60
Total	12	5.8	13	4.1	4.1	8.4	8.40

NOTES: SSA = sub-Saharan Africa. Averages of predicted loss rates for the year 2009. Losses are reported in percentages.
SOURCE: Prepared by K. Grünberger for presentation at the workshop. Based on Food and Agriculture Organization data.

TABLE 5-3 How Results Would Change Losses in Food Balance Sheets

Food Group	SSA	Northern Africa and Middle East	Latin America	Western Industrialized Countries	Eastern Europe and Central Asia	Asia and Pacific	Total
Cereals	–1.5	–2.2	2.0	–2.0	–0.4	–2.2	–1.1
Roots and tubers	–2.1	1.2	3.7	3.3	–0.7	0.3	0.6
Sugar crops	–4.9	0.7	–1.0	1.1	1.1	–3.2	–2.1
Pulses	0.3	–1.5	1.4	–1.8	–2.3	0.9	–0.5
Tree nuts	5.9	2.5	1.0	–2.3	–0.4	–0.6	0.1
Oil crops	0.7	–0.6	4.3	–1.8	–0.8	1.2	0.6
Vegetables	9.5	0.2	9.8	–1.5	–0.3	3.1	2.5
Fruits	5.2	–1.7	4.5	–2.2	–2.2	0.9	0.8
Stimulants and spices	–3.1		–2.7	–9.5		–2.0	–2.9
Milk	–2.7	–3.2	–1.0	–0.7	–0.6	–3.0	–2.2
Eggs	–6.8	–3.3	–0.3	–1.7	–1.1	–4.3	–3.5
Meat		1.1	–0.6	2.1	–0.4	–42.4	–1.4
Total	1.5	–1.0	4.5	–1.6	–1.0	0.1	0.5

NOTES: SSA = sub-Saharan Africa. Averages of predicted loss rates for the year 2009. Losses are reported in percentages. High differences in losses of meat in Asia and Pacific are due to high losses in the FBS of Myanmar.
SOURCE: Prepared by K. Grünberger for presentation at the workshop. Based on Food and Agriculture Organization data.

updates to single points in time. Since the loss ratios are expected to continue changing, she asked whether FAO has thought about how to carry estimates of change forward into the future. Schmidhuber said keeping factors up to date is a perpetual problem that does not only apply to updating the waste numbers. FAO hopes the experimental design approach will provide an anchor for the food balance sheets with a calibration to a measured result that could be repeated in the future to provide an updated anchor. FAO expects to use such results along with an imputation model that rolls them out over time.

Nusser commented that the temporal modeling, including civil and military unrest and the climate, would help FAO do predictions into the future. She commented that when good independent data are available, there is a lot of promise for this approach to provide a framework to predict losses and how they change in response to local conditions. Schmidhuber explained FAO would not be able to predict into the future. If the model includes a term for something like civil unrest, the regression R^2 may be increased, but civil unrest is impossible to predict.

Robertson asked about efforts to harmonize loss ratios across different entities. She said that from her perspective, it seems there would be value in having a standard database on loss ratios, and she considered how the Food Loss and Waste Protocol might give users guidance on these ratios. She asked if the only loss ratios are those developed by FAO and ERS. For FAO, Schmidhuber stated FAO makes everything it has publicly available. He expressed his concern about the old loss ratios providing a standard, and noted FAO is trying to update conversion factors, extraction rates, and loss factors. For ERS, Buzby and Jekanowski stated the conversion factors used in FADS are all available on the ERS website in the food availability (FA) and loss-adjusted food availability (LAFA) spreadsheets. Updates to factors are documented in either the FA documentation[7] or the LAFA documentation.[8]

STATEMENT OF MORVARID BAGHERZADEH
OECD METHODS FOR ESTIMATING FOOD WASTE

Bagherzadeh started by describing the OECD's role and its membership. It provides policy advice and has a strong statistical structure because of the belief that good policy advice needs information about

[7]For FA documentation, see http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system/food-availability-documentation.aspx [July 2014].

[8]For LAFA documentation, see http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system/loss-adjusted-food-availability-documentation.aspx [July 2014].

fundamentals. Through time, OECD has also developed as a forum to share best practices.

She said OECD's project on food waste was initiated in 2010 when agriculture ministers from member countries and emerging economies met in Paris. Part of their discussions focused on the possibility that reducing food waste could be an answer to food security issues. The ministers asked OECD to look into the topic. In 2011, OECD developed its Green Growth Strategy, aimed at helping countries anchor their economic growth in green growth. The strategy identified reducing food waste as a means to increase available food supply and reduce pressure on resources and climate.

OECD has just completed the first phase of work by taking stock of existing data. They have not collected data but rather identified data that are available, Bagherzadeh explained, as well as tried to identify the policies relevant to influencing food waste. The next phase will be to model the impact of reducing food waste on agricultural markets and trade. The third phase will be to try to draw policy lessons from incentives and disincentives to reduce food waste that apply to the processing and retail industries.

Bagherzadeh went on to say that analysts at OECD have observed that two sets of policy objectives relate to food waste: one related to food security, or optimizing food availability, and the second related to the state of the environment, which includes minimizing waste management needs. Governments have had to face waste and sometimes limited food supply, and they want to produce enough to supply demand. One of the elements of waste is food. Governments also want to optimize the end-of-life treatment of food waste and to consider the allocation of finite resources—the competition between agriculture and other uses of scarce resources such as water. As she commented, "half of a loaf of bread may be water. If the loaf is thrown away, the water resource has been wasted." Water is also important to industrial processes, energy production, and transportation.

She noted that these policy objectives have led to two measurement strategies. For food security, governments try to measure food available for consumption. As a result, as presented earlier in the workshop (see Chapter 2), waste is measured when the food leaves the food chain. For the environment, with an objective to limit and manage waste, the policy leads to measuring waste when it enters the waste management system. OECD analysts have observed that these policy objectives have led to development of laws and regulations that sometimes require reporting. This reporting requirement, in turn, leads to the production of data, which is how FAO and OECD have populated their databases, and she suggested the same may be true for ERS.

Bagherzadeh said examples of measurements withdrawn from available food include the FADS LAFA data (described in Chapter 2), FAO food waste estimates (not the balance sheets described in Chapter 3, she clarified, but other initiatives at FAO), and numerous household-level surveys. Examples of data collected about waste reduction include inputs to waste treatment facilities in the European Union and other places (although a gap occurs in places with no central waste management or no treatment at all); business registers in Japan, Korea, and European countries (but without data on small businesses); and curbside collection with separation of food waste in Korea,[9] which has very good estimates of household food waste but no data from urban areas.

Bagherzadeh pointed to the report *Global Food Losses and Food Waste* (Gustavsson et al., 2011).[10] She characterized it as a very important analysis of food loss and waste and pointed to a conclusion in the report that if global food loss were attached to a single country, that country would be the third largest contributor to greenhouse gases in the world.

She gave four country examples of efforts to improve the measurement of food waste and loss, noting the examples provide steps forward but also have limitations. Her first example was the United States. She referred to Buzby's description about U.S. initiatives to improve data on food loss at retail and consumer levels (see Chapter 2). Her second example was Finland. A study found households are the main contributors to food waste, although OECD analysts suspect this finding is because Finland has not examined the rest of the food chain. Bagherzadeh's third example was a preparatory study conducted in the European Union (EU) that indicated that households are the main contributors to waste, but that manufacturing is also important. She said that 3 percent of EU emissions are from food waste. One limitation of this effort is the data from member countries are quite heterogeneous. Her fourth example, also from the EU, was a specific collection of food waste begun by Eurostat two years ago.[11] Results are anticipated in 2014, with expectation of a fine breakdown of where in the supply chain food waste could be produced. Bagherzadeh said the limitations are that it is a voluntary process, and not many countries are participating.

Bagherzadeh described the methodology behind OECD's stocktaking study of food waste data. Data sources included a web and literature

[9]Korea has implemented a technology for curbside collection with separate measurement of food waste.

[10]Gustavsson et al. (2013) describe the methodology used for the 2011 study and also estimates greenhouse gasses.

[11]Eurostat has developed a plug-in or satellite table as part of its annual survey on waste to collect finer levels of detail on food waste activity. It has greater detail about industry types and food types.

review, a one-sheet questionnaire added to a regular annual OECD survey of member countries, and the Eurostat ENV-WASGEN accounts for waste dataset. Approximately 3,000 data points for 31 countries were assembled. Each data point is classified according to country and region, definition used, economic activity, commodities or grouping, measurement unit, and year. Overall the information illustrates data coverage by sector. For example, household waste is quite well covered, data on agricultural waste are weak, and there is some information about manufacturing and food services waste, she explained.

She said results vary by country, and she used examples from three countries to describe the share of food waste by stage in the supply chain: household, food services, large-scale consumers, manufacturing, and agriculture. In Germany, more than half the waste was at the household level; in Denmark and Japan, household waste was less than half. In Japan, the largest share, more than half, was in the manufacturing sector. These results contributed to the conclusion by OECD analysts that households are not necessarily the main contributors to food waste; instead, lack of information and knowledge about the other sources of waste leads to the view that households are the main source.

She observed that the OECD study has found that measurements of food waste available in different countries are different, depending on the country's objectives. How waste is measured, units of measurement, and reporting differ, as does the time period of reporting. She observed that the WRI effort described by Robertson (summarized earlier in this chapter) reflects an area to explore. Differences are not necessarily bad, she said, but may be an obstacle to making comparisons. It is important to understand what is being measured, why, and how it will be used.

Bagherzadeh gave some examples of important differences in definitions. The OECD study used the term "waste" as shorthand for loss and waste. She pointed out that in Europe, the term "waste" must be used carefully because of a directive that dictates how products are treated once they are so labeled. As a result, industry has started to use the term "by-product" instead. According to the directive, an item labeled waste has to be immediately taken in by the waste management system, and it cannot be used as food. This is one reason why industry has very little food waste; it is reported as a food by-product.

As another definitional issue, she talked about the labels "edible" versus "inedible," which vary by country or sometimes ethnicity. For example, in China, parts of animals are eaten that are not eaten in Europe. Elsewhere, some people consider vegetable peels to be edible, while others do not. Her conclusion is that the edible versus inedible distinction is cultural and judgmental, and as a result, it is not a good category for use in official breakdowns.

Another definitional issue is "avoidable" versus "unavoidable." As an example, she said OECD heard presentations from an industry that steams carrots. In the process, carrots were peeled first, and the peel was used as a thickener in soup. She stated that what is avoidable and unavoidable is technology-driven. Her conclusion again is that this concept is not a good category for official breakdowns.

Finally, Bagherzadeh discussed the concept of consumption by humans, saying that if something intended for human consumption is diverted to another use, it is classified as waste in some definitions. However, in some cases, it becomes feed for animals, which could represent a detour before it comes back on someone's plate. She questioned policies that would categorize such products as waste.

Bagherzadeh said that she applauded the current initiatives by WRI, UNEP, FUSION, and others to look at such issues as definitions and measurement of food waste. She said these efforts will ultimately strengthen food waste data and represent the beginning of a learning curve. She said it is important to share data and best practices, while minimizing resource expenditures to the extent possible. Definitional issues, as noted above, and system boundary issues about what food and the supply chain are necessitate discussion and sharing. She noted the importance of accepting statistical differences. It does not necessarily mean the quality is bad, but rather that the statistic was developed to fill a different objective.

Bagherzadeh referred the audience to three OECD reports:

- *Food Waste Along the Food Chain* (in press)
- *Food Losses and Food Waste in China: A First Estimate* (Liu, 2014), and
- *Food Chain Analysis Network: Summary Report of the 4th Meeting* (OECD, 2014).

The first is the result of the OECD stocktaking exercise she described.[12] The second, *Food Losses and Food Waste in China*, was released in 2014. In China, she said, a big issue is food waste from eating away from home, which occurs more frequently with a booming economy. The impact on waste is compounded by such cultural issues as when people go out, they may demonstrate opulence by ordering too much food. Bagherzadeh noted the trend to eat outside the home more frequently exists in many countries. In these countries, restaurants are a source of increasing food waste. The third publication is a summary report of the Food Chain

[12]It is expected to be released as part of the OECD Food, Agriculture and Fisheries Papers, possibly during 2014. When released, it will be available at http://www.oecd-ilibrary.org/agriculture-and-food/oecd-food-agriculture-and-fisheries-working-papers_18156797 [August 2014].

Analysis Network meeting held in June 2013, where Buzby presented the FADS approach. Bagherzadeh noted that the Food Chain Analysis Network brings together governments, business, and academia to share information.

STATEMENT OF SHELLY SCHNEIDER EPA METHODS: CURRENT AND FOOD AVAILABILITY-BASED METHODS

Schneider's presentation described the work done by Franklin Associates for EPA. She started out by introducing a series of reports and data produced by EPA titled *Municipal Solid Waste (MSW) in the United States: Facts and Figures*.[13] The latest report (U.S. Environmental Protection Agency, 2014) has data from 1960 to 2012 and looks at 40 to 50 product categories, including food waste. Other categories include plastic bottles, office paper, and corrugated boxes. The original audience, still important, was state and local solid waste managers. The report describes the contents of solid waste from households and from commercial/institutional facilities.

Schneider explained that Franklin Associates works with EPA on food waste management. In the mid-1980s, EPA economists worked with William and Marjorie Franklin to develop the original methodology, based on landfill sorting. Landfill sorting involves taking waste from a packer truck, sampling it, and weighing it. She said the problem with food waste is that there is compaction and transfer of moisture, particularly to paper goods. It is difficult to get a valid measurement by weight.

In the 1990s when municipalities became more interested in managing organic waste, sampling studies began at the point of generation, closer to the source where the waste is ready for management, Schneider said. The methodology changed to the current sample-based methodology, where the sources are residential and commercial/institutional. The industrial sector (preconsumer) is not included, nor is one product: fats, grease, and oils.[14]

Currently 20 communities are represented by residential curbside sampling studies, including communities located in Arizona, California, Canada, Illinois, Minnesota, Missouri, North Carolina, Vermont, Washington, and Wisconsin. Missing are data from the southern part of the United States (except North Carolina). It is anticipated as more residential programs to recover food waste come on board, additional sampling studies will represent more areas of the country. The data range for the average

[13]Available: http://www.epa.gov/osw/nonhaz/municipal/msw99.htm [July 2014].

[14]EPA is looking into quantifying fats, greases, and oils.

from those 20 communities is 0.16-0.67 pounds per person per day, with an overall average of 0.35 pounds per person per day.

There are 60 sampling studies from the commercial sector compiled from the following sectors: grocery stores (14), restaurants (17), hotels (2), prisons (6), universities and colleges (5), schools (5), and hospitals and nursing homes (11). Demographic or economic factors, such as number of employees, number of prisoners, or number of students, are used to generalize results from these studies to the sector total. Using this methodology, the estimate for total food waste in the commercial sector in 2012 was about 60 million tons, with 54 percent coming from restaurants and 25 percent coming from grocery stores.[15] She noted a limitation of the approach is the small number of data points, especially in sectors such as hotels. As new sampling points become available, they are added to the dataset and included in the methodology.

Schneider explained that Franklin Associates started looking into using the ERS LAFA data to estimate food waste for MSW in 2012. They calculated food losses in pounds per capita per year for the following categories and subproducts: dairy (27 products); added fats and oils (13 products); fruit (63 products); grains (9 products); meats, poultry, fish, eggs, and nuts (24 products); added sugar and sweeteners (6 products); and vegetables (67 products). For each product, they started with the LAFA data and looked at the different stages (primary, retail, and consumer) and loss adjustments. They assumed the difference between primary and retail would be industrial, and the difference between retail and consumer would be commercial. After capturing food loss at each level for each product in each category, they considered the management of that waste. They separated waste by product and category into solid and liquid, and estimated what part of the solid was disposed of through the sewer system. With this process the goal was to partition the FADS data into two main categories, nonmunicipal solid waste (assumed to be industrial process loss) and municipal solid waste that is broken into three categories: liquid food lost to sewer, solid food loss to sewer system, and food loss to solid waste system. The last item is needed for the MSW report.

With this breakdown, 31 percent of the total LAFA food loss was process waste, 18 percent liquid lost to the sewer system, 7 percent solid waste lost to the sewer system, and 44 percent was municipal solid waste (14 percent retail and 30 percent consumer[16]) lost to the solid waste sys-

[15]Sampling curbside or at the back of the restaurant or grocery store means that measurement is postdonation of unsalable or leftover food that might be used to feed people or animals.

[16]FAFL consumer food loss includes restaurant, institutional, and residential loss.

tem. Schneider stressed the differences between the sample-based and food availability approaches. For example, the LAFA consumer category includes food away from home, while in the sample-based approach, food losses away from home at restaurants and institutions are included in the commercial sector.

To prepare an estimate of total food loss to the solid waste system based on the LAFA data, three additional items need to be estimated and subtracted out for the number to be as comparable as possible to the estimate based on the sample-based methodology: food donations, food used for animal feed, and food for industrial use. Schneider said Franklin Associates prepared an estimate for food donations based on information from measurements by two of the biggest organizations in the country. As yet, they do not have an estimate of food used for animal feed. She said the estimate for industrial use of food waste currently represents the rendering industry, which uses outdated meat and seafood from grocery stores and yellow grease collected from restaurants. For 2012, food loss inputs to the solid waste system based on the LAFA data were about one-third again higher than the estimate derived by the sample-based method. Schneider stressed that the comparison work is not complete, and EPA continues to evaluate reasons for differences.

FACILITATED DISCUSSION WITH PANELISTS AND AUDIENCE

Schwab gave some background information about why EPA is interested in food issues. She reminded the audience that as Schneider explained, EPA has a food waste data series that runs from 1960 to 2012. Schwab said she has been involved in studying food waste since 1997 and worked with USDA on the 1999 publication *Waste Not, Want Not: Feeding the Hungry and Reducing Solid Waste Through Food Recovery* (U.S. Environmental Protection Agency, 1999). This publication established the food recovery hierarchy, which was trying to emphasize source reduction to limit food waste: feeding hungry people through donation, feeding animals, rendering, and composting, all trying to limit the amount of food waste going to landfills.

The reason EPA is involved, she said, is because of the pollution associated with landfills. Food waste is large on the food production side and levels off through transportation. However, once food becomes waste and goes to landfills, the impact is huge. Landfills are the third largest generators of greenhouse gases in the United States after mining and agriculture, she noted, and EPA also works with developing countries to help them limit food waste going into landfills. The goal is to help countries attain their greenhouse gas climate change commitments.

Schwab underscored that dealing with food waste is not easy. As

described earlier, there are issues of definitions, data, and methodology. One challenge to the methods described by Schneider, she noted, is that if one is off by a small fraction, the result could be a large error in the national estimate.

She referred to the presentation by Tabitha Rich (see Chapter 3) that Canada may have survey information concerning transportation and storage loss from primary to retail, and asked whether this information could be used to verify the loss factors in the United States or other countries. She went on to say that it used to be common wisdom that in developing countries most of the food was lost in transportation and storage and not as much at the consumer level, but she has observed this is not the case.

Schwab then challenged the audience to identify data gaps and to discuss priority approaches for filling them.

Robertson observed that the workshop has highlighted the fact that many assumptions are embedded in the available datasets but sometimes not considered when comparisons are made. Keeping the assumptions in mind might help illuminate reasons for differences and guide efforts needed to fill data gaps. She asked Schneider to clarify one of the assumptions being made when the LAFA data are used to estimate the amount of municipal solid waste. She asked if all of the loss between retail weight and consumer weight is going to municipal solid waste, or if their assumption is that some is diverted to other uses. Schneider responded that they make a distinction between liquid and solid waste and try to estimate what goes into the sewer system as opposed to being handled as solid waste. In addition, if other uses are known, such as rendering, they try to capture this information as well.

Robertson asked whether Franklin Associates has tried to capture the increasing use of anaerobic digesters or composting facilities. Schneider clarified that the amount going to anaerobic digestion would be in the food waste generation number. In their accounting of food waste, food waste is generated when it is ready to be managed (prior to recovery or disposal). Schwab added that the issue of anaerobic digestion is important both nationally and internationally. She said EPA is trying to focus on sustainable materials management. She explained that anaerobic digestion means taking organic materials, sewage, sludge, manures, or food waste, and putting it in giant enclosed vats. The material goes methanogenic, anaerobic, without air, so it is intentionally creating methane gas as renewable energy. The process removes the energy and leaves the bulk residual material (including the fibrous material from food waste). In many instances, the bulk residual material still ends up in a landfill. In a landfill, the bulk material can still create some methane that causes problems. However, the bulk of food did not go away and was not beneficially used. EPA would like to see the bulk residual material go back into

the soil. She explained that this would close the loop, adding nutrients and carbon back to the soil and achieving carbon sequestration, water retention, and drought resistance. She clarified that anaerobic digestion and composting are different. Compositing returns nutrients to the soil, while anaerobic digestion is preprocessing. She pointed to a number of entities that advocate waste to energy, or sending their food by-products to anaerobic digestion for energy. Most of these entities stop accounting for food at that point. She noted that this is another piece of the food supply chain with issues about accounting and measurement. She went on to say that Germany has used anaerobic digestion for a long time, and in the past most of the residual material went to landfills. She thinks that more of it is being used now. One of the challenges is that it has been found that adding food to manures results in higher gas generation. As a result, there is an increasing demand to use food waste in anaerobic digestion.

Unnevehr noted that many communities in the United States are picking up food waste, or parts of it, separately, and EPA is using community-level samples. The retail scanner data that ERS is evaluating would support an analysis within those communities of the volume of food being sold. That might provide data on what is going into those households. If those information sources could be linked, the data might support an assessment of total food waste. Schneider agreed, saying perhaps an indicator could be developed.

Schwab presented a statement and question from Lisa Johnson sent through the workshop webcast. According to Johnson, fruit and vegetable losses in the United States have been historically estimated between 20 and 50 percent of the crop, due to grade standards, labor issues, weather, policy, and grower decisions, among other reasons. Often these fruits and vegetables are disposed of on the farm, and she asked about looking at this as a way to increase supply for human consumption. Buzby replied that very little data are available for losses on the farm. She referred to Kader (2005) and a small study by Dana Gunders (Natural Resources Defense Council, 2012) on the topic. She said understanding farm-level loss would be very resource-intensive with different states, commodities produced, weather conditions, pest conditions, and other variables, and it would also vary widely by year. Mark Jekanowski added that he thinks that most farmer decisions are made for sound economic reasons, and some loss on the farm is inevitable. Grades and standards exist to serve consumer or market needs. He said there could be a debate about whether or not those grades and standards are appropriate, or whether there are better channels for diverting some of the product that does not meet grades and standards. However, he stated that losses due to weather, labor, pests, and so on are not avoidable losses. He then asked about how to account for lower yields that result from a farmer's decision to use

organic practices. He repeated that the issue of loss on the farm is complicated and, if not done properly, has the potential to be misinterpreted and misused.

Krebs-Smith suggested that the workshop could consider how to best document food loss and waste. Quoting from Robertson's talk, she noted "what gets measured gets managed." Without measures, decisions cannot be made about whether something is reasonable or not. There could be good reasons for all the losses in the system, but the purpose of the workshop, she said, is not to evaluate these reasons but to help determine how to develop a full accounting and how to measure food loss and waste to support policy decisions in the future.

Helen Jensen said she understands Krebs-Smith's point, but noted the difficulty because of the diversion of food to other uses. For example, if apples do not meet grade standards, some are diverted into other human food uses, such as applesauce; some are diverted to animal feed; and some are plowed and enrich the soil. Robertson described another gap due to gleaning—food left on the farm that is still edible and picked by volunteers for human consumption.

Nusser suggested that in information gathering, it is important to account for the part that is not of primary interest. From a political or public relations perspective, it might be useful to think about the nature of food waste. If an economic decision results in food not going through the regular availability channels, it might be useful to know what happened to it. She suggested what is needed is more than just measuring a number but also getting an understanding of reasons for actions and outcomes of actions. With data and understanding, it would be possible to better evaluate the food situation. She expressed hope that this is what will result from the Food Waste and Loss Protocol described by Robertson. She reiterated that it is difficult to identify gaps without a systematic understanding of what loss is in a common language.

Schwab agreed, saying she does not want to lose focus on the waste part of the downstream side, where outcomes may be more controllable. She noted that some losses are easier to measure than others, and some types of retailers or other entities are more interested than others in participating in efforts to measure food loss. Grocery stores, for example, are willing to share their information and work with EPA on reducing waste, but manufacturers are more reluctant to share data. According to her, they do not want to be viewed as wasteful and they want to avoid government regulations.

She reminded the audience that Bagherzadeh described the situation in Europe where manufacturers do not use the term "waste," instead calling it by-product. She asked whether OECD has any data on such by-products and what is done with them. Bagherzadeh replied that when

food is called a by-product, it is made into another product. She reported WRAP in the United Kingdom has done intensive work with industry. They use a confidentiality clause that allows them access to data on food waste in the processing industry. They are then able to publish summary statistics about waste in industry, but individual results are protected.

Schwab said perhaps the use of confidentiality agreements or other ways to create aggregate information while protecting individual data is one way to move forward. Nusser stated that the use of confidentiality agreements and protection of data from individual entities is very common in the survey world and has been well documented.

Robertson described the Food Waste Reduction Alliance[17] (FWRA) in the United States, a collaborative effort among three trade associations: Food Marketing Institute, a supermarket trade association; Grocery Manufacturers Association; and National Restaurant Association. FWRA conducted a survey directly with retailers and manufacturers, and results were posted last year on the FWRA website.[18] Next year FWRA will survey restaurants. Food waste is broken into animal feed and different diversion methods, as well as disposal.

Jensen asked about any work on substitution—for example, the apples that go to feed pigs may displace the pig's regular food (e.g., corn or grain). In an accounting sense, the apples are displacing the pig's regular food.

Schwab described a food recovery challenge at EPA, when businesses and industry were asked to provide information on what had been source-reduced, what had been donated, and what had been sent for animal feed. She said they can do some accounting, but results are not generalizable to the nation. She said the amount of food used for animal feed has been dropping over the years because of food safety concerns. Recently it has increased somewhat because grain and corn prices have increased.

Schwab explained that in Europe, more entities send food to hog farmers than in the United States. In the European system, a retail outlet can send leftover sandwiches, for example, to a local hog farmer. Europe tends to have many small hog farms, she noted, whereas the United States has fewer but larger hog farms. As a result in the United States, food waste is often generated far away from farms, perhaps in urban areas, and it does not make economic sense to transport food waste long distances. Food waste is 80 to 90 percent water, and cost efficiencies limit how far it can be shipped for compost or animal feed to 25 to 30 miles. As a result, she said, use of food waste for animal feed is not as prevalent in the United States as it is in Europe.

[17]See http://www.foodwastealliance.org/ [July 2014].

[18]See http://www.foodwastealliance.org/about-our-work/assessment/ [July 2014].

Jensen noted that food waste from household kitchens is one source, but the waste or by-product from produce is quite a large component of feed in some regions and for some industries. Jekanowski stated that citrus pulp from processing oranges into juice is commonly used as livestock feed. Presumably the same could be true for other processed fruits and vegetables, but he said he does not know of any studies that have looked into this. Thornsbury added that, many times, the waste or by-product will get pelletized and incorporated into animal feed, and many processes try to make use of by-products to recover value. Jensen added that most likely the largest of the components is dry distiller's grain, which is the by-product of corn from the ethanol industry.

Robertson said that as part of the Food Loss and Waste Protocol, the collaborators want to define "food," which she said will lead to some points Bagherzadeh raised about edible versus inedible food and avoidable waste versus unavoidable waste. She said the European Parliament has a definition of food, which comes in a regulation on food safety.[19] As she quoted, the definition states "food means any substance or product whether processed, partially processed, or unprocessed, intended to be or reasonably expected to be ingested by humans." The next sentence states "food includes drink, chewing gum, and any substance including water intentionally incorporated into the food during its manufacture, preparation, or treatment." She noted that this definition is based on what is ingested, or planned to be ingested, which excludes such items as eggshells, meat bones, and pineapple skins.

[19]Definition from Article 2 of Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002. See http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002R0178:EN:HTML [July 2014].

6

Wrap-Up

This chapter summarizes the final session of the workshop. The session began with a presentation by Harry de Gorter (Cornell University) about the economic framework for evaluating the implications of food loss and waste, followed by an open discussion with the audience. To close, Mary Muth (RTI International and chair of the steering committee) provided a summary of the lessons she said she learned from the workshop. Finally, Jean Buzby, chief of the Diet, Safety, and Health Economics Branch of the Economic Research Service (ERS), described some possible future actions for ERS that she said she gleaned from workshop discussions.

STATEMENT OF HARRY DE GORTER ECONOMIC FRAMEWORK FOR EVALUATING THE IMPLICATIONS OF FOOD LOSS AND WASTE

De Gorter identified three economic reasons for food loss and waste in a very broad general context. First, it would not pay to have zero food waste. Food waste is a result of optimizing agents on both the supply and demand sides. More importantly, he said, for many agents in the food chain, the cost of having too little food is much greater than the cost of having too much food. Referring to the earlier example of unharvested acres (see Chapter 4), de Gorter said these unharvested crops could be described as waste, but, as noted earlier, most farmers' decisions are based on sound economic reasons. Likewise, he noted, decisions along

the food chain are often based on sound economic reasons. For example, if unharvested acres were taxed, the result would be a reduction in the amount of planted acres, which would reduce the number of harvested acres. De Gorter commented that this reduction would hurt farmers, as well as everyone else, including consumers. Thus, he said, if the reason for unharvested acres is low prices at harvest, this suggests credit constraints, but if unharvested acres were caused by labor problems or pests, then there may be other policy solutions. If a farmer has contracts to fill downstream, he/she plants more than he/she expects to harvest. He reiterated his view that taxing unharvested acres would be suboptimal for society.

The second economic reason for food loss or waste is market failure, he said. Farmers and entities along the supply chain are optimizing and maximizing their own welfare and profits, but they have imperfect information. There are credit constraints and economies of coordination along the supply chain, especially in developing countries, where policies might help correct market failures. In contrast to an extensive literature on the economics and environmental issues related to curbside fees and on taxing businesses for waste, including emissions, he observed that the literature on the cost of having too much or too little food is underdeveloped.

De Gorter said the third economic reason is nonoptimizing agents, where behavioral economics is important. Everyone is subject to psychological, sociological, and cultural biases, and different types of policies are needed. De Gorter referred to Wansink (2006) as an example of a behavioral economist's work on food. He stated that he is not as optimistic about what might be accomplished via policies in this area as are some experts in the field.

De Gorter noted that the three economic reasons for food loss and waste have implications for the definitions for food loss and waste. He stated that no definition makes sense to an economist. Food loss is typically viewed as unintended on the supply side, so it mainly occurs during production or postharvest processing. In contrast, food waste is typically viewed as intended on the demand side, such as waste in restaurants and by consumers due to negligence or conscious decisions to throw food away. The problem is that if there are intentional losses at the farm level and unintentional waste by the consumer, the economics do not relate to the standard definition of food waste. Moreover, there are intentional losses at the farm level and unintentional waste by consumers. As discussed earlier (see Chapter 5), there are also issues related to the definitions of edible versus nonedible food and avoidable versus nonavoidable waste.

He cited his paper (de Gorter, 2014) for the logic behind his discussion, noting that he will revise the document based on discussions and presentations at the workshop. He said the paper considers three parts

to the food chain: farm gate (preharvest to first point of sale), middlemen, and final consumers. Looking at each part for economic outcomes reveals that from an economic view, reducing spoilage at the farm gate is a win-win strategy as producer revenues increase and consumer prices decline. This would happen because reducing spoilage contracts the margin between farm and wholesale or farm and retail. In addition, reducing loss at the farm level could reduce farm prices. While this would always help consumers, he said, the net outcome to producers is not clear.

He said waste at the farm gate is of greatest importance to developing countries. It is more important for policies to focus on problems of infrastructure to promote agricultural development and productivity improvement than to focus on waste. He said nothing in economic theory suggests policy should focus on waste, per se.

For the middlemen, the second part in the chain, whether to tax waste or coordinate supply is particularly an issue in developing countries. As an example, he said, Massachusetts has banned food waste,[1] but economists tend to think it is better to tax it. Taxing food waste would result in increased efficiencies and would reduce waste, he asserted. There would be more food donations, secondary markets would develop, and more food would be used for animal feed, anaerobic digesters, and compost. De Gorter noted the economic literature on the benefit of taxing environmental externalities.

Lastly, for final consumers, there are transactions costs, imperfect information, and behavioral issues, where public awareness campaigns or "nudge policy" might be useful. He cited Thaler and Sunstein (2008) for their work in nudge policy, a new area of interest among economists. As an example, he said if the goal is to change consumers' decision making, they might receive a green garbage bag in which to put all their food waste. After a while people realize how much food they are wasting, and they may change their decision making.

De Gorter described a study by behavioral economists of food waste in the United States that will be modeled on a study just completed in Brazil (Porpino and Parente, 2014). In Brazil, the study involved a group of households just above the poverty line—poor, but at an income gradient where they do not get welfare payments. The study found poor consumers prefer to go to nonlocal supermarkets to save money, but they end up buying much more food to have on hand and to serve in large quantities. However, they waste a lot of food, according to the study.

This use of food is partially cultural, the study found. The households had a desire to signal wealth, make sure their children were well fed, and

[1]For information, see http://www.mass.gov/eea/agencies/massdep/recycle/solid/massachusetts-waste-disposal-bans.html [July 2014].

show hospitality, even though they had limited resources. A new study will look at food waste in similar income families in the United States to see if the same patterns hold. He thinks the pattern might well hold, noting that this would not have been true in the 1950s and 1960s.

De Gorter described the five elements of the United Nations' Zero Hunger Challenge[2] (ZHC): (1) zero stunted children less than 2 years of age; (2) 100 percent access to adequate food year round; (3) all food systems sustainable; (4) 100 percent increase in smallholder productivity and income; and (5) zero loss or waste of food. He repeated that the last element, zero loss or waste of food, is not economical, because costs increase sharply as waste is reduced. He stated it might be better to use resources elsewhere to reduce hunger and malnutrition, but acknowledged one motivation for focusing on zero food waste is because it is large and highly visible. He stated that if 32 percent of food is wasted, there is a moral issue associated with hunger. There are large future food needs to 2050, and, as discussed at this workshop, there are resource degradation and greenhouse gas emissions. Zero food waste sounds like a triple-dividend policy to reduce hunger, save resources, and save the environment, he commented. However, he suggested it would be more economical to direct policies toward natural resource use and the environment, regardless of waste, and focus other policies on overall food security and agricultural development.

He questioned whether a broader perspective on food waste might be useful, for example, evaluating whether some uses of food are inefficient. Examples might include food fed to livestock, food converted to products with fewer nutrients, food diverted to biofuels, and food consumed beyond 2,000 calories per day.

According to de Gorter, it is better if policies directed to food waste relate to the environment or natural resources policy. He said that there would be synergetic effects on food waste if policy dealt with market failures and improving infrastructure (transportation and cold storage for developing countries). Sometimes, he said, not harvesting makes sense. There is a question about how responsive consumers would be to waste reduction initiatives, for example, the tradeoff between convenience and food safety. He stated that there may be useful policy initiatives that increase food waste, such as by supporting research and development for productivity improvements and developing high-value agriculture. He said that there have been a number of examples where food agricultural products in developing countries have participated in high-value chains for fruits, vegetables, and horticultural crops, and they have been very

[2]For information, see http://www.un.org/en/zerohunger/challenge.shtml [July 2014].

successful. They result in higher amounts of waste, he commented, but maybe that is good.

De Gorter noted most food loss occurs on the farm in developing countries, while most food loss is at the consumer level in developed countries. He asked how reducing waste in developed countries would help poor countries. He observed that the five elements of the ZHC are interdependent. Putting more emphasis on the first four elements will reduce food waste if those first four are achieved. He noted the need to reform some current policies related to agriculture. For example, in India, he said, interregional trade is blocked and there is government pricing and stockholding. De Gorter suggested that a review of current policies for food and agriculture with an assessment of how they affect food waste would be useful. In other words, he suggested, "go to the root cause of problems rather than focus on food waste." There are opportunity costs to focusing funds on food waste, he said, including rural development, food security, and agricultural development.

DISCUSSION

Laurian Unnevehr said her personal perspective about the behavioral aspect referred to by de Gorter is that it is difficult to buy a reasonable portion at many restaurants. She noted that one-quarter of U.S. households are single-person households and the same may be true in Europe. Furthermore, she noted, as populations age, even in middle-income countries, the proportion of single-person households will increase. This intensifies issues related to purchasing only what will be eaten. She asked whether de Gorter's behavioral colleagues might consider developing or evaluating shopping planning tools. She suggested what is needed are different interventions to get at the interface between what people buy, what they need to eat, and what they are going to cook.

Jensen asked de Gorter to elaborate on induced innovations that come when policies that may not necessarily be focused on a problem have a longer-term effect. As examples, she mentioned environmental issues—the innovations that have happened in seed technology that relate to reduced pesticide use, or policies to reduce overuse of fertilizer that come from increasing the tax on fertilizers.

De Gorter replied with an example. He said taxing greenhouse gas emissions at the consumer level or along the supply chain would induce technological innovations. He went on to say that if there were a market failure, then there would be public support for technologies because they are a public good. He said that if losses at the farm level in developing countries are due to market failure, then public good investment in transportation and cold storage would be a solution. Jensen added that there

are implications that come about with certain policies or changing relative prices by adding taxes. She noted research and development would have an effect in developing countries as well as in the United States.

De Gorter responded that he thought Jensen was going to comment on a sociological component of the current process. The current movement focused on food waste by nongovernmental organizations and international organizations heightens public awareness and shifts people's mentality, which he referred to in a sense as an induced innovation.

FINAL THOUGHTS FROM MARY MUTH

Muth provided a few concluding comments, first focusing on the objectives outlined for the workshop in Chapter 1. She said she had heard expressions of interest from some participants in estimating food availability and food loss separately for food at home and away from home. She noted that some of the data sources mentioned during the workshop might be able to creatively accomplish this estimation.

She noted that some participants expressed a strong interest in reevaluating the conversion factors used at the processing level, particularly those that have remained fixed over time. She suggested a reevaluation of the factors, possibly collecting more information at the farm and manufacturing levels to try to improve the estimates. She expressed encouragement for innovations that could help keep the series up to date over time to better reflect changes due to technology.

Muth noted that many participants during the workshop discussed farm-level waste and whether it is waste when crops are left unharvested for economic reasons. She suggested it may be worth reviewing why waste occurs at the farm level to determine whether there are reasons for measuring such losses that are consistent with the objectives of the ERS for its Food Availability Data System (FADS).

She noted that a participant had observed that food loss estimates are point estimates, and that consideration of uncertainly levels, perhaps through simulation, would be useful to obtain a range of estimates of food loss or perhaps develop confidence intervals. She said she thinks this might be an area worth considering.

Muth noted that many participants discussed the definitions of waste, loss, and other elements of those definitions. She suggested ERS might consider waste and loss along the supply chain to evaluate what waste is and what it is not at each point. It also may be worthwhile, she suggested, for ERS to consider whether the loss-adjusted food availability (LAFA) data as they are constructed now are sufficient for the current uses of the data, and whether they are satisfying ERS objectives for providing the data.

Muth closed by saying these points stood out for her during the workshop, but there were other important ideas that might also be useful. She suggested evaluating ideas by considering how well they meet ERS objectives for FADS.

FINAL THOUGHTS FROM JEAN BUZBY

Buzby stated that every presentation provided her a lot of information and food for thought. She summarized some of the ideas she gleaned

- Doing more exploratory analysis of some of the data resources mentioned by Alanna Moshfegh (see Chapter 4), particularly trying to identify commodities associated with imports and exports of processed or multi-ingredient products and incorporating them into the FADS system.
- Estimating food at home versus food away from home using some of the data highlighted in Chapter 4.
- Getting a better assessment of the magnitude of food donations, rendering, and transfers to thrift stores.
- Using scanner or other types of data as a comparison with ERS estimates to see if improved estimates might be derived.

She closed by thanking the speakers and audience for an interesting and useful workshop.

Bibliography

Abass, A. B., Ndunguru, G., Mamiro, P., Alenkhe, B., Mlingi, N., and Bekunda M. (2014). Post-harvest food losses in a maize-based farming system of semi-arid Savannah area of Tanzania. *Journal of Stored Products Research* 57:49–57.

Abdulla, M., Martin, R.C., Gooch, M., and Jovel, E. (2012). The importance of quantifying food waste in Canada. *Journal of Agriculture, Food Systems, and Community Development* 3(2):137–151.

Ahmed, A.A. (2008). Post-harvest losses of fish in developing countries. *Nutrition and Health* 19(4):273–287.

Aranceta, J., Pérez R.C., Naska A., Vadillo, V.R., and Trichopoulou, A. (2006). Nut consumption in Spain and other countries. *British Journal of Nutrition* 96(S2):S3–S11.

Arnade, C.A., Calvin, L., and Kuchler, F. (2009). Consumer response to a food safety shock: The 2006 food-borne illness outbreak of *E. coli* O157: H7 linked to spinach. *Applied Economic Perspectives and Policy* 31(4):734–750.

Balanza, R., García-Lorda, P., Pérez-Rodrigo, C., Arancanceta, J., Bulló Bonet, M., and Salas-Salvadó, J. (2007). Trends in food availability determined by the Food and Agriculture Organization's food balance sheets in Mediterranean Europe in comparison with other European areas. *Public Health Nutrition* 10(2):168–176.

Baldwin, S., and Chung, K. (2007). Sustainable disposal of edible food byproducts at university research farms. *International Journal of Sustainability in Higher Education* 8(1):69–85.

Barnard, N.D. (2010, May). Trends in food availability, 1909–2007. *American Journal of Clinical Nutrition* 91(5):1530S–1536S. Available: http://ajcn.nutrition.org/content/91/5/1530S.full.pdf+html?sid=4b1ed8a1-7545-40a1-a60a-e164f955f0db [July 2014].

Batres-Marquez, S.P., and Jensen, H.H. (2002). *Quantifying Wheat Flour Exported and Imported in Processed Food Commodities.* Center for Agricultural and Rural Development, Department of Economics, Iowa State University. Report prepared for USDA/CSREES Fund for Rural America through the University of Arizona.

Beatty, T.K.M., and LaFrance, J.T. (2005). U.S. demand for food and nutrients in the 20th century. *American Journal of Agricultural Economics* 87:1159–1166.

Beretta, C., Stoessel, F., Baier, U., and Hellweg, S. (2013). Quantifying food losses and the potential for reduction in Switzerland. *Waste Management* 33(3):764–773.

Bernstand, A., and la Cour Jansen, J. (2012). Review of comparative LCAs of food waste management systems: Current status and potential improvements. *Waste Management* 32(12):2439–2455. Available: http://www.ncbi.nlm.nih.gov/pubmed/22922048 [August 2014].

Blair, D., and Sobal, J. (2006). Luxus consumption: Wasting food resources through overeating. *Agriculture and Human Values* 23(1):63–74.

Blasbalg, T.L., Hibbeln, J.R., Ramsden,C.E. Majchrzak, S.F, and Rawlings, R.R. (2011). Changes in consumption of omega-3 and omega-6 fatty acids in the United States during the 20th century. *American Journal of Clinical Nutrition* 93(5):950–962. Available: http://ajcn.nutrition.org/content/93/5/950.full.pdf+html?sid=4b1ed8a1-7545-40a1-a60a-e164f955f0db [August 2014].

Bloom, J. (2010). *American Wasteland*. Cambridge, MA: Da Capo Press.

Broadley, M.R., Chilimba, A.D., Joy, E.J., Young, S.D., Black, C.R., Ander, L.E., et al. (2012). Dietary requirements for magnesium, but not calcium, are likely to be met in Malawi based on national food supply data. *International Journal for Vitamin and Nutrition Research* 82(3):192–199. Available: http://www.ncbi.nlm.nih.gov/pubmed/23258400 [August 2014].

Brown, T., Hipps, N.A. Easteal, S., Parry, A., and Evans J.A. (2014). Reducing domestic food waste by lowering home refrigerator temperatures. *International Journal of Refrigeration* 40(0):246–253. Available: http://www.sciencedirect.com/science/article/pii/S0140700713003629 [August 2014].

Buzby, J.C. (2005). Cheese consumption continues to rise. *Amber Waves* Findings 1(February). Economic Research Service. U.S. Department of Agriculture. Available: http://webarchives.cdlib.org/sw1vh5dg3r/http://ers.usda.gov/AmberWaves/February05/Findings/CheeseConsumption.htm [August 2014].

Buzby, J.C. (2012). Cutting consumer food waste. In the International Food Policy Research Institute 2012 Global Food Policy Report *Food Policy in 2012: Walk the Talk*. Available: http://www.ifpri.org/gfpr/2012/agricultural-productivity [August 2014].

Buzby, J.C., and Farah, H. (2006a). Americans switch from fresh to frozen potatoes. *Amber Waves* Findings 4(June). Economic Research Service, U.S. Department of Agriculture. Available: http://webarchives.cdlib.org/sw1vh5dg3r/http://ers.usda.gov/AmberWaves/June06/Findings/Potatoes.htm [August 2014].

Buzby, J.C., and Farah, H. (2006b). Chicken consumption continues longrun rise. *Amber Waves* Findings 4(April). Economic Research Service, U.S. Department of Agriculture. Available: http://webarchives.cdlib.org/sw1vh5dg3r/http://ers.usda.gov/AmberWaves/April06/Findings/Chicken.htm [August 2014].

Buzby, J.C., and Haley, S. (2007). Coffee consumption over the last century. *Amber Waves* Findings(June). Economic Research Service, U.S. Department of Agriculture. Available: http://webarchives.cdlib.org/sw1vh5dg3r/http://ers.usda.gov/AmberWaves/June07/Findings/Coffee2.htm [August 2014].

Buzby, J.C., and Hyman, J. (2012). Total and per capita value of food loss in the United States. *Food Policy* 37(5):561–570. Available: http://www.sciencedirect.com/science/article/pii/S0306919212000693 [July 2014].

Buzby, J.C., and Perry, J. (2006). ERS food availability data under revision. *Amber Waves* Behind the Data 4(June). Economic Research Service, U.S. Department of Agriculture. Available: http://webarchives.cdlib.org/sw1vh5dg3r/http://ers.usda.gov/AmberWaves/June06/Indicators/BehindData2.htm [August 2014].

Buzby, J.C., and Pollack, S.L. (2008). Almonds lead increase in tree nut consumption. *Amber Waves* Findings 6(June). Economic Research Service, U.S. Department of Agriculture. Available: http://webarchives.cdlib.org/sw1vh5dg3r/http://ers.usda.gov/AmberWaves/June08/Findings/Almonds.htm [August 2014].

Buzby, J.C., and Wells, H.F. (2007). Meeting fruit and vegetable dietary recommendations will impact agriculture. *Amber Waves* Findings, 5(April). Economic Research Service, U.S. Department of Agriculture. Available: http://webarchives.cdlib.org/sw1vh5dg3r/http://ers.usda.gov/AmberWaves/April07/Findings/Meeting.htm [August 2014].

Buzby, J.C., and Wells, H.F. (2011). New loss estimates suggest higher vegetable and protein consumption. *Amber Waves* 9(September). Economic Research Service, U.S. Department of Agriculture. Available: http://www.ers.usda.gov/amber-waves/2011-september/loss-estimates.aspx#.U_yRJ6PD_Gg [August 2014].

Buzby, J.C., Farah H., and Vocke, G. (2005). Will 2005 be the year of the whole grain? *Amber Waves* Feature 3(June). Economic Research Service, U.S. Department of Agriculture. Available: http://webarchives.cdlib.org/sw1vh5dg3r/http://ers.usda.gov/AmberWaves/June05/Features/Will2005WholeGrain.htm [August 2014].

Buzby, J.C., Wells, H.F., and Vocke, G. (2006). *Possible Implications for U.S. Agriculture from Adoption of Select Dietary Guidelines.* Economic Research Report No. (ERR-31). Economic Research Service, U.S. Department of Agriculture. Available: http://www.ers.usda.gov/publications/err-economic-research-report/err31.aspx [July 2014].

Buzby, J.C., Lin, B-H., Wells, H.F., Lucier, G. and Perez, A. (2008). *Canned Fruit and Vegetable Consumption in the United States: A Report to Congress.* Delivered by the Secretary of Agriculture to Congress, September 30. Administrative Publication No. (AP-032). Economic Research Service, U.S. Department of Agriculture. Available: http://www.ers.usda.gov/publications/ap-administrative-publication/ap-032.aspx [August 2014].

Buzby, J.C., Wells, H.F., Axtman, B., and Mickey, J. (2009). *Supermarket Loss Estimates for Fresh Fruit, Vegetables, Meat, Poultry, and Seafood and Their Use in the ERS Loss-Adjusted Food Availability Data.* Economic Information Bulletin No. (EIB-44). Economic Research Service, U.S. Department of Agriculture. Available: http://www.ers.usda.gov/publications/eib-economic-information-bulletin/eib44.aspx [July 2014].

Buzby, J.C., Wells H.F., Kumcu, A., Lin, B-H., Lucier, G., and Perez, A. (2010). *Canned Fruit and Vegetable Consumption in the United States: An Updated Report to Congress.* Administrative Publication No. (AP-050). Economic Research Service, U.S. Department of Agriculture. Available: http://www.ers.usda.gov/media/134841/ap050.pdf. [August 2014].

Buzby, J.C., Hyman, J., Stewart, H., and Wells, H.F. (2011). The value of retail- and consumer-level fruit and vegetable losses in the United States. *Journal of Consumer Affairs* 45(3):492–515. Available: http://onlinelibrary.wiley.com/doi/10.1111/j.1745-6606.2011.01214.x/pdf [July 2014].

Buzby, J.C., Wells, H.F., and Bentley J. (2013). ERS's food loss data help inform the food waste discussion. *Amber Waves* (June). Economic Research Service, U.S. Department of Agriculture. Available: http://www.ers.usda.gov/amber-waves/2013-june/ers-food-loss-data-help-inform-the-food-waste-discussion.aspx#.VA7xrqPD_Gg [August 2014].

Buzby, J.C., Wells, H.F., and Aulakh J. (2014). Food loss—Questions about the amount and causes still remain. *Amber Waves* Feature (June). Economic Research Service, U.S. Department of Agriculture. Available: http://www.ers.usda.gov/amber-waves/2014-june/food-loss%E2%80%94questions-about-the-amount-and-causes-still-remain.aspx#.U_ySyKPD_Gg [August 2014].

Buzby, J.C., Wells, H.F., and Hyman, J. (2014). *The Estimated Amount, Value, and Calories of Postharvest Food Losses at the Retail and Consumer Levels in the United States.* Economic Information Bulletin No. (EIB-121). Economic Research Service, U.S. Department of Agriculture. Available: http://www.ers.usda.gov/publications/eib-economic-information-bulletin/eib121.aspx [July 2014].

Carden, T.J, and Carr, T.P. (2013). Food availability of glucose and fat, but not fructose, increased in the U.S. between 1970 and 2009: Analysis of the USDA food availability data system. *Nutrition Journal* 12:130. Available: http://www.nutritionj.com/content/pdf/1475-2891-12-130.pdf [August 2014].

Claro, R.M., Jaime, P.C., Lock, K., Fisberg, R.M., and Monteiro, C.A. (2010). Discrepancies among ecological, household, and individual data on fruits and vegetables consumption in Brazil. *Cadernos de Saude Publica* 26(11):2168–2176.

Conforti, P., and Grünberger, K. (Forthcoming). *Reconciling Food Balance Sheets and National Household Surveys.* FAO Statistics Division Working Paper Series. Food and Agriculture Organization of the United Nations.

Connors, P.L., Bednar, C., Davenport, B.A., and Kennon, L.R. (2013). An infographic communicates food choice and waste in Texas middle schools. *Journal of the Academy of Nutrition and Dietetics* 113(9):A61.

Cuellar, A.D., and Webber, M.E. (2010). Wasted food, wasted energy: The embedded energy in food waste in the United States. *Environmental Science and Technology* 44(16):6464–6469.

de Gorter, H. (2014). *Evaluating the Zero Loss or Waste of Food Challenge and Its Practical Implications.* Background draft paper prepared for the Food and Agriculture Organization of the United Nations.

Diaz, A.V., and Garcia, A.C. (2013). Evaluation of factors affecting plate waste of inpatients in different healthcare settings. *Nutricion Hospitalaria* 28(2):419–427.

Drewnowski, A., and Specter, S.E. (2004). Poverty and obesity: The role of energy density and energy costs. *American Journal of Clinical Nutrition* 79(1):6–16. Available: http://ajcn.nutrition.org/content/79/1/6.full.pdf+html?sid=179d1c6a-3f1c-445a-8360-2d55f932ff05 [August 2014].

Duffey, K.J., and Popkin, B.M. (2008). High-fructose corn syrup: Is this what's for dinner? *American Journal of Clinical Nutrition* 88(6):1722S–1732S.

Elliott, S.S., Keim, N.L., Stern, J.S., Teff, K., and Havel, P.J. (2002). Fructose, weight gain, and the insulin resistance syndrome. *American Journal of Clinical Nutrition* 76(5):911–922. Available: http://ajcn.nutrition.org/content/76/5/911.full.pdf+html?sid=b39d00ed-b872-4431-8fb6-cd31778fea7f [July 2014].

Eriksson, M., Strid, I., and Hansson, P-A. (2012). Food losses in six Swedish retail stores: Wastage of fruit and vegetables in relation to quantities delivered. *Resources, Conservation, and Recycling* 68:14–20.

European Commission. (2012). *Addressing Food Waste in Times of Crisis.* Brussels Policy Briefing No. 28 (June). Available: http://brusselsbriefings.files.wordpress.com/2012/06/br28_food-waste_programme.pdf [July 2014].

Evans-Cowley, J.S., and Arroyo-Rodríguez, A. (2013). Integrating food waste diversion into food systems planning: A case study of the Mississippi Gulf Coast. *Journal of Agriculture, Food Systems, and Community Development* 3(3):1–19.

Ewalt, G.E., Rogers, E., Bishop, J., and Dickman P. (2011). The effect of room service-style food service on inpatient plate waste. *Journal of the American Dietetic Association* 111(9):A61.

Eyles, H., Jiang, Y., and Mhurchu, C.N. (2010). Use of household supermarket sales data to estimate nutrient intakes: A comparison with repeat 24-hour dietary recalls. *Journal of the American Dietetic Association* 110(1):106–110.

Ferreira, M., Martins Margarida, L., and Ada, R. (2013). Food waste as an index of foodservice quality. *British Food Journal* 115(11):1628–1637.

Fiorillo, D. (2013). Household waste recycling: National survey evidence from Italy. *Journal of Environmental Planning and Management* 56(8):1125–1151.

Food and Agriculture Organization. (2001). *Food Balance Sheets. A Handbook*. Rome: Author. Available: http://www.fao.org/docrep/003/x9892e/x9892e00.htm [July 2014].

Food and Agricultural Organization. (2014). *Technical Conversion Factors for Agricultural Commodities.* Rome: Author. Available: http://www.fao.org/fileadmin/templates/ess/documents/methodology/tcf.pdf [September 2014].

Freedman, M.R., and Bartoli, C. (2012). Food intake patterns and plate waste among community meal center guests in San Jose, California. *Journal of the Academy of Nutrition and Dietetics* 112(9):A89.

Freedman, M.R., and Brochado, C. (2009). Does reducing portion size reduce food intake and plate waste? *Obesity* 17:S161-S162.

Freedman, M.R., and Brochado, C. (2010). Reducing portion size reduces food intake and plate waste. *Obesity* 18(9):1864–1866.

Fulkerson, J.A., Nelson, M.C., Lytle, L., Moe, S., Heitzler, C., and Pasch, K.E. (2008). The validation of a home food inventory. *International Journal of Behavioral Nutrition and Physical Activity* 5:55.

Garcia-Closas, R., Berenguer, A., and Gonzalez, C.A. (2006). Changes in food supply in Mediterranean countries from 1961 to 2001. *Public Health Nutrition* 9(1):53–60.

Gentil, E. C., Gallo, D., and Christensen, T.H. (2011). Environmental evaluation of municipal waste prevention. *Waste Management* 31(12):2371–2379.

Gjerris, M., and Gaiani, S. (2013). Household food waste in Nordic countries: Estimations and ethical implications. *Etikk I Praksis* 7(1):6–23.

Golzarand, M., Mirmiran, P., Jessri, M., Toolabi, K., Mojarrad, M., and Azizi, F. (2012). Dietary trends in the Middle East and North Africa: An ecological study (1961 to 2007). *Public Health Nutrition* 15(10):1835–1844.

Gooch, M., Felfel, A., and Marenick, N. (2010). *Food Waste in Canada: Opportunities to* Increase the Competitiveness of Canada's Agri-Food Sector, While Simultaneously *Improving the Environment.* Value Chain Management Centre. Available: Available: http://vcm-international.com/wp-content/uploads/2013/04/Food-Waste-in-Canada-112410.pdf [October 2014].

Gooch, M., Marenick, N., Laplain, D., and Dent, B. (2013). *Cut Waste, GROW PROFIT™: Reducing Food Waste by Addressing the Disconnect Between the Attitude and Behaviour of Producers and Managers of Businesses Situated along the Value Chain.* Value Chain Management Centre. Available: http://vcm-international.com/wp-content/uploads/2013/06/Cut-Waste-GROW-PROFIT-Food-and-Associated-Wastes-May-30-2013.pdf [October 2014].

Goonan, S., Mirosa, M., and Spence, H. (2014). Getting a taste for food waste: A mixed-methods ethnographic study into hospital food waste before patient consumption conducted at three New Zealand foodservice facilities. *Journal of the Academy of Nutrition and Dietetics* 114(1):63–71.

Grieger, J.A., and Nowson, C.A. (2007). Nutrient intake and plate waste from an Australian residential care facility. *European Journal of Clinical Nutrition* 61(5):655–663.

Griffin, M., Sobol, J., and Lyson, T.A. (2009). An analysis of a community food waste stream. *Agriculture and Human Values* 26(1-2):67–81.

Grünberger, K. (2013). *Imputation of Loss Ratios for SUA/FBS Commodities. A Technical Report.* Paper produced as part of the Food and Agriculture Organization of the United Nations CapEx Project.

Guo, C., Hoekstra, R.M., Schroeder, C.M., Pires, S. M., Ong, K.L., Hartnett, E., et al. (2011). Application of Bayesian Techniques to model the burden of human salmonellosis attributable to U.S. food commodities at the point of processing: Adaptation of a Danish model. *Foodborne Pathogens and Disease* 8(4):509–516.

Gustavsson, J., Cederberg, C., Sonesson, U., and Emanuelsson, A. (2013). *The Methodology of the FAO Study: Global Food Losses FAO–2011.* SIK Report 857. The Swedish Institute for Food and Biotechnology. Available: http://www.sik.se/archive/pdf-filer-katalog/SR857.pdf [July 2014].

Gustavsson, J., Cederberg, C., Sonesson, U., van Otterdijk, R., and Meybeck, A. (2011). *Global Food Losses and Food Waste: Extent Causes and Prevention*. Rome: Food and Agriculture Organization. Available: http://www.fao.org/docrep/014/mb060e/mb060e00.pdf [July 2014].

Hall, K.D., Guo, J., Dore, M., and Chow, C. (2009). The progressive increase of food waste in America and its environmental impact. *PLoS ONE* [Electronic Resource] 4(11). Available: http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0007940 [November 2014].

Hanson, N.I., Neumark-Sztainer, D., Eisenberg, M.E., Story, M., and Wall, M. (2005). Associations between parental report of the home food environment and adolescent intakes of fruits, vegetables and dairy foods. *Public Health Nutrition* 8(1):77–85.

Hawkesworth, S., Dangour, A., Johnston, D., Lock, K., Poole, N., Rushton, J., et al. (2010). Feeding the world healthily: The challenge of measuring the effects of agriculture on health. *Philosophical Transactions of the Royal Society of London-Series B: Biological Sciences* 365(1554):3083–3097.

Herrero, M., Laca, A. and Diaz, M. (2013). Life cycle assessment focusing on food industry wastes. Pp. 265–280 in *Food Industry Wastes: Assessment and Recuperation of Commodities*, M.R. Kosseva and C. Webb (Eds). San Diego: Academic Press.

Hiza, H.A.B., and Bente, L. (2011). *Nutrient Content of the U.S. Food Supply: Developments Between 2000 and 2006.* Home Economics Research Report No. 59.Washington, DC: Center for Nutrition Policy and Promotion, U.S. Department of Agriculture.

Hiza, H.A.B., Bente, L., and Fungwe, T. (2008). *Nutrient Content of the U.S. Food Supply, 2005.* Home Economics Research Report No. 58. Washington, DC: Center for Nutrition Policy and Promotion, U.S. Department of Agriculture. Available: http://www.cnpp.usda.gov/sites/default/files/nutrient_content_of_the_us_food_supply/FoodSupply2005Report.pdf [August 2014].

Hodges, R.J., Buzby, J.C., and Bennett, B. (2011). Postharvest losses and waste in developed and less developed countries: Opportunities to improve resource use. *Journal of Agricultural Science* 149(S1):37–45. Available: http://www.bis.gov.uk/assets/foresight/docs/food-and-farming/science/11-561-sr15-postharvest-losses-and-waste [July 2014].

Hoelzer, K., Pouillot, R., Egan, K., and Dennis, S. (2012). Produce consumption in the United States: An analysis of consumption frequencies, serving sizes, processing forms, and high-consuming population subgroups for microbial risk assessments. *Journal of Food Protection* 75(2):328–340.

Holden, J.M., and Lemar, L.E. (2008). Assessing vitamin D contents in foods and supplements: challenges and needs. *American Journal of Clinical Nutrition* 88(2):551S–553S. Available: http://ajcn.nutrition.org/content/88/2/551S.full.pdf+html?sid=4b1ed8a1-7545-40a1-a60a-e164f955f0db [August 2014].

Huang, S.T.Y. (2010). A recycling index for food and health security: Urban Taipei. *Asia Pacific Journal of Clinical Nutrition* 19(3):402–411.

Huang, W., Wanga, J., Daia, X., Lia, M., and Hardera, M.K. (2014). More than financial investment is needed: Food waste recycling pilots in Shanghai, China. *Journal of Cleaner Production* 67:107–116.

Irz, X. (2010). Modeling physical quantities of food and nutrients consumed from aggregate data-with an application to Finland. *Agricultural Economics* 41(3-4):293–304.

Jacobs, K., and Sumner, D.A. (2002). *The Food Balance Sheets of the Food and Agriculture Organization: A Review of Potential Ways to Broaden the Appropriate Uses of the Data.* Available: http://182.160.112.236/agridrupal/sites/default/files/FBS_Review_of_Potential_Ways_to_Broaden_the_Uses_of_Data.pdf [July 2014].

Jensen, H.H. (2011). Changing nutritional content of food. Pp. 629–648 in *Oxford Handbook of the Economics of Food Consumption and Policy*, J.L. Lusk, J. Roosen, and J. F. Shogren (Eds.). New York: Oxford University Press.

Joy, E.J.M., Young, S.D., Black, C.R., Ander, E.L., Watts, M.J., and Broadley, M.R. (2013). Risk of dietary magnesium deficiency is low in most African countries based on food supply data. *Plant and Soil* 368(1-2):129–137.

Kader, A.A. (2005), Increasing food availability by reducing postharvest losses of fresh produce. *Acta Horticulturae* (ISHS) 682:2169–2176.

Kallbekken, S., and Saelen, H.H. (2013). Nudging hotel guests to reduce food waste as a win-win environmental measure. *Economics Letters* 119(3):325–327.

Kantor, L.S. (1998). *A Dietary Assessment of the U.S. Food Supply: Comparing Per Capita Food Consumption with Food Guide Pyramid Serving Recommendations.* Agricultural Economics Report No. (AER772). Washington, DC: Economic Research Service, U.S. Department of Agriculture. Available: http://webarchives.cdlib.org/sw1tx36512/http://www.ers.usda.gov/Publications/AER772/ [July 2014].

Kantor, L.S., Lipton, K., Manchester, A., and Oliveira, V. (1997). Estimating and addressing America's food losses. *Food Review* January–April:2–12. Available: http://webarchives.cdlib.org/sw1bc3ts3z/http:/ers.usda.gov/publications/foodreview/jan1997/jan97a.pdf [July 2014].

Koester, U. (2013). Total and per capita value of food loss in the United States: Comments. *Food Policy* 41:63–64.

Kosseva, M.R. (2009). Processing of food wastes. *Advances in Food and Nutrition Research* 58: 57–136.

Krebs-Smith, S.M. (2001). Choose beverages and food to moderate your intake of sugars: Measurement requires quantification. *Journal of Nutrition* 131(2):527S–535S.

Krebs-Smith, S.M., Reedy, J., and Bosire, C. (2010). Healthfulness of the U.S. food supply: Little improvement despite decades of dietary guidance. *American Journal of Preventive Medicine* 38(5):472–477.

Kummu, M., de Moel, H., Porkka, M., Siebert, S., Varis, O., and Ward, P.J. (2012). Lost food, wasted resources: Global food supply chain losses and their impacts on freshwater, cropland, and fertilizer use. *Science of the Total Environment* 438:477–489.

LaFrance, J.T. (2008). The structure of U.S. food demand. *Journal of Econometrics* 147:336–349.

Langley, J., Yoxall, A., Manson, G., Lewis, W., Waterhouse, A., Thelwall, D., et al. (2009). The use of uncertainty analysis as a food waste estimation tool. *Waste Management and Research* 27(3):199–206.

Laugesen, M. (2005). Decreased red meat fat consumption in New Zealand: 1995-2002. *New Zealand Medical Journal* 118(1226):U1751.

Leibman, B. (2010, March). The changing American diet: A report card. *Nutrition Action Healthletter* 11. Center for Science in the Public Interest. Available: http://cspinet.org/new/pdf/changing_american_diet_13.pdf [November 2014].

Leopold Center for Sustainable Agriculture. (2008). *Model-Estimated Potential Demand for Foods by County.* U.S. Food Market Estimator, Iowa State University. Available: http://www.ctre.iastate.edu/marketsize/about.html [July 2014].

Lin, A.Y.C., Huang, S.T., and Wahlqvist, M.L. (2009). Waste management to improve food safety and security for health advancement. *Asia Pacific Journal of Clinical Nutrition* 18(4):538–545.

Lipinski, B., Hanson, C., Waite, R., Searchinger, T., Lomax, J., and Kitinoja, L. (2013). *Reducing Food Loss and Waste: Creating a Sustainable Food Future Installment Two.* World Resources Institute. Available: http://www.wri.org/publication/creating-sustainable-food-future-installment-two [July 2014].

Liu, G. (2014). *Food Losses and Food Waste in China: A First Estimate.* OECD Food, Agriculture and Fisheries Papers No. 66. Paris: OECD. Available: http://www.oecd-ilibrary.org/agriculture-and-food/food-losses-and-food-waste-in-china_5jz5sq5173lq-en [August 2014].

Liu, J., Lundqvist, J.,Weinberg, J., and Gustafsson, J. (2013). Food losses and waste in China and their implication for water and land. *Environmental Science and Technology* 47(18): 10137–10144.

Longo-Silva, G., ToloniI, M., Rodrigues, S., RochaII, A., and de Aguiar Carrazedo Taddei, J.A. (2013). Qualitative evaluation of the menu and plate waste in public day care centers in Sao Paulo city, Brazil. *Revista De Nutricao-Brazilian Journal of Nutrition* 26(2):135–144.

Mancino, L., and Buzby, J.C. (2005). Americans whole grain consumption below guidelines. Economic Research Service, U.S. Department of Agriculture. *Amber Waves* Findings (April). Available: http://webarchives.cdlib.org/sw1tx36512/http://www.ers.usda.gov/Amberwaves/April05/Findings/WholeGrainConsumption.htm [August 2014].

Marlette, M.A., Templeton, S.B., and Panemangalore, M. (2005). Food type, food preparation, and competitive food purchases impact school lunch plate waste by sixth-grade students. *Journal of the American Dietetic Association* 105(11):1779–1782.

Martin, C.K., Correa, J.B., Han, H., Allen, H.R., Rood, J.C., Champagne, C.M., Gunturk, B.K., and Bray, G.A. (2012). Validity of the Remote Food Photography Method (RFPM) for estimating energy and nutrient intake in near real-time. *Obesity* 20(4):891–899.

Martin, C.K., Han, H., Coulon, S.M., Allen, H.R., Champagne, C.M., and Anton, S.D. (2009). A novel method to remotely measure food intake of free-living individuals in real time: The remote food photography method. *British Journal of Nutrition* 101(3):446–456.

Martins, M.L., Cunha, L.M., Rodrigues, S.S.P., and Rocha, A. (2013). Overall plate waste determinations at primary school's canteens: A comparison of two methods. *Annals of Nutrition and Metabolism* 63:1535.

Mayer-Davis, E.J. (2003). Whole-grain intake and insulin sensitivity: The insulin resistance atherosclerosis study. *American Journal of Clinical Nutrition* 78(5):965–971. Available: http://ajcn.nutrition.org/content/78/5/965.full.pdf+html?sid=179d1c6a-3f1c-445a-8360-2d55f932ff05 [August 2014].

McGuirk, A., Driscoll, P., Alwang, J., and Huang, H. (1995). System misspecification testing and structural change in the demand for meats. *Journal of Agricultural and Resource Economics* 20(1):1–21.

McNamara, P.E., Ranney, C.K., Kantor, L.S., and Krebs-Smith, S.M. (1999). The gap between food intakes and the pyramid recommendations: Measurement and food system ramifications. *Food Policy* 24:117–133.

Meier, T., Christena, O., Semler, E., Jahreis, G., Voget-Kleschin, L., Schrode, A., and Artmann, M. (2014). Balancing virtual land imports by a shift in the diet. Using a land balance approach to assess the sustainability of food consumption. Germany as an example. *Appetite* 74:20–34.

Miao, Z., Beghin, J.C., and Jensen, H.H. (2012). Taxing sweets: Sweetener input tax or final consumption tax. *Contemporary Economic Policy* 30(3):344–361.

Miller P., Reedy J., Kirkpatrick S., Krebs-Smith, S.M. (in press). The United States food supply is not consistent with dietary guidance: Evidence from an updated evaluation using the Healthy Eating Index-2010. *Journal of the Academy of Nutrition and Dietetics* [published online November 1]. Available: http://www.andjrnl.org/article/S2212-2672(14)01363-X/abstract [November 2014].

Morrison, R.M., Smith, T.A., and Lin, B.-H. (2009). Got data? Multiple data sources track U.S. food consumption. *Amber Waves* 7(1):39–41. Available: http://webarchives.cdlib.org/sw1s17tt5t/http://ers.usda.gov/AmberWaves/March09/DataFeature/ [July 2014].

Morrison, R.M., Buzby, J.C., and Wells, H.F. (2010). Guess who's turning 100? Tracking a century of American eating. *Amber Waves* 8(1):12–19. Available: http://webarchives.cdlib.org/sw1tx36512/http://www.ers.usda.gov/amberwaves/march10/features/trackingacentury.htm [July 2014].

Muth, M.K., Kosa, K.M., Nielsen, S.J., and Karns, S.A. (2007). *Exploratory Research on Estimation of Consumer-Level Food Loss Conversion Factors.* Agreement No. 58-4000-6-0121. Research Triangle Park, NC: RTI International. Available: http://www.rti.org/pubs/0210449_food_loss_report_7-07.pdf [July 2014].

Muth, M.K., Karns, S.A, Nielsen, S.J., Buzby, J.C., and Wells, H.F. (2011). *Consumer-Level Food Loss Estimates and Their Use in the ERS Loss-Adjusted Food Availability Data.* Technical Bulletin No. (TB-1927). Economic Research Service, U.S. Department of Agriculture. Available: http://www.ers.usda.gov/publications/tb-technical-bulletin/tb1927.aspx [August 2014.]

Nahman, A., and De Lange, W. (2013). Costs of food waste along the value chain: Evidence from South Africa. *Waste Management* 33(11):2493–2500.

Nahman, A., De Lange, W., Oelofse, S., and Godfrey, L. (2012). The costs of household food waste in South Africa. *Waste Management* 32(11):2147–2153.

Naska, A., Berg, M.A., Cuadrado, C., Freisling, H., Gedrich, K., Gregoric, M., et al. (2009). Food balance sheet and household budget survey dietary data and mortality patterns in Europe. *British Journal of Nutrition* 102(1):166–171.

National Research Council. (2012). *A Sustainability Challenge: Food Security for All: Report of Two Workshops.* Committee on Food Security for All as a Sustainability Challenge. Washington, DC: The National Academies Press. Available: http://www.nap.edu/catalog.php?record_id=13378 [August 2014].

Natural Resources Defense Council. (2012). *Environmental Issues: Food and Agriculture Crop Shrink—Drivers of Fruit and Vegetable Loss at Production.* Available: http://www.nrdc.org/food/crop-shrink.asp [July 2014].

Natural Resources Defense Council. (2013). *Food Facts: Your Scraps Add Up.* Fact sheet. Available: http://www.nrdc.org/living/eatingwell/files/foodwaste_2pgr.pdf [July 2014].

Nestle, M. (2003). *Food Politics*. Berkeley: University of California Press.

Ngo, J., Engelen, A., Molag, M., Roesle, J., García-Segovia, P., and Serra-Majem, L. (2009). A review of the use of information and communication technologies for dietary assessment. *British Journal of Nutrition* 101(S2):S102–S112.

Nicholls, T. (2010). Mitigate food loss to feed more people right now. *Nature* 466(7309):920.

Oelofse, S.H.H., and Nahman, A. (2013). Estimating the magnitude of food waste generated in South Africa. *Waste Management and Research* 31(1):80–86.

Offiong, E.E., and Ita, P.B. (2012). Climate change and agricultural production. *Global Journal of Agricultural Sciences* 11(1):25–31.

Okrent, A.M., and Alston, J.M. (2012). The effect of farm policy and retail food policies on obesity and economic welfare in the United States. *American Journal of Agricultural Economics* 94(3):611–646.

Organisation for Economic Co-operation and Development. (2014). *Food Waste along the Food Chain: Available Data and Relevant Policies.* A summary of the Fourth Meeting of the Food Chain Analysis Network, June 2013. Available: http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=TAD/CA/APM/WP/RD(2013)8/FINAL&docLanguage=En [August 2014.]

Parfitt, J., Barthel. M., and Macnaughton, S. (2010). Food waste within food supply chains: Quantification and potential for change to 2050. *Philosophical Transactions of the Royal Society of London-Series B: Biological Sciences* 365(1554):3065–3081.

Park, Y.K., and Yetley, E.A. (1993). Intakes and food sources of fructose in the United States. *American Journal of Clinical Nutrition* 58(5):737S–747S. Available: http://ajcn.nutrition.org/content/58/5/737S.full.pdf+html?sid=4b1ed8a1-7545-40a1-a60a-e164f955f0db [August 2014].

Patel, N., and Handu, D.J. (2010). Impact of change in school menu on acceptability as measured by the plate waste method. *Journal of the American Dietetic Association* 110(9).

Pedreschi, R., Lurie, S., Hertog, M., Nicolaï, B., Mes, J., and Woltering, E. (2013). Post-harvest proteomics and food security. *Proteomics* 13(12-13):1772–1783.

Pereira, M.A., Jacobs, Jr., D.R., Pins, J.J, Raatz, S.K., Gross, M.D., Slavin, J.L., and Seaquist, E.R. (2003). Effect of whole grains on insulin sensitivity in overweight hyperinsulinemic adults. *American Journal of Clinical Nutrition* 78(5):965–971. Available: http://ajcn.nutrition.org/content/78/5/965.full.pdf+html?sid=179d1c6a-3f1c-445a-8360-2d55f932ff05_[August 2014].

Pfaltzgraff, L.A., De bruyn, M., Cooper, E.C., Budarina, V., and Clark, J.H. (2013). Food waste biomass: A resource for high-value chemicals. *Green Chemistry* 15(2):307–314.

Phillips, C., Hoenigman, R., Higbee, B., and Reed, T. (2013). Understanding the sustainability of retail food recovery. *PLoS ONE* 8(10):e75530. Available: http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0075530 [November 2014].

Piggott, N.E., and Marsh, T.L. (2004). Does food safety information impact U.S. meat demand? *American Journal of Agricultural Economics* 86(1):154–174.

Popkin, B., and Nielsen, S. (2003). The sweetening of the world's diet. *Obesity Research* 11(11):1325–1333. doi: 10.1038/oby.2003.179.

Porpino, G., and Parente, J. (2014). *Food Waste Paradox: Antecedents of Food Disposal in Low Income Households That Cook from Scratch.* Prepared for the International Food Marketing Research Symposium. Aarhus University, Aarhus, Denmark.

Prusky, D. (2011). Reduction of the incidence of postharvest quality losses, and future prospects. *Food Security* 3(4):463–474.

Reedy, J., Krebs-Smith, S.M., and Bosire, C. (2010). Evaluating the food environment: Application of the Healthy Eating Index-2005. *American Journal of Preventative Medicine* 38(5):465–471.

Ridoutt, B.G., Juliano, P., Sanguansri, P., and Sellahewa, J. (2010). The water footprint of food waste: Case study of fresh mango in Australia. *Journal of Cleaner Production* 18(16–17): 1714–1721.

Robillard, A.S., and Robinson, S. (2003). Reconciling household surveys and national accounts data using a cross entropy estimation method. *Review of Income and Wealth* 49(3):395–406. Available: http://ideas.repec.org/p/fpr/tmddps/50.html [July 2014].

Salhofer, S., Obersteiner, G., Schneider, F., and Lebersorger, S. (2008). Potentials for the prevention of municipal solid waste. *Waste Management* 28(2):245–259.

Schmidhuber, J., and Traill, W.B. (2006). The changing structure of diets in the European Union in relation to healthy eating guidelines. *Public Health Nutrition* 9(5):584–595.

Schneider, F. (2013). The evolution of food donation with respect to waste prevention. *Waste Management* 33(3):755–763.

Schwalb, M., Rosevear, C., Chin, R., and Barrington, S. (2011). Food waste treatment in a community center. *Waste Management* 31(7):1570–1575.

Sharp, V., Giorgi, S., and Wilson, D.C. (2010). Delivery and impact of household waste prevention intervention campaigns (at the local level). *Waste Management and Research* 28(3):256–268.

Sheehy, T., and Sharma S. (2010). The nutrition transition in Barbados: Trends in macronutrient supply from 1961 to 2003. *British Journal of Nutrition* 104(8):1222–1229.

Sheehy, T., and Sharma, S. (2011). Use of FAO food balance sheets to estimate the potential ability of novel folate-enriched eggs to increase the folate supply in European Union countries. *Public Health Nutrition* 14(3):551–556.

Sigman-Grant, M., and Morita, J. (2003). Defining and interpreting intakes of sugars. *American Journal of Clinical Nutrition* 78(4):815S–826S. Available: http://ajcn.nutrition.org/content/78/4/815S.full.pdf+html?sid=4b1ed8a1-7545-40a1-a60a-e164f955f0db [August 2014].

Statistics Canada. (2014). *Food Supply and Disposition.* Background paper. Available: http://www23.statcan.gc.ca/imdb-bmdi/document/3475_D1_T9_V3-eng.pdf [August 2014].

Stehfest, E., van den Berg, M., Woltjer, G., Msangi, S., and Westhoek, H. (2013). Options to reduce the environmental effects of livestock production: Comparison of two economic models. *Agricultural Systems* 114(0):38–53.

Stuart, T. (2009). *Waste: Uncovering the Global Food Scandal*. London: W.W. Norton.

Suh, S., and Yee, S. (2011). Phosphorus use-efficiency of agriculture and food system in the U.S. *Chemosphere* 84(6):806–813.

Swanson, M.P. (2008). Digital photography as a tool to measure school cafeteria consumption. *The Journal of School Health* 78(8):432–437.

Tarr, J.B., Tamura, T., and Stokstad, E.L. (1981). Availability of vitamin B6 and pantothenate in an average American diet in man. *American Journal of Clinical Nutrition* 34(7):1328–1337. Available: http://ajcn.nutrition.org/content/34/7/1328.full.pdf+html?sid=4b1ed8a1-7545-40a1-a60a-e164f955f0db [August 2014].

Tenn, S., and Yun, J.M. (2008). Biases in demand analysis due to variation in retail distribution. *International Journal of Industrial Organization* 26(4):984–997.

Thaler, R.H., and Sunstein, C.R. (2008). *Nudge: Improving Decisions About Health, Wealth, and Happiness*. New York: Penguin Books.

The Prince's Charities' International Sustainability Unit. (2011) *What Price Resilience? Towards Sustainable and Secure Food Systems.* Available: http://pcfisu.org/wp-content/uploads/pdfs/TPC0632_Resilience_report_WEB11_07_SMALLER.pdf [August 2014].

Thiagarajah, K., and Getty, V.M. (2013). Impact on plate waste of switching from a tray to a trayless delivery system in a university dining hall and employee response to the switch. *Journal of the Academy of Nutrition and Dietetics* 113(1):141.

Trichopoulou, A., Naska, A., and the DAFNE III Group. (2003). European food availability data bank based on household budget surveys. *European Journal of Public Health* 13(3 supplement):24–28.

Unnevehr, L., Eales, J., Jensen, H., Lusk, J., McCluskey, J., and Kinsey, J. (2010). Food and consumer economics. *American Journal of Agricultural Economics* 92(2):506–521.

U.S. Department of Agriculture and U.S. Department of Health and Human Services. (2010). *Dietary Guidelines for Americans 2010*. 7th Edition. Washington, DC: U.S. Government Printing Office. Available: http://www.cnpp.usda.gov/DietaryGuidelines [August 2014].

U.S. Environmental Protection Agency. (1999). *Waste Not, Want Not: Feeding the Hungry and Reducing Solid Waste Through Food Recovery.* EPA 530-R-99-040. Available: http://www.epa.gov/epawaste/conserve/pubs/wast_not.pdf [July 2014].

U.S. Environmental Protection Agency. (2010). *Organics: Co-Digestion Economic Analysis Tool (CoEAT). CoEAT User's Guide.* Available: http://www.epa.gov/region9/organics/coeat/index.html [July 2014].

U.S. Environmental Protection Agency. (2014). *Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2012.* EPA fact sheet. Available: http://www.epa.gov/osw/nonhaz/municipal/pubs/2012_msw_fs.pdf [August 2014.]

Vasantha Rupasinghe, H.P., and Li, J.Y. (2013). Value-added fruit processing for human health, Chapter 7 in *Agricultural and Biological Sciences, Food Industry*, I. Muzzalupo (Ed). Available: http://www.intechopen.com/books/food-industry/value-added-fruit-processing-for-human-health [August 2014].

Venkat, K. (2012). The climate change and economic impacts of food waste in the United States. *International Journal on Food System Dynamics* 2:431–446. Available: http://www.cleanmetrics.com/pages/ClimateChangeImpactofUSFoodWaste.pdf [July 2014].

Vocke, G., Buzby, J.C., and Wells, H.F. (2008). Consumer preferences change wheat flour use. *Amber Waves* Findings(September). Economic Research Service, U.S. Department of Agriculture. Available: http://webarchives.cdlib.org/sw1vh5dg3r/http://ers.usda.gov/AmberWaves/September08/Findings/WheatFlour.htm [August 2014].

Wang, Y., and Li, S. (2008). Worldwide trends in dairy production and consumption and calcium intake: Is promoting consumption of dairy products a sustainable solution for inadequate calcium intake? *Food and Nutrition Bulletin* 29(3):172–185.

Wansink, B. (2006). *Mindless Eating—Why We Eat More Than We Think*. New York: Bantam-Dell.

Weber, C.L., and Matthews, H.S. (2008). Food-miles and the relative climate impacts of food choices in the United States. *Environmental Science and Technology* 42(10):3508–3513.

Wells, H.F. (2012a). A dietary assessment of fruit consumption. Pg. 26 in *Fruit and Tree Nuts Outlook Report*. FTS 354. Washington, DC: Economic Research Service, U.S. Department of Agriculture. Available: http://www.ers.usda.gov/media/970458/fts354.pdf [August 2014].

Wells, H.F. (2012b). A dietary assessment of vegetable consumption. Pg. 27 in *Vegetable and Pulses Outlook Report*. VGS 351. Washington, DC: Economic Research Service, U.S. Department of Agriculture. Available: http://www.ers.usda.gov/media/922639/vgs351.pdf [August 2014].

Wells, H.F., and Buzby, J.C. (2007). ERS Food Availability data look at consumption in three ways. *Amber Waves* 5(3):40–41. Available: http://webarchives.cdlib.org/sw1vh5dg3r/http://ers.usda.gov/AmberWaves/June07/DataFeature/ [July 2014].

Wells, H.F., and Buzby, J.C. (2008a). *Dietary Assessment of Major Trends in U.S. Food Consumption, 1970-2005.* Economic Information Bulletin No. (EIB-33). Economic Research Service, U.S. Department of Agriculture. Available at: http://www.ers.usda.gov/media/210681/eib33_1_.pdf [August 2014].

Wells, H.F., and Buzby, J.C. (2008b). High-fructose corn syrup usage may be leveling off. *Amber Waves* Findings, 6(February). Economic Research Service, U.S. Department of Agriculture. Available: http://webarchives.cdlib.org/sw1wp9v27r/http://ers.usda.gov/AmberWaves/February08/PDF/HighFructose.pdf [August 2014].

Wikstrom, F., and Williams, H. (2010). Potential environmental gains from reducing food losses through development of new packaging: A life-cycle model. *Packaging Technology and Science* 23(7):403–411.

Willett, W. (2012). *Nutritional Epidemiology*. Third Edition, Monographs in Epidemiology and Biostatistics. New York: Oxford University Press.

Williams, H., and Wikström, F. (2011). Environmental impact of packaging and food losses in a life cycle perspective: A comparative analysis of five food items. *Journal of Cleaner Production* 19(1):43–48.

Williams, P., and Walton, K. (2011). Plate waste in hospitals and strategies for change. *e-SPEN Journal* 6(6):e235-e241.

Williamson, D.A., Allen, H.R., Martin, P.D., Alfonso, A., Gerald, B., and Hunt, A. (2004). Digital photography: A new method for estimating food intake in cafeteria settings. *Eating and Weight Disorders* 9(1):24–28.

World Health Organization. (2009). *Report of the Workshop on Integration of Data on Household Food Availability and Individual Dietary Intakes.* Copenhagen, Denmark, April 28–29. Report No. 5. Available: http://ec.europa.eu/health/nutrition_physical_activity/docs/implementation_report_a1e_en.pdf [November 2014].

Wright, C.B. (2011). Using visual plate waste to measure the impact of reorganization of a hospital food delivery system. *Journal of the American Dietetic Association* 111(9):A29.

Yasin, N.H.M., Mumtaz, T., Hassan, M.A., and Tahman, N.A. (2013). Food waste and food processing waste for biohydrogen production: A review. *Journal of Environmental Management* 130:375–385.

Young, C.E., and Kantor, L.S. (1999). Moving toward the Food Guide Pyramid. Chapter 20 in *Implications for U.S. Agriculture*. Agricultural Economics Reports, AIB-750 No. 34071. Washington, DC: Economic Research Service, U.S. Department of Agriculture. Available: http://www.ers.usda.gov/media/91096/aib750t_1_.pdf [August 2014].

Zhang, W.J., Bai, C., and Liu, G. (2007). A longer-term forecast on global supply and demand of food products. *Journal of Food Agriculture and Environment* 5(1):105–110.

Zheng, Y., Kinnucan, H., and Kaiser, H. (2010). Measuring and testing advertising-induced rotation in the demand curve. *Applied Economics* 42(13):1601–1614.

Appendix A

Glossary and Acronyms

GLOSSARY

Beginning stocks
Existing supplies of a farm commodity that consist of remaining stock carried over from the previous year's production. (Definition from Economic Research Service (ERS) Food Availability Data System (FADS) Glossary[1])

Boneless, trimmed-weight equivalent
In FADS, red meat (beef, veal, pork, lamb, and mutton), poultry (chicken and turkey), and fish estimates are fairly comparable. For most of these products, the measure excludes bones, edible offals, and game consumption. Boneless trimmed poultry includes skin, neck, and giblets but excludes chicken used for commercially prepared pet food. (Definition from ERS FADS Glossary)

Carcass-weight equivalent (CWE)
The weight of meat cuts and meat products converted to an equivalent weight of a dressed carcass. Includes bone, fat, tendons, ligaments, and inedible trimmings (whereas product weight may or may not). (Definition from ERS FADS Glossary)

[1]The FADS Glossary is available at http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system/glossary.aspx [October 2014].

Commodity
A commodity is (1) an article of trade or commerce, esp. a product as distinguished from a service; (2) something of use, advantage or value; (3) any unprocessed or partially processed good, as a grain, fruit or vegetable, or a precious metal; (4) *Obs*. a quantity of goods. (Definition from *Random House Webster's College Dictionary*, copyright 1992)

Commodity tree
A commodity tree is a symbolic representation of the flow from a primary commodity to various processed products derived from it, together with the conversion factors from one commodity to another. (Definition from the Food and Agriculture Organization [FAO][2] of the United Nations)

Consumer weight
In the ERS Loss-Adjusted Food Availability (LAFA) data series in FADS, the weight of the product (annual, per capita) as it is purchased at the retail level for use by consumers for at-home consumption or as it is purchased by food services or institutions for away-from-home consumption (e.g., at restaurants, fast food outlets, hospitals, and schools). It is the weight after retail-level losses have been subtracted. The consumer weight is the weight of the food before losses at the consumer level (e.g., inedible share and other cooking loss and uneaten food) have been subtracted. (Definition from ERS FADS Glossary)

Consumption
In economics, the using up of goods or services or the amount used up. In common usage, consumption can also mean the ingestion of food by eating or drinking. In ERS's FADS (per capita), the food availability and the nutrient availability series provide estimates of the amount of food and nutrients used up; the LAFA data series provides estimates of food intake or the amount of food eaten or ingested. (Definition from ERS FADS Glossary)

Conversion factors
There are different types of conversion factors. One type is used to convert raw agricultural commodities into consumer products—for example, converting beef from a carcass weight to a boneless weight or converting a dozen shell eggs to kilograms of dried eggs. These factors may change over time in response to changes in agricultural production and marketing practices. In contrast, conversion factors for weights and measures

[2]Available: http://www.fao.org/fileadmin/templates/ess/documents/methodology/tcf.pdf [October 2014].

for agricultural commodities and their products are constant over time. For example, 2 pints of liquid always equal 1 quart. (Definition from ERS FADS Glossary)

Crop year
The year in which a crop is harvested in contrast to the marketing year. For wheat, barley, and oats, the crop year is June 1 to May 31. For corn, sorghum, and soybeans, it is October 1 to September 30, and for cotton, peanuts, and rice, it is August 1 to July 31. (Definition from ERS FADS Glossary)

Cup equivalent (cup eq)
A standard of comparison for comparable amounts of various fruits, vegetables, and milk products. In the fruit and vegetable groups, a cup eq is the amount of a food considered equivalent to 1 cup of a cut-up fruit or vegetable; in the milk group, one cup eq is the amount of food considered equivalent to 1 cup of milk. (Definition from ERS FADS Glossary)

Dietary guidelines
Guidelines developed every 5 years by the U.S. Department of Agriculture and the U.S. Department of Health and Human Services, emphasizing variety, balance, and moderation in the total diet without making recommendations regarding specific foods to include or exclude. The *Dietary Guidelines for Americans, 2010*[3] provides recommendations based on gender, age, and level of physical activity. (Definition from ERS FADS Glossary)

Disappearance
The food availability data are often referred to as food disappearance data because the data represent the amount of the food supply that "disappears" from farms, net imports, and storage facilities into the food marketing system and is available for consumption in the United States during a year.

Ending stocks
The remainder of current crop production carried over into the next crop year. (Definition from ERS FADS Glossary)

Farm weight
The weight of a commodity as measured on the farm before further conditioning and processing. (Definition from ERS FADS Glossary)

[3]Available: http://www.cnpp.usda.gov/DietaryGuidelines [September 2014].

Food balance sheet
Food balance sheets present a comprehensive picture of the pattern of a country's food supply during a specified reference period. The food balance sheet shows for each food item—that is, each primary commodity and a number of processed commodities potentially available for human consumption—the sources of supply and its utilization. The total quantity of foodstuffs produced in a country added to the total quantity imported and adjusted to any change in stocks that may have occurred since the beginning of the reference period gives the *supply* available during that period. On the *utilization* side, a distinction is made between the quantities exported, fed to livestock, used for seed, processed for food use and nonfood uses, lost during storage and transportation, and food supplies available for human consumption at the retail level, that is, as the food leaves the retail shop or otherwise enters the household. ERS FADS is also based on food balance sheets. (Definition from FAO[4])

Food group
A set of food items grouped together based on similarities in nutrient content and/or use by consumers and identified as a group for dietary guidance. In *MyPlate*, the basic food groups are "grains"—bread, rice, and pasta; "fruits"; "vegetables"; "milk and milk products"—milk, yogurt, and cheese; and "meat and beans"—meat, poultry, fish, dry edible beans/dry peas and lentils, eggs, and nuts. (Definition from ERS FADS Glossary)

Food loss
According to FAO of the United Nations, food loss means "any change in the availability, edibility, wholesomeness or quality of the food that prevents it from being consumed by people." In ERS FADS, food loss represents the edible amount of food, postharvest, that is available for human consumption but is not consumed for any reason. It includes cooking loss and natural shrinkage (e.g., moisture loss); loss from mold, pests, or inadequate climate control; and food waste. Also see *food waste.* (Definition from ERS FADS Glossary)

Food pattern equivalent
A standardized amount of food, such as a cup or an ounce, used to provide dietary guidance or to make comparisons among similar foods. (Definition from ERS FADS Glossary)

[4]See http://www.fao.org/docrep/003/x9892e/X9892e01.htm#P46_1749 [September 2014].

Food subgroup
A distinct subset of foods within a food group with specified similarities and a recommended quantity for consumption. In the *Dietary Guidelines for Americans, 2010,* the vegetable group is composed of the following subgroups: dark green vegetables, red and orange vegetables, beans and peas, starchy vegetables, and other vegetables. The grain group is composed of whole grains and refined grains subgroups. (Definition from ERS FADS Glossary)

Food waste
Food waste is a component of food loss and occurs when an edible item goes unconsumed, as in food discarded by retailers due to color or appearance and plate waste by consumers. ERS FADS is used to estimate food loss and not food waste (a subset of food loss). Also see *food loss*. (Definition from ERS FADS Glossary)

Loss at the consumer level
In the ERS LAFA data series in FADS, this type of loss includes food consumed at home and away from home (e.g., restaurants and fast food outlets) by consumers and food services. Losses at the consumer level have two components:

1. "Nonedible share" of a food (e.g., asparagus stalk, apple core). Data on the nonedible share is from the National Nutrient Database for Standard Reference,[5] compiled by the U.S. Department of Agriculture's Agricultural Research Service (ARS).
2. "Cooking loss and uneaten food such as plate waste" from the edible share. This measure is given as the percent or share of food available at the consumer level. (Definition from ERS FADS Glossary)

Loss from primary to retail weight
In the ERS LAFA data series in FADS, this type of loss measures the percentage or share of food loss between the primary weight (in most cases, the farm weight) and the retail weight. (Definition from ERS FADS Glossary)

Loss at the retail level
In the ERS LAFA data series in FADS, the loss in supermarkets, megastores such as Walmart, and other retail outlets, including convenience stores and mom-and-pop grocery stores. This type of loss does not include losses in restaurants and other foodservice outlets because that is cap-

[5]Available: http://ndb.nal.usda.gov/ [September 2014].

tured in the "loss at the consumer level." This measure is the percentage or share of food available at the retail to consumer level. (Definition from ERS FADS Glossary)

Marketing year
The 12-month period following harvest during which a commodity may be sold domestically, exported, or put into reserve stocks. The year varies by country and commodity. (Definition from ERS FADS Glossary)

MyPlate
A set of information and tools to help consumers follow the recommendations in the *Dietary Guidelines for Americans, 2010.* The Food Guidance System includes food intake patterns, print and web-based consumer materials, interactive tools, and information for professionals. *MyPlate* states that the amount of food needed varies by age, sex, and level of activity. It provides tables showing recommended daily amounts (or allowances) in terms of number of cups (for fruits, vegetables, and milk), ounces (for grains and meat), and teaspoons for oils. (Definition from ERS FADS Glossary)

Nonedible share
In the ERS LAFA data series in FADS, nonedible share is that portion of a food commodity that is not normally consumed, such as an asparagus stalk, apple core, peach pit, or chicken bones. Data on the nonedible share are from the National Nutrient Database for Standard Reference, compiled by ARS. (Definition from ERS FADS Glossary)

Nutrient availability
Data on the nutrient availability for foods and food groups is from the National Nutrient Database for Standard Reference,[6] compiled by U.S. Department of Agriculture's ARS. It includes amounts of nutrients (water, protein, fats [by type], sugars [by type], vitamins, minerals, etc.) per 100 grams of a food or food group. Nutrient availability by household is also available.

Other loss (cooking loss and uneaten food)
In the ERS LAFA data series in FADS, this type of loss includes all of the losses that occur at the consumer level, including plate waste, spoilage, and cooking losses. This type of loss does not include the nonedible share, which is accounted for separately. This measure is on a per capita per year basis. (Definition from ERS FADS Glossary)

[6]Available: http://ndb.nal.usda.gov/ [September 2014].

Primary weight
In ERS FADS, the weight at a primary distribution level, which is dictated for each commodity by the structure of the marketing system and data availability. In most cases, the primary weight is the farm weight. For meat and poultry, the primary weight is the carcass weight. (Definition from ERS FADS Glossary)

Product weight
See *retail weight*. (Definition from ERS FADS Glossary)

Resident population
Includes all residents (both civilian and Armed Forces) living in the United States. The geographic universe for the resident population is the 50 states and the District of Columbia. For purposes of FADS tables, the measure is the population at the midpoint of the calendar or market year as a proxy for the average population during the time period. (Definition from ERS FADS Glossary)

Resident population plus Armed Forces overseas
Includes residents of the United States and members of the Armed Forces on active duty stationed outside the United States. Military dependents and other U.S. citizens living abroad are not included. (Definition from ERS FADS Glossary)

Retail weight
The weight of a product as it is sold at the retail level. In the meat trade, retail weight is differentiated from carcass-weight equivalent and may or may not include the weight of bone, fat, or additional water. Also called *product weight*. (Definition from ERS FADS Glossary)

Serving
See *dietary guidelines* and *MyPlate.*

Value chain
As product transformations and transactions take place along a chain of interrelated activities from farm to fork, value is added successively. The term "value chain" has thus been used to characterize this interconnected, coordinated set of links and linkages that take place as products move along a continuum between primary production and the consumer. (Definition from FAO[7])

[7]See http://www.fao.org/ag/ags/agribusiness-development/value-chain-training/en/?no_cache=1 [September 2014].

ACRONYMS

AMIS	Agricultural Market Information System
API	application programming interface
ARS	Agricultural Research Service
CGF	Consumer Goods Forum
CIR	Current Industrial Reports
CNPP	Center for Nutrition Policy and Promotion
CNSTAT	Committee on National Statistics
CPC	Central Product Classification
CPI	consumer price index
DAAF	Department of Agriculture and Agri-Food Canada
EPA	U.S. Environmental Protection Agency
ERS	Economic Research Service
EU	European Union
FA	food availability
FADS	Food Availability Data System
FAFH	food away from home
FAH	food at home
FAO	Food and Agriculture Organization of the United Nations
FAPRI	Food and Agricultural Policy Research Institute
FBS	food balance sheet
FCL	FAOSTAT Commodity List
FICRCD	Food Intakes Converted to Retail Commodities Database
FNB	Food and Nutrition Board
FNDDS	Food and Nutrient Database for Dietary Studies
FNS	Food and Nutrition Service
FoodAPS	Food Acquisition and Purchase Survey
FPED	Food Patterns Equivalents Database
FPID	Food Patterns Equivalents Ingredient Database
FUSIONS	Food Use for Social Innovation by Optimizing Waste Prevention Strategies
FWRA	Food Waste Reduction Alliance
GDP	gross domestic product
GNI	gross national income
GS	Global Strategy to Improve Rural and Agricultural Statistics
GTAP	Global Trade Analysis Project

HEI	Healthy Eating Index
HS	Harmonized System
IFPRI	International Food Policy Research Institute
IMPACT	International Model for Policy Analysis of Agricultural Policies and Trade
IOM	Institute of Medicine
IRI	Information Resources Incorporated
LAFA	loss-adjusted food availability
MSW	municipal solid waste
NASS	National Agricultural Statistics Service
NHANES	National Health and Nutrition Examination Survey
NHS	National Household Survey
NRC	National Research Council
OECD	Organisation for Economic Co-operation and Development
PL	private label
PSU	primary sampling units
RW	random weight
SNAP	Supplemental Nutrition Assistance Program
SSA	sub-Saharan Africa
SUA	supply and utilization accounts
UN	United Nations
UNEP	United Nations Environment Programme
UNSD	United Nations Statistical Division
UPC	uniform product code
USDA	U.S. Department of Agriculture
WASDE	World Agricultural Supply and Demand
WBCSD	World Business Council on Sustainable Development
WCA	World Census on Agriculture
WRAP	Waste and Resources Action Programme
WRI	World Resources Institute
WWEIA	What We Eat in America

Appendix B

Agenda

DATA AND RESEARCH TO IMPROVE THE U.S. FOOD AVAILABILITY DATA SYSTEM AND ESTIMATES OF FOOD LOSS A WORKSHOP

April 8 and 9, 2014
~~~~~~~~~~~~
The National Academy of Sciences
500 5th Street NW
Conference Room 201

Objectives:

- Evaluate the data sources and underlying calculations for the U.S. Department of Agriculture, Economic Research Service core Food Availability (FA) data series, Loss-Adjusted Food Availability (LAFA) data series, and the food loss estimates produced in the series.
- Explore and evaluate the potential use of other data sources for the FA data, LAFA data, and food loss conversion factors.
- Develop an understanding of the range of uses of the data for reporting of statistics and trends, economic modeling, and other uses.
- Contrast the content of the data series and calculation methods to international approaches.
- Identify potential alternative approaches and possible improvements to the series based on alternative data sources and calculation methods.

This workshop is sponsored by the Economic Research Service of the U.S. Department of Agriculture
~~~~~~~~~~~~

DAY 1: TUESDAY, APRIL 8, 8:30 AM-5:00 PM, CONFERENCE ROOM 201

8:00-8:30 AM	Registration (conference room 201)
8:30-8:45	Welcome and Introductions - Constance F. Citro (*Director, Committee on National Statistics*) - Mary Muth (*Committee Chair; RTI International*)
8:45-9:00	Background for the Workshop Motivation and Objectives for the Workshop - Mary Bohman (*Administrator, U.S. Department of Agriculture—Economic Research Service [USDA-ERS]*)

SESSION 1: Current Methods, Data, and Uses for the Food Availability System and Food Loss Estimates
MODERATOR: Cheryl Christensen (*Chief of Food Security and Development, USDA-ERS*)

9:00 AM	Food Availability Data—Structure and Uses - Mark Jekanowski (*Chief, Crops Branch, USDA-ERS*)
9:30	Loss-Adjusted Food Availability Data—Structure and Uses and Food Loss Estimates - Jean Buzby (*Chief, Diet, Safety, and Health Economics Branch, USDA-ERS*)
10:00	Q&A with Speakers
10:30	***BREAK***

SESSION 2: Historical and Current Uses of the Data for Economic Modeling and Reporting of Statistical Trends
MODERATOR: Sarah Nusser (*Department of Statistics, Iowa State University*)

11:00 AM	The Food Availability Data System: Importance for Research - Laurian Unnevehr (*Professor Emerita, University of Illinois, Urbana-Champaign*)
11:20	Economic Modeling of Food Consumption, Production, and Policy - Helen Jensen (*Professor, Iowa State University*)
11:40	Q&A with Speakers
12:00 PM	***LUNCH***

1:00	Using the Food Availability Data to Examine Issues of Nutrition and Diet Quality - Susan Krebs-Smith (*Chief, Risk Factor Monitoring and Methods Branch, National Cancer Institute*)
1:20	An Overview of Canadian Food Availability Estimates - Tabitha Rich (*Economist, Agriculture and Agri-Food Canada*)
1:40	Q&A with Speakers
2:00	***BREAK***

SESSION 3: Alternative Approaches for Estimating Food Availability—International and Domestic
MODERATOR: Jay Variyam (*Director, Food Economics Division, USDA-ERS*)

2:30	Overview of FAO Methods - Josef Schmidhuber (*Deputy Director, Statistics Division, FAO*)
2:50	Comparing and Reconciling Food Consumption from Household Surveys and Food Balance Sheets - Klaus Grünberger (*Consultant, Statistics Division, FAO*)
3:10	Potential Uses of Scanner Data and Other Data Resources - Aylin Kumcu (*Agricultural Economist, Food Markets Branch, USDA-ERS*)
3:30	Disaggregation of Food Mixtures in Nutrition Data - Alanna Moshfegh (*Research Leader, Food Surveys Research Group, USDA-ARS*)
3:50	Facilitated Discussion with Panelists and Audience Discussant: Mary Muth (*Committee Chair; RTI International*)

Questions for Discussion:

- Where are the most important knowledge gaps?
- Do data exist to support research to fill any remaining substantial knowledge gaps?
- If not, could such data be generated?
- Are there lessons to be learned from other countries and international organizations?

- Are commodities and commodity groups treated the same within the FA and the LAFA data series?
- What are the most promising opportunities in terms of new data for the FA data series, the LAFA data series, or the associated food loss estimates?

4:30 PM **PLANNED ADJOURNMENT**

DAY 2: WEDNESDAY, APRIL 9, 8:30 AM-11:30 PM, CONFERENCE ROOM 201

8:30 AM Welcome Back and Brief Recap from Day 1
- Mary Muth (*Committee Chair; RTI International*)

SESSION 4: Alternative Approaches for Estimating Food Loss—International and Domestic
MODERATOR: Josef Schmidhuber (*Deputy Director, Statistics Division, FAO*)

8:40 Food Loss and Waste Protocol
- Kai Robertson (*Lead Advisor, World Resources Institute*)

9:00 A Model for Imputing Food Losses in Food Balance Sheets
- Klaus Grünberger (*Consultant, Statistics Division, FAO*)

9:20 Stocktaking of Food Waste in OECD Countries: How Policy Objectives Have Shaped Data Production
- Morvarid Bagherzadeh (*Policy Analyst, OECD*)

9:40 EPA Methods: Sample-Based and Food Availability-Based Methods
- Shelly Schneider (*Principal Environmental Scientist, Franklin Associates*)

10:00 Facilitated Discussion with Panelists and Audience
Discussant: Jean Schwab (*Senior Policy Advisor and Program Manager, U.S. Environmental Protection Agency*)

Questions for Discussion:
- Where are the most important knowledge gaps?
- Do data exist to support research to fill any remaining substantial knowledge gaps?
- If not, could such data be generated?

- Are there lessons to be learned from other countries and international organizations?
- Are commodities and commodity groups treated the same within the FA and the LAFA data series?
- What are the most promising opportunities in terms of new data for the FA data series, the LAFA data series, or the associated food loss estimates?

Workshop Wrap-Up

10:40	Economic Framework for Evaluating the Implications of Food Loss and Waste - Harry de Gorter (*Professor, Cornell University*)
11:00	Q&A
11:10	Final Thoughts - Mary Muth (*Committee Chair; RTI International*) - Jean Buzby (*Chief, Diet, Safety, and Health Economics Branch, USDA-ERS*)

11:30 AM **PLANNED ADJOURNMENT**

Appendix C

Workshop Participants

STEERING COMMITTEE MEMBERS

Susan Krebs-Smith, *Chief, Risk Factor Monitoring and Methods Branch, Applied Research Program, Division of Cancer Prevention and Control, National Cancer Institute*
Mary Muth (Chair), *Director, Food and Nutrition Policy Research Program, RTI International*
Sarah Nusser, *Professor, Department of Statistics, Center for Survey Statistics and Methodology, Iowa State University*
Josef Schmidhuber, *Deputy Director, Statistics Division, UN Food and Agriculture Organization*
Jean Schwab, *Senior Program Analyst, Office of Resource Conservation and Recovery, U.S. Environmental Protection Agency*

SPONSOR (USDA-ERS)

Mary Bohman, *Administrator*
Jean Buzby, *Chief, Diet, Safety, and Health Economics Branch*

MODERATORS

Cheryl Christensen, *Chief of Food Security and Development, USDA-ERS*
Sarah Nusser, *Professor, Department of Statistics, Center for Survey Statistics and Methodology, Iowa State University*

Josef Schmidhuber, *Deputy Director, Statistics Division, UN Food and Agriculture Organization*
Jay Variyam, *Director, Food Economics Division, USDA-ERS*

PRESENTERS

Morvarid Bagherzadeh, *Policy Analyst, OECD*
Jean Buzby, *Chief, Diet, Safety, and Health Economics Branch*
Harry de Gorter, *Professor, Cornell University*
Klaus Grünberger, *Consultant, Statistics Division, Food and Agriculture Organization*
Mark Jekanowski, *Chief, Crops Branch, USDA-ERS*
Helen Jensen, *Professor, Iowa State University*
Susan Krebs-Smith, *Chief, Risk Factor Monitoring and Methods Branch, Applied Research Program, Division of Cancer Prevention and Control, National Cancer Institute*
Aylin Kumcu, *Agricultural Economist, Food Markets Branch, USDA-ERS*
Alanna Moshfegh, *Research Leader, Food Surveys Research Group, USDA-ARS*
Tabitha Rich, *Economist, Agriculture and Agri-Food Canada*
Kai Robertson, *Lead Advisor, World Resources Institute*
Josef Schmidhuber, *Deputy Director, Statistics Division, UN Food and Agriculture Organization*
Shelly Schneider, *Principal Environmental Scientist and Project Manager, Franklin Associates*
Laurian Unnevehr, *Professor Emerita, University of Illinois at Urbana-Champaign*

DISCUSSANTS

Mary Muth (Chair), *Director, Food and Nutrition Policy Research Program, RTI International*
Jean Schwab, *Senior Program Analyst, Office of Resource Conservation and Recovery, U.S. Environmental Protection Agency*

STAFF

Constance Citro, *Director, Committee on National Statistics, DBASSE*
Nancy Kirkendall, *Senior Program Officer, Committee on National Statistics, DBASSE*
Anthony Mann, *Program Coordinator, Committee on National Statistics, DBASSE*
Maria Oria, *Senior Program Officer, Food and Nutrition Board, IOM*

Ann Yaktine, *Interim Board Director, Food and Nutrition Board, IOM*

GUESTS

Mohan Balmoori, *Manager, Sustainability RQ&I, ConAgra Foods* (by WebEx)
Linda Barr, *Chief; Chemicals Management Branch, Office of Resource Conservation and Recovery, U.S. Environmental Protection Agency*
Jeanine Bentley, *Social Science Analyst, Food Economics Division, USDA-ERS*
Mark Denbaly, *Deputy Director for Data, Food Economics Division, USDA-ERS*
Ray DeVirgiliis, *Science Program Associate, ILSI North America*
Erik Dohlman, *Chief, Animal Products and Cost of Production Branch, USDA-ERS*
Stephanie Goodwin, *Health Policy Fellow, Office of Disease Prevention and Health Promotion, HHS, Office of the Assistant Secretary for Health*
Tobias Gumbert, *Research Fellow, University of Muenster*
Dana Gunders, *Staff Scientist, Health Program, Natural Resources Defense Council* (by WebEx)
Kevin Hall, *Senior Investigator, National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health*
Lisa Johnson, *Ph.D. Candidate, NC State* (by WebEx)
Alison Kretser, *ILSI North America*
Ephraim Liebtag, *Deputy Director for Research, Food Economics Division, USDA-ERS*
Carlos Ludena, *Climate Change Economist, Inter-American Development Bank*
Rosanna Morrison, *Assistant Director for Product Coordination and Dissemination, Food Economics Division, USDA-ERS*
Tim Park, *Food Markets Branch, USDA-ERS*
Ted Payne, *U.S. Department of Agriculture Geospatial Program Manager, Enterprise Geospatial Management Office, USDA*
Hope Pillsbury, *Materials Conservation and Recycling Branch, EPA Office of Resource Conservation and Recovery*
Jill Reedy, *Risk Factor Monitoring and Methods Branch, Division of Cancer Control and Population Sciences, National Cancer Institute*
David Ryfisch, *Researcher, Inter-American Development Bank*
Patrick Stover, *Professor and Director, Division of Nutritional Sciences, Cornell University* (by WebEx)
Suzanne Thornsbury, *Senior Advisor for Agricultural Economics and Rural Communities, USDA Office of the Chief Scientist*
Hodan Farah Wells, *Agricultural Economist, USDA-ERS*

Appendix D

Biographical Sketches of Speakers and Steering Committee Members

MORVARID BAGHERZADEH is an economist covering agricultural policies at OECD. Her current projects include stocktaking food waste data and policies relevant to food waste in OECD countries and monitoring developments in the European Union's agricultural policies.

MARY E. BOHMAN is administrator of the Economic Research Service (ERS) of the U.S. Department of Agriculture (USDA). She has served in a number of positions in ERS and was on the Agricultural Sciences faculty at the University of British Columbia.

JEAN C. BUZBY is chief of the Diet, Safety, and Health Economics Branch in the Food Economics Division of USDA/ERS. She oversees research and analysis on topics related to diet and health, including how U.S. food assistance programs affect diet and health, and topics related to food safety.

CHERYL CHRISTENSEN is chief of the Food Security and Development Branch in the Market and Trade Economics Division of USDA/ERS. The branch provides monitoring and analysis of global food security conditions; conducts research on the factors affecting food security and agricultural development; and explores the impact of factors such as climate change on food security in key countries.

CONSTANCE F. CITRO is director of the Committee on National Statistics (CNSTAT) of the National Academy of Sciences, a position she has held since May 2004. She began her career with CNSTAT in 1984.

HARRY DE GORTER is professor in the Charles H. Dyson School of Applied Economics and Management at Cornell University. His research focuses on agriculture and trade policy with recent work on biofuels, food waste, agricultural trade reform, and the Doha Development Agenda.

KLAUS GRUNBERGER is a consultant in the Statistics Division of the United Nations' Food and Agriculture Organization (FAO). He is working on a comparison and reconciliation of food consumption from household surveys and food balance sheets and an econometric model for estimating food losses.

MARK D. JEKANOWSKI is chief of the Crops Branch in the Market and Trade Economics Division of the USDA/ERS, where he oversees research and market outlook activities for grains, oilseeds, cotton, sugar, and specialty crops.

HELEN H. JENSEN is professor of economics, and leads the food and nutrition policy research in the Center for Agricultural and Rural Development at Iowa State University. Her research addresses the economics and design of food and nutrition programs and policies, food insecurity, food demand and markets, and food safety regulations.

SUSAN M. KREBS-SMITH *(steering committee member)* is chief of the Risk Factor Monitoring and Methods Branch, Division of Cancer Control and Population Sciences of the National Cancer Institute. She oversees research on surveillance of risk factors related to cancer, methodological issues to improve the assessment of those factors, and issues related to guidance and food policy.

AYLIN KUMCU is an economist in the Food Economics Division at USDA/ERS. Her research focuses on retail food prices and household demand for food.

JEFFREY T. LAFRANCE *(steering committee member)* is professor of economics at Monash University in Melbourne, Australia. His research interests include food; agricultural and natural resource policy; microeconomic theory, models, and methods; and consumer and producer behavior.

ALANNA MOSHFEGH is research leader of the Food Surveys Research Group at the USDA Beltsville Human Nutrition Research Center. Her research interests and responsibilities focus on food consumption behavior and nutritional adequacy of American diets, food and nutrition policy, and dietary guidelines.

MARY K. MUTH *(steering committee chair)* is director of the Food and Nutrition Policy Research Program at RTI International in North Carolina. She also serves as adjunct associate professor in the Department of Agricultural and Resource Economics at North Carolina State University.

SARAH M. NUSSER *(steering committee member)* is a professor in the Department of Statistics, Center for Survey Statistics and Methodology, at Iowa State University. She also serves as a faculty member in the Ecology and Evolutionary Biology Graduate Program and the Human Computer Interaction Graduate Program.

TABITHA RICH is an economist with Agriculture and Agri-Food Canada. She is currently a research economist focusing on issues related to the economic importance of the agri-food sector and previously worked as a market analyst producing commodity forecasts.

KAI ROBERTSON represents the World Resources Institute as lead advisor for the Food Loss and Waste Protocol, a multistakeholder effort to create the global standard and guidance for measuring food loss and waste.

JOSEF SCHMIDHUBER *(steering committee member)* is deputy director in the Statistics Division of the United Nations Food and Agriculture Organization (FAO). His areas of interest include commodity market analysis and outlook, trade and investment in agriculture, global food and nutrition issues, and climate change.

SHELLY SCHNEIDER is a principal environmental scientist and project manager for Franklin Associates, where she specializes in the collection, analysis, and management of solid waste data and the analysis of solid waste management systems.

JEAN M. SCHWAB *(steering committee member)* is a senior policy advisor and program manager in the Office of Resource Conservation and Recovery at the U.S. Environmental Protection Agency (EPA). Currently, she is leading EPA's new National Food Recovery Initiative.

LAURIAN UNNEVEHR has served on the faculty of the Department of Agricultural and Consumer Economics at the University of Illinois at Urbana-Champaign, where she is now a professor emerita. Her contributions to the economics of food policy include the consumer benefits from agricultural research, the changing structure of food demand, and the economic tradeoffs in food safety and nutrition regulation.

JAY VARIYAM is director of the Food Economics Division at USDA/ERS. His research interests include understanding the determinants of nutrition, diet quality, and diet-related health outcomes, with special focus on the roles of information, nutrition knowledge, and educational attainment.

COMMITTEE ON NATIONAL STATISTICS

The Committee on National Statistics was established in 1972 at the National Academies to improve the statistical methods and information on which public policy decisions are based. The committee carries out studies, workshops, and other activities to foster better measures and fuller understanding of the economy, the environment, public health, crime, education, immigration, poverty, welfare, and other public policy issues. It also evaluates ongoing statistical programs and tracks the statistical policy and coordinating activities of the federal government, serving a unique role at the intersection of statistics and public policy. The committee's work is supported by a consortium of federal agencies through a National Science Foundation grant.

FOOD AND NUTRITION BOARD

The Food and Nutrition Board, established more than 60 years ago, addresses issues of safety and adequacy of the nation's food supply; establishes principles and guidelines of adequate dietary intake; and renders authoritative judgments on the relationships among food intake, nutrition, and health. Its major focus is to evaluate emerging knowledge of nutrient requirements and relationships between diet and the reduction of risk of common chronic diseases and to relate this knowledge to strategies for promoting health and preventing disease in the United States and internationally; and to assess aspects of food science and technology that affect the nutritional quality and safety of food and influence health maintenance and disease prevention.