

Notes

Preface

1. U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS), “U.S. Farmers Plant the Largest Corn Crop Since 1937,” press release (Washington, DC: 29 June 2012); largest ever corn crop prediction from USDA, World Agricultural Outlook Board (WAOB), *World Agricultural Supply and Demand Estimates* (Washington, DC: 12 June 2012), p. 23, and from USDA, NASS, *Quick Stats 2.0*, electronic database, at quickstats.nass.usda.gov, downloaded 11 July 2012.
2. USDA, *Production, Supply and Distribution*, electronic database, at www.fas.usda.gov/psdonline, updated 11 July 2012.
3. National Oceanic and Atmospheric Administration (NOAA), National Weather Service (NWS), “National Forecast Maps,” at www.weather.gov/forecastmaps; NOAA, NWS, St. Louis, MO Weather Forecast Office, at www.crh.noaa.gov/lsx.
4. Andrew Johnson, Jr., “Corn Prices Soar as Midwest Bakes,” *Wall Street Journal*, 9 July 2012; University of Nebraska–Lincoln, National Drought Mitigation Center, “U.S. Drought Monitor,” at droughtmonitor.unl.edu, various dates; USDA, WAOB, *Weekly Weather and Crop Bulletin* (Washington, DC: 11 July 2012), p. 2.

5. USDA, NASS, *Crop Progress* (Washington, DC: various dates); Emiko Terazono and Javier Blas, “US Slashes Corn Production Forecast,” *Financial Times*, 11 July 2012.
6. Chicago Board of Trade (CBOT) futures data from CME Group, “Market Commentary and Analysis: Agriculture,” various dates, at www.cmegroup.com/education/market-commentary/ag/index.html; USDA, op. cit. note 2.
7. CBOT futures data from TradingCharts.com, Inc., “Oilseed & Grain Futures/Commodities Charts/Quotes,” at futures.tradingcharts.com/grains_oilseeds.html, viewed 5 June 2012; International Monetary Fund, “IMF Primary Commodity Prices,” at www.imf.org/external/np/res/commod/index.aspx, updated 6 July 2012.

Chapter 1. Food: The Weak Link

1. U.S. Department of Agriculture (USDA), *Production, Supply and Distribution*, electronic database, at www.fas.usda.gov/psdonline, updated 12 June 2012; U.N. Food and Agriculture Organization (FAO), “FAO Food Price Index,” at www.fao.org/worldfoodsituation/wfs-home/foodpricesindex/en, updated 5 July 2012.
2. Chicago Board of Trade (CBOT) futures data from TradingCharts.com, Inc., “Oilseed & Grain Futures/Commodities Charts/Quotes,” at futures.tradingcharts.com/grains_oilseeds.html, viewed 5 June 2012; International Monetary Fund (IMF), “IMF Primary Commodity Prices,” at www.imf.org/external/np/res/commod/index.aspx, updated 6 July 2012; FAO, *The State of Food Insecurity in the World 2011: How Does International Price Volatility Affect Domestic Economies and Food Security?* (Rome: 2011), pp. 44–47; Ian MacKinnon, “Farmers Fall Prey to Rice Rustlers as Price of Staple Crop Rockets,” (London) *Guardian*, 31 March 2008; Ellen Knickermyer, “In Egypt, Upper Crust Gets the Bread,” *Washington Post*, 5 April 2008; James Bone, “UN Peacekeeper Killed in Haiti Riots Over Food Prices,” (London) *The Times*, 14 April 2008; Ronald Buchanan, “Mexico Protest Prompts Food Price Assurance,” *Financial Times*, 1 February 2007.

3. CBOT futures data from TradingCharts.com, Inc., op. cit. note 2; IMF, op. cit. note 2; Christian Parenti, “The Price of Bread: A Measure of Political Stability,” *Mother Jones*, 19 July 2011.
4. Douglas E. Bowers, Wayne D. Rasmussen, and Gladys L. Baker, *History of Agricultural Price-Support and Adjustment Program, 1933–1985* (Washington, DC: USDA, 1984); Lester R. Brown, *Eco-Economy: Building an Economy for the Earth* (New York: W. W. Norton & Company, 2001), pp. 145–46; historical grain prices from IMF, *International Financial Statistics*, electronic database, at www.imfststatistics.org/imf, various years.
5. U.N. Population Division, *World Population Prospects: The 2010 Revision*, electronic database, at esa.un.org/unpd/wpp/index.htm, updated 3 May 2011; historical grain prices from IMF, op. cit. note 4; USDA, op. cit. note 1; Bowers, Rasmussen, and Baker, op. cit. note 4.
6. Tadlock Cowan, *Conservation Reserve Program: Status and Current Issues* (Washington, DC: Congressional Research Service, 22 January 2010), p. 1.
7. USDA, op. cit. note 1.
8. Ibid.
9. Sandra Postel, *Pillar of Sand* (New York: W. W. Norton & Company, 1999), pp. 13–21; Michon Scott, “Mayan Mysteries,” in National Aeronautics and Space Administration (NASA), Earth Science Data and Information Systems Project, *Supporting Earth Observing Science 2004* (Washington, DC: 2004), pp. 37–43; Jared Diamond, *Collapse: How Societies Choose to Fail or Succeed* (New York: Penguin Group, 2005).
10. Figure 1–1 from FAO, op. cit. note 1; food expenditures from USDA, “Table 7: Food Expenditures by Families and Individuals as a Share of Disposable Personal Income,” at www.ers.usda.gov/briefing/cpi/foodandexpenditures/data/Expenditures_tables/table7.htm, updated 13 July 2011, from International Food Policy Research Institute (IFPRI),

- “Food Price Crisis and Financial Crisis Present Double Threat for Poor People,” press release (Washington, DC: 1 December 2008), and from Joachim von Braun, *Food and Financial Crises: Implications for Agriculture and the Poor* (Washington, DC: IFPRI, 2008), p. 5.
11. FAO, op. cit. note 2, pp. 44–47.
 12. Ibid.; Organisation for Economic Co-operation and Development, *OECD Economic Surveys: India 2011* (Paris: 2011).
 13. Save the Children, *A Life Free from Hunger: Tackling Child Malnutrition* (London: 2012).
 14. Ibid., p. iv; International Institute for Population Sciences (IIPS) and Macro International, *National Family Health Survey (NFHS-3), 2005–06: India: Volume I* (Mumbai, India: IIPS, 2007), p. 269; Susan Horton, “Opportunities for Investments in Nutrition in Low-income Asia,” *Asian Development Review*, vol. 17, nos. 1, 2 (1999), pp. 246–73.
 15. Adam Nossiter, “For Congo Children, Food Today Means None Tomorrow,” *New York Times*, 2 January 2012; Deutsche Welthungerhilfe, IFPRI, and Concern Worldwide, *2011 Global Hunger Index: The Challenge of Hunger: Taming Price Spikes and Excessive Food Price Volatility* (Bonn, Washington, DC; and Dublin: 2011), p. 17.
 16. GlobeScan Inc., “Multi-country Nutrition Poll 2011 Topline Report,” as commissioned by Save the Children (London: 17 February 2012), pp. 5, 11, 12.
 17. U.N. Population Division, op. cit. note 5.
 18. FAO, *The State of Food and Agriculture 2009* (Rome: 2009), p. 12; USDA, op. cit. note 1.
 19. Lester R. Brown, “Exploding U.S. Grain Demand for Automotive Fuel Threatens World Food Security and Political Stability,” *Plan B Update* (Washington, DC: Earth Policy Institute, 3 November 2006); Lester R. Brown, “Distillery Demand for Grain to Fuel Cars Vastly Understated: World

- May Be Facing Highest Grain Prices in History,” *Plan B Update* (Washington, DC: Earth Policy Institute, 4 January 2007); F.O. Licht, *World Ethanol and Biofuels Report*, vol. 10, no. 16 (24 April 2012), p. 323; USDA, op. cit. note 1; USDA, *Feed Grains Database*, electronic database, at www.ers.usda.gov/data-products/feed-grains-database.aspx, downloaded 16 May 2012.
20. Ward’s Automotive Group, *World Motor Vehicle Data 2011* (Southfield, MI: 2011).
 21. USDA, op. cit. note 1.
 22. Countries with water bubbles from Lester R. Brown, *Plan B 2.0: Rescuing a Planet Under Stress and a Civilization in Trouble* (New York: W. W. Norton & Company, 2006), p. 43; from Isam E. Amin et al., “Major Problems Affecting the Principal Aquifers in Lebanon,” in Geological Society of America, *Abstracts with Programs*, vol. 40, no. 6 (2008), p. 471; from Dale Lightfoot, *Survey of Infiltration Karez in Northern Iraq: History and Current Status of Underground Aqueducts* (Paris: UNESCO, September 2009); from “Afghanistan: Groundwater Overuse Could Cause Severe Water Shortage,” *Integrated Regional Information Networks (IRIN) News*, 14 September 2008; and from U.N. Population Division, op. cit. note 5.
 23. USDA, op. cit. note 1; John Briscoe and R. P. S. Malik, *India’s Water Economy: Bracing for a Turbulent Future* (Washington, DC: World Bank, 2006); U.N. Population Division, op. cit. note 5; USDA, *Census of Agriculture: Farm and Ranch Irrigation Survey* (Washington, DC: various years).
 24. Lester R. Brown, *Increasing World Food Output: Problems and Prospects* (Washington, DC: USDA, Economic Research Service (ERS), 1965), pp. 13–14; USDA, op. cit. note 1.
 25. FAO, *FAOSTAT*, electronic database, at faostat.fao.org, updated 23 February 2012.
 26. Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2007: The Physical Science Basis. Contribution of*

- Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge, U.K.: Cambridge University Press, 2007), p. 2; IPCC, *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the IPCC* (Cambridge, U.K.: Cambridge University Press, 2012), pp. 111–14.
27. John E. Sheehy, International Rice Research Institute, e-mail to Janet Larsen, Earth Policy Institute, 1 October 2002; David Lobell and Gregory Asner, “Climate and Management Contributions to Recent Trends in U.S. Agricultural Yields,” *Science*, vol. 299, no. 5609 (14 February 2003), p. 1,032; IPCC, *Climate Change 2007*, op. cit. note 26, p. 749.
 28. USDA, op. cit. note 1; Brian Wright, *International Grain Reserves and Other Instruments to Address Volatility in Grain Markets*, Working Paper presented at the World Grain Forum 2009, St. Petersburg, Russia, 6–7 June 2009, p. 22.
 29. USDA, op. cit. note 1; CBOT futures data from TradingCharts.com, Inc., op. cit. note 2; IMF, op. cit. note 2; *Financial Times*, “In Depth: The Global Food Crisis,” at www.ft.com/foodprices, updated 6 May 2008; USDA, ERS, “U.S. Rice Industry: Background Statistics and Information,” at www.ers.usda.gov/news/ricecoverage.htm, updated 30 April 2008; FAO, “Soaring Food Prices: Facts, Perspectives, Impacts and Actions Required,” paper presented at High-level Conference on World Food Security: The Challenges of Climate Change and Bioenergy, Rome, 3–5 June 2008.
 30. Office of the President, Republic of the Philippines, “RP Assured of 1.5 Million Metric Tons of Rice Supply from Vietnam Annually,” press release (Manila: 26 March 2008); USDA, op. cit. note 1; “Yemen to Seek Australian Food Cooperation,” *WorldGrain.com*, 19 May 2008; “Bahrain to Own Rice Farms in Thailand,” *TradeArabia News Service*, 30 May 2008; Javier Blas, “Nations Make Secret Deals Over Grain,” *Financial Times*, 10 April 2008.

31. GRAIN, *Seized! The 2008 Land Grab for Food and Financial Security* (Barcelona: October 2008); Joachim von Braun and Ruth Meinzen-Dick, “Land Grabbing” by Foreign Investors in Developing Countries, Policy Brief No. 13 (Washington, DC: IFPRI, April 2009); Klaus Deininger and Derek Byerlee, *Rising Global Interest in Farmland: Can It Yield Sustainable and Equitable Benefits?* (Washington, DC: World Bank, January 2011); George C. Schoneveld, *The Anatomy of Large-scale Farmland Acquisitions in Sub-Saharan Africa*, Working Paper 85 (Bogor, Indonesia: Center for International Forestry Research, 2011); Fred Pearce, *The Land Grabbers: The New Fight over Who Owns the Earth* (Boston: Beacon Press, 2012); U.N. World Food Programme, “Countries,” at www.wfp.org/countries, viewed 17 June 2012.
32. Deininger and Byerlee, op. cit. note 31, p. 51; USDA, op. cit. note 1; Karen Frenken and Jean-Marc Faurès, *Irrigation Potential in Africa: A Basin Approach* (Rome: FAO, 1997), at www.fao.org/docrep/w4347e/w4347e00.htm.
33. Deininger and Byerlee, op. cit. note 31, p. 49; John Vidal, “Fears for the World’s Poor Countries as the Rich Grab Land to Grow Food,” (London) *Guardian*, 3 July 2009.

Chapter 2. The Ecology of Population Growth

1. U.N. Population Division, *World Population Prospects: The 2010 Revision*, electronic database, at esa.un.org/unpd/wpp/index.htm, updated 3 May 2011; United Nations, *The World at Six Billion* (New York: October 1999), at www.un.org/esa/population/publications/sixbillion/sixbillion.htm.
2. Lester R. Brown, *The Twenty-Ninth Day* (New York: W. W. Norton & Company, 1978).
3. U.N. Population Division, op. cit. note 1.
4. U.N. Population Division, op. cit. note 1; millions of women in Susheela Singh et al., *Adding It Up: The Costs and Benefits of Investing in Family Planning and Maternal and Newborn Health* (New York: Guttmacher Institute and U.N. Population Fund, 2009), pp. 16–20.

5. U.N. Population Division, *Assumptions Underlying the 2010 Revision* (New York: 2011), at esa.un.org/wpp/Documentation/pdf/WPP2010_ASSUMPTIONS_AND_VARIANTS.pdf.
6. Countries overpumping from Lester R. Brown, *Plan B 2.0: Rescuing a Planet Under Stress and a Civilization in Trouble* (New York: W. W. Norton & Company, 2006), p. 43; from Isam E. Amin et al., “Major Problems Affecting the Principal Aquifers in Lebanon,” in Geological Society of America, *Abstracts with Programs*, vol. 40, no. 6 (2008), p. 471; from Dale Lightfoot, *Survey of Infiltration Karez in Northern Iraq: History and Current Status of Underground Aqueducts* (Paris: UNESCO, September 2009); from “Afghanistan: Groundwater Overuse Could Cause Severe Water Shortage,” *Integrated Regional Information Networks (IRIN) News*, 14 September 2008; and from U.N. Population Division, op. cit. note 1.
7. U.N. Food and Agriculture Organization (FAO), *Review of the State of World Marine Fishery Resources* (Rome: 2011), pp. 12–13.
8. Albert G.J. Tacon, Mohammad R. Hasan, and Marc Metian, *Demand and Supply of Feed Ingredients for Farmed Fish and Crustaceans: Trends and Prospects*, FAO Fisheries and Aquaculture Technical Paper No. 564 (Rome: 2011).
9. U.N. Population Division, op. cit. note 1; FAO, FAOSTAT, electronic database, at faostat.fao.org, updated 23 February 2012.
10. U.N. Convention to Combat Desertification, Regions “Africa” and “Asia,” at www.unccd.int/en/regional-access, viewed 21 June 2012.
11. “Trends in Extent of Forest, 1990-2010” in FAO, *Global Forest Resources Assessment 2010: Global Tables* (Rome: 2010); FAO, FAOSTAT, electronic database, at faostat.fao.org, updated 21 July 2011.

12. U.N. Population Division, op. cit. note 1; population stability defined by a rate of natural increase of -0.4 to 0.4 percent, using data from Population Reference Bureau, *2011 World Population Data Sheet* (Washington, DC: 2011).
13. U.N. Population Division, op. cit. note 1; Population Reference Bureau, op. cit. note 12.
14. Jorge A. Brea, “Population Dynamics in Latin America,” *Population Bulletin*, vol. 58, no. 1 (March 2003); U.N. Population Division, op. cit. note 1.
15. U.N. Population Division, op. cit. note 1.
16. Ibid.; FAO, FAOSTAT, op. cit. note 11.
17. Frank Notestein, “Population—The Long View,” in P. W. Schultz, ed., *Food for the World* (University of Chicago Press: 1945); Population Action International (PAI), “How Demographic Transition Reduces Countries’ Vulnerability to Civil Conflict,” fact sheet (Washington, DC: updated 17 December 2004).
18. U.N. Population Division, op. cit. note 1; FAO, FAOSTAT, op. cit. note 11.
19. Fund for Peace and Foreign Policy, “Failed States,” *Foreign Policy*, July/August 2012, pp. 85–99; U.N. Population Division, op. cit. note 1.
20. U.N. Population Division, op. cit. note 1; Fund for Peace and Foreign Policy, op. cit. note 19.
21. For a discussion of the “demographic bonus,” see Richard P. Cincotta, Robert Engelman, and Daniele Anastasion, *The Security Demographic: Population and Civil Conflict After the Cold War* (Washington, DC: PAI, 2003), pp. 33–36.
22. Andrew Mason, “Population Change and Economic Development: What Have We Learned from the East Asia Experience?” *Applied Population and Policy*, vol. 1, no. 1 (2003), pp. 10–11; U.N. Population Division, op. cit. note 1; International Monetary Fund (IMF), *World Economic*

- Outlook Database*, at www.imf.org/external/pubs/ft/weo/2012/01/weodata/index.aspx, updated April 2012; Kyung Lah, “Japan: Economy Slips to Third in World,” *CNN*, 14 February 2011.
23. U.N. Population Division, op. cit. note 1; IMF, op. cit. note 22.
 24. U.N. Population Division, op. cit. note 1; IMF, “China Economic Outlook,” at www.imf.org/external/country/CHN/rr/2012/020612.pdf, 6 February 2012; IMF, op. cit. note 22; Economist Intelligence Unit, “China: Market Assessment,” at country.eiu.com/China, fact sheet, 1 August 2011; other demographic bonus countries in Cincotta, Engelman, and Anastasion, op. cit. note 21, p. 36.
 25. Cincotta, Engelman, and Anastasion, op. cit. note 21, pp. 27–31.

Chapter 3. Moving Up the Food Chain

1. U.N. Food and Agriculture Organization (FAO), *FISHSTAT*, electronic database, at www.fao.org/fishery/statistics/en, updated 14 March 2012; U.N. Population Division, *World Population Prospects: The 2010 Revision*, electronic database, at esa.un.org/unpd/wpp/index.htm, updated 3 May 2011.
2. FAO, *Review of the State of World Marine Fishery Resources* (Rome: 2011), pp. 12–14.
3. Land area estimate from Stanley Wood, Kate Sebastian, and Sara J. Scherr, *Pilot Analysis of Global Ecosystems: Agroecosystems* (Washington, DC: International Food Policy Research Institute and World Resources Institute, 2000), p. 3.
4. Calories from staple foods from FAO, *FAOSTAT*, electronic database, at faostat.fao.org, updated 2 June 2010; effect of income on demand for animal protein in FAO, *The State of Food and Agriculture 2009: Livestock in the Balance* (Rome: 2009), pp. 11–12.
5. Meat data from Worldwatch Institute, *Signposts 2002*, CD-ROM (Washington, DC: 2002), and from FAO, *FAOSTAT*, electronic database, at faostat.fao.org, updated 23 February 2012; population data for per person calculations from U.N. Population Division, op. cit. note 1.
6. FAO, *State of Food and Agriculture 2009*, op. cit. note 4, pp. 11–12; FAO, op. cit. note 5.
7. Figure 3–1 data for 1950–60 from Worldwatch Institute, op. cit. note 5; data for 1961–2010 from FAO, op. cit. note 5; beef and grasslands from Henning Steinfeld et al., *Livestock’s Long Shadow: Environmental Issues and Options* (Rome: FAO, 2006); conversion ratio of grain to beef based on Allen Baker, *Feed Situation and Outlook* staff, U.S. Department of Agriculture (USDA), Economic Research Service (ERS), discussion with author, 27 April 1992, on Linda Bailey, *Livestock and Poultry Situation* staff, USDA, ERS, discussion with author, 27 April 1992, and on data taken from various issues of *Feedstuffs*; poultry conversion factor derived from data in Robert V. Bishop et al., *The World Poultry Market—Government Intervention and Multilateral Policy Reform* (Washington, DC: USDA, 1990).
8. Figure 3–2 data from USDA, *Production, Supply and Distribution*, electronic database, at www.fas.usda.gov/psonline, updated 12 June 2012.
9. Agriculture reform in China from Bryan Lohmar et al., *China’s Ongoing Agricultural Modernization*, Economic Information Bulletin No. 51 (Washington, DC: USDA, ERS, 2009); number of pigs in China from FAO, op. cit. note 5; traditional pig production in Mindi Schneider, *Feeding China’s Pigs* (Washington, DC: Institute for Agriculture and Trade Policy, 2011), p. 6; large-scale pig production from Fred Gale, Daniel Marti, and Dinghuan Hu, *China’s Volatile Pork Industry* (Washington, DC: USDA, ERS, February 2012); pork consumption from USDA, op. cit. note 8; U.N. Population Division, *World Urbanization Prospects: The 2011 Revision Population Database*, electronic database, at esa.un.org/unpd/wup/unup/index_panel1.html, updated 2011.

10. U.N. Population Division, op. cit. note 1; USDA, op. cit. note 8.
11. FAO, op. cit. note 5; efficiency of poultry production from Mike Donohue, "How Breeding Companies Help Improve Broiler Industry Efficiency," *The Poultry Site*, 20 February 2009; USDA, ERS, "Food Availability: Spreadsheets," at www.ers.usda.gov/Data/FoodConsumption/FoodAvailSpreadsheets.htm, updated 1 February 2011; USDA, op. cit. note 8.
12. Lester R. Brown, *Outgrowing the Earth* (New York: W. W. Norton & Company, 2004), pp. 11–14.
13. FAO, op. cit. note 5; FAO, op. cit. note 1; U.N. Population Division, op. cit. note 1.
14. FAO, op. cit. note 1.
15. Figure 3–3 data and aquaculture production from FAO, op. cit. note 1; early estimates from Earth Policy Institute based on growth rates in FAO, op. cit. note 5, and in FAO, op. cit. note 1.
16. FAO, op. cit. note 1; Rebecca Goldberg and Rosamond Naylor, "Future Seascapes, Fishing, and Fish Farming," *Frontiers in Ecology and the Environment*, vol. 3, no. 1 (February 2005), pp. 21–28; Rosamond L. Naylor et al., "Effects of Aquaculture on World Fish Supplies," *Nature*, 29 June 2000, p. 1,022.
17. USDA, op. cit. note 8; U.N. Population Division, op. cit. note 1; Oliver Flake and Hui Jiang, *India and China: Divergent Markets for U.S. Agricultural Exports* (Washington, DC: USDA, Foreign Agricultural Service, 24 February 2012); Matt Andrejczak, "Tyson Makes Push into India's Chicken Market," *Market Watch*, 30 June 2008; FAO, op. cit. note 5.
18. USDA, op. cit. note 8; U.N. Population Division, op. cit. note 1.
19. FAO, op. cit. note 5; U.N. Population Division, op. cit. note 1.
20. FAO, op. cit. note 5.
21. FAO, op. cit. note 5; FAO, op. cit. note 1.
22. Danilo Domingues Millen et al., "Current Outlook and

- Future Perspectives of Beef Production in Brazil," *Animal Frontiers*, vol. 1, no. 2 (October 2011), pp. 46–51; USDA, op. cit. note 8.
23. Conversion ratio of grain to beef based on Baker, op. cit. note 7, on Bailey, op. cit. note 7, and on data taken from various issues of *Feedstuffs*; pork conversion ratio from Leland Southard, *Livestock and Poultry Situation and Outlook* staff, USDA, ERS, discussion with author, 27 April 1992; eggs calculated from David Harvey, USDA, ERS, discussion with J. Matthew Roney, 9 July 2012; poultry derived from data in Bishop et al., op. cit. note 7; catfish and carp based on Naylor et al., op. cit. note 16.
24. Growth rates calculated from FAO, op. cit. note 5, and from FAO, op. cit. note 1.
25. USDA, op. cit. note 8; Jack Cook, *An Introduction to Hog Feeding Spreads* (Chicago: Chicago Mercantile Exchange, 2009), p. 3.
26. USDA, op. cit. note 8.
27. Meat producers from FAO, op. cit. note 5; soy use for feed from USDA, op. cit. note 8.
28. FAO, op. cit. note 5.
29. S. C. Dhall and Meena Dhall, "Dairy Industry—India's Strength in Its Livestock," *Business Line*, Internet Edition of *Financial Daily* from *The Hindu* group of publications, at www.indiaserver.com/businessline/1997/11/07/stories/03070311.htm, 7 November 1997; Surinder Sud, "India Is Now World's Largest Milk Producer," *India Perspectives*, May 1999, pp. 25–26; A. Banerjee, "Dairying Systems in India," *World Animal Review*, vol. 79, no. 2 (1994).
30. FAO, op. cit. note 5; U.N. Population Division, op. cit. note 1.
31. Dhall and Dhall, op. cit. note 29; Banerjee, op. cit. note 29.
32. John Wade, Adam Branson, and Xiang Qing, *China Grain and Feed Annual Report 2002* (Beijing: USDA, March 2002);

- China's crop residue production and use from Gao Tengyun, "Treatment and Utilization of Crop Straw and Stover in China," *Livestock Research for Rural Development*, vol. 12, no. 1 (February 2000).
33. USDA, ERS, "China's Beef Economy: Production, Marketing, Consumption, and Foreign Trade," *International Agriculture and Trade Reports: China* (Washington, DC: July 1998), p. 28.
 34. S. F. Li, "Aquaculture Research and Its Relation to Development in China," in World Fish Center, *Agricultural Development and the Opportunities for Aquatic Resources Research in China* (Penang, Malaysia: 2001); FAO, op. cit. note 1.
 35. Growth rates based on FAO, op. cit. note 5, and FAO, op. cit. note 1.
 36. USDA, ERS, "Food Availability: Spreadsheets," at www.ers.usda.gov/Data/FoodConsumption/FoodAvailSpreadsheets.htm, updated 1 February 2011; FAO, *FAOSTAT*, op. cit. note 4; Janet Larsen, "Peak Meat: U.S. Meat Consumption Falling," *Data Highlight* (Washington, DC: Earth Policy Institute, 7 March 2012).
 37. U.N. Population Division, op. cit. note 1; FAO, *FAOSTAT*, op. cit. note 4.
 38. U.N. Population Division, op. cit. note 1; USDA, op. cit. note 8.
 39. USDA, op. cit. note 8.

Chapter 4. Food or Fuel?

1. Lester R. Brown, *Food or Fuel: New Competition for the World's Cropland*, Worldwatch Paper 35 (Washington, DC: Worldwatch Institute, March 1980); Constanza Valdes, *Brazil's Ethanol Industry: Looking Forward* (Washington, DC: U.S. Department of Agriculture (USDA), June 2011).
2. Valdes, op. cit. note 1; U.S. use of corn for ethanol production from USDA, *Feed Grains Database*, electronic database, at www.ers.usda.gov/data-products/feed-grains-database.aspx, downloaded 5 June 2012.

3. U.S. Department of Energy (DOE), Energy Information Administration (EIA), "U.S. All Grades All Formulations Retail Gasoline Prices," at www.eia.gov/petroleum/data.cfm#prices, viewed 6 June 2012; International Monetary Fund (IMF), "IMF Primary Commodity Prices," at www.imf.org/external/np/res/commod/index.aspx, updated 6 July 2012; Chicago Board of Trade futures data from TradingCharts.com, Inc., "Oilseed & Grain Futures/Commodities Charts/Quotes," at futures.tradingcharts.com/grains_oilseeds.html, viewed 11 June 2012; conversion of corn to ethanol from Renewable Fuels Association (RFA), "Ethanol Facts: Agriculture," at ethanolrfa.org/pages/ethanol-facts-agriculture, updated March 2012.
4. Pace of ethanol plant construction from Lester R. Brown, "Exploding U.S. Grain Demand for Automotive Fuel Threatens World Food Security and Political Stability," *Plan B Update* (Washington, DC: Earth Policy Institute, 3 November 2006).
5. Figure 4–1 from USDA, *Production, Supply, and Distribution*, electronic database, at www.fas.usda.gov/psdonline, updated 12 June 2012; USDA, op. cit. note 2.
6. IMF, op. cit. note 3; Chicago Board of Trade, op. cit. note 3.
7. Grain required to fill an SUV tank calculated from corn to ethanol conversion from RFA, op. cit. note 3, and minimum consumption level for survival from World Food Programme (WFP) and United Nations High Commissioner for Refugees, *WFP/UNHCR Guidelines for Estimating Food and Nutritional Needs in Emergencies* (Rome: 1997); potential ethanol production from entire U.S. grain harvest calculated using data from USDA, op. cit. note 5; U.S. gasoline consumption from DOE, EIA, *Annual Energy Outlook 2012 Early Release* (Washington, DC: February 2012), and from energy conversion factor from Oak Ridge National Laboratory, "Bioenergy Conversion Factors," at bioenergy.ornl.gov/papers/misc/energy_conv.html, viewed 12 June 2012; number of people who could be fed calculated from USDA, op. cit. note 2, and

- from U.N. Population Division, *World Population Prospects: The 2010 Revision*, electronic database, at esa.un.org/unpd/wpp/index.htm, updated 3 May 2011. Because the total grain consumption includes industrial use and seed, this is thought to be a conservative estimate.
8. Ethanol production from F.O. Licht, *World Ethanol and Biofuels Report*, vol. 10, no. 16 (24 April 2012), p. 323; share of gasoline demand from DOE, op. cit. note 7, with energy conversion factor from Oak Ridge National Laboratory, op. cit. note 7.
 9. F.O. Licht, *World Ethanol and Biofuels Report*, vol. 6, no. 4 (23 October 2007), p. 63; F.O. Licht, *World Ethanol and Biofuels Report*, vol. 7, no. 18 (26 May 2009), p. 3; F.O. Licht, op. cit. note 8.
 10. Biodiesel production data from F.O. Licht, cited in Suzanne Hunt and Peter Stair, "Biofuels Hit a Gusher," *Vital Signs 2006–2007* (Washington, DC: Worldwatch Institute, 2006), pp. 40–41; F.O. Licht, *World Ethanol and Biofuels Report*, vol. 7, no. 2 (23 September 2008), p. 29; F.O. Licht, *World Ethanol and Biofuels Report*, vol. 10, no. 14 (27 March 2012), p. 281; ethanol quantity from F.O. Licht, op. cit. note 8.
 11. F.O. Licht, 27 March 2012, op. cit. note 10, p. 281.
 12. Table oils from USDA, op. cit. note 5; Bob Flach et al., *EU-27 Annual Biofuels Report* (Washington, DC: USDA, 2011); European feedstocks from "Biofuel Blending Targets and Production in Selected Countries," in Keith L. Kline et al., *Biofuel Feedstock Assessment For Selected Countries* (Oak Ridge, TN: Oak Ridge National Laboratory, February 2008); U.S. feedstocks from DOE, EIA, *Monthly Biodiesel Production Report* (Washington, DC: 5 June 2012).
 13. Yields per acre from D. J. Connor and C. G. Hernandez, "Crops for Biofuel: Current Status and Prospects for the Future," in R. W. Howarth and S. Bringezu, eds., *Biofuels: Environmental Consequences and Interactions with Changing Land Use* (Ithaca, NY: Scientific Committee on Problems of

- the Environment, Cornell University, 2009), p. 68, and from U.N. Food and Agriculture Organization (FAO), *The State of Food and Agriculture 2008* (Rome: 2008), pp. 16, 57.
14. Yields per acre from FAO, op. cit. note 13, p. 16.
 15. Net energy ratios from Connor and Hernandez, op. cit. note 13, p. 70.
 16. *Ibid.*; gallons per acre from FAO, op. cit. note 13, p. 16.
 17. Number of automobiles from Ward's Automotive Group, *World Motor Vehicle Data 2011* (Southfield, MI: 2011); global income distribution based on Isabel Ortiz and Matthew Cummins, *Global Inequality: Beyond the Bottom Billion—A Rapid Review of Income Distribution in 141 Countries* (New York: UNICEF, 2011), with gross domestic product from World Bank, *World DataBank*, electronic database, at databank.worldbank.org, downloaded 11 June 2012, and world population from op. cit. note 7.
 18. Hillary Rodham Clinton, "Remarks at the Clinton Global Initiative Closing Plenary," speech, 25 September 2009; IMF, op. cit. note 3; Chicago Board of Trade, op. cit. note 3; examples of unrest from Lester R. Brown, "World Facing Huge New Challenge on Food Front: Business-as-Usual Not a Viable Option," *Plan B Update* (Washington, DC: Earth Policy Institute, 16 April 2008), and from Thomas L. Friedman, "The Other Arab Spring," *New York Times*, 7 April 2012.
 19. Celia W. Dugger, "As Prices Soar, U.S. Food Aid Buys Less," *New York Times*, 29 September 2007; number of child deaths from malnutrition from Save the Children, *A Life Free from Hunger: Tackling Child Malnutrition* (London: 2012), p. iv; countries where the WFP supplies food aid include both Emergency Operations and Protracted Relief and Recovery Operations from WFP, "Operations," at www.wfp.org/operations, viewed 12 June 2012.
 20. Doug Koplow, *A Boon to Bad Biofuels: Federal Tax Credits and Mandates Underwrite Environmental Damage at*

- Taxpayer Expense* (Cambridge, MA: Earth Track and Friends of the Earth, 2009); Susan Reidy, "Biofuels Industry Post-Tax Breaks," *Biofuels Business Quarterly*, 20 March 2012.
21. U.S. Environmental Protection Agency (EPA), "EPA Finalizes Regulations for the National Renewable Fuel Standard Program for 2010 and Beyond," regulatory announcement (Washington, DC: February 2010); USDA, *A USDA Regional Roadmap to Meeting the Biofuels Goals of the Renewable Fuels Standard by 2022*, Strategic Production Report (Washington, DC: 23 June 2010).
 22. David Biello, "The False Promise of Biofuels," *Scientific American*, vol. 305, no. 2 (August 2011), pp. 59–65; Robert Wisner, "Cellulosic Ethanol: Will the Mandates be Met?" *Ag Marketing Resource Center Energy Newsletter*, University of Iowa, September 2009.
 23. Mario Parker, "Range Fuels Cellulosic Ethanol Plant Fails, U.S. Pulls Plug," *Bloomberg*, 2 December 2011; Robert F. Service, "Is There a Road Ahead for Cellulosic Ethanol?" *Science*, vol. 329, no. 5,993 (13 August 2010), pp. 784–85; F.O. Licht, *World Ethanol and Biofuels Report*, various issues.
 24. European Commission, "Biofuels and Other Renewable Energy in the Transport Sector," at ec.europa.eu/energy/renewables/biofuels/biofuels_en.htm, viewed 19 June 2012; land acquisitions for biofuel production from George C. Schoneveld, *The Anatomy of Large-scale Farmland Acquisitions in Sub-Saharan Africa*, Working Paper 85 (Bogor, Indonesia: Center for International Forestry Research, 2011), pp. 1, 7–9; jatropa as a biofuel from Promode Kant and Shuirong Wu, "The Extraordinary Collapse of Jatropa as a Global Biofuel," *Environmental Science & Technology*, vol. 45 (August 2011), pp. 7,114–15.
 25. Opposition to biofuels in Barbara Lewis, "EU Energy Chief Against Higher Biofuel Target for Now," *Reuters*, 7 February 2012, from Greenpeace, "Fueling the Flames: Biodiesels Tested: How Europe's Biofuels Policy Threatens the Climate,"

- fact sheet (Vienna, Austria: 2011), and from WWF, "WWF Position on Biofuels in the EU," position paper (Brussels: July 2007); deforestation as a result of biofuel production from Catherine Bowyer, *Anticipated Indirect Land Use Change Associated with Expanded Use of Biofuels and Bioliqids in the EU—An Analysis of the National Renewable Energy Action Plans* (London: Institute for European Environmental Policy, 2010); "land grabbing" from Lorenzo Cotula, "The International Political Economy of the Global Land Rush: A Critical Appraisal of Trends, Scale, Geography and Drivers," *The Journal of Peasant Studies*, vol. 39, nos. 3–4 (July–October 2012), pp. 649–80.
26. Industry stance from RFA, *Accelerating Industry Innovation: Ethanol Industry Outlook 2012* (Washington, DC: 2012); emissions in National Research Council, *Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy* (Washington, DC: National Academies Press, 2011); Emanuela Menichetti and Martina Otto, "Energy Balance & Greenhouse Gas Emissions of Biofuels from a Life Cycle Perspective," in Howarth and Bringezu, *op. cit.* note 13; Timothy Searchinger et al., "Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land-Use Change," *Nature*, vol. 319, (29 February 2008), pp. 1,238–40; Paul Crutzen et al., "N₂O Release from Agro-Biofuel Production Negates Global Warming Reduction by Replacing Fossil Fuels," *Atmospheric Chemistry and Physics*, vol. 7, no. 4 (August 2007), pp. 11,191–205.
 27. Pedro Alvarez et al., *Fundamentals of a Sustainable U.S. Biofuels Policy*, research paper (Houston, TX: James A. Baker III Institute for Public Policy, Rice University, 2010); National Research Council, *op. cit.* note 26.
 28. F.O. Licht, *op. cit.* note 8, pp. 317, 323; David Shaffer, "Ethanol Makers Feel the Squeeze," *Minneapolis Star Tribune*, 5 June 2012; Roxana Hegeman, "Ethanol Makers Idle Plants Amid High Corn Prices," *Associated Press*, 29 June 2012.

29. U.S. automotive fuel from DOE, EIA, "U.S. Product Supplied of Finished Motor Gasoline (Thousand Barrels)," at eia.gov/petroleum/data.cfm, updated 28 July 2011; size of U.S. motor vehicle fleet based on Polk Company data cited in National Automobile Dealers Association, *NADA DATA 2012* (McLean, VA: 2012); Lester R. Brown, "U.S. Gasoline Use Declining: Keystone XL Pipeline Not Needed," *Plan B Update* (Washington, DC: Earth Policy Institute, 6 October 2011).
30. Corporate Average Fuel Economy (CAFE) standard in 2025 from U.S. Department of Transportation (DOT), National Highway Traffic Safety Administration (NHTSA), "President Obama Announces Historic 54.5 mpg Fuel Efficiency Standard," press release (Washington, DC: 29 July 2011); EPA-estimated fuel efficiency for 2008–12 from DOT, NHTSA, *Summary of Fuel Economy Performance* (Washington, DC: 12 March 2012).
31. Cost of wind energy to power cars from Michael B. McElroy, "Time to Electrify: Reducing Our Dependence on Imported Oil—While Addressing the Threat of Climate Change," *Harvard Magazine* (July/August 2011), pp. 36–39.
32. For more information, see Lester R. Brown, "Paving the Planet: Cars and Crops Competing for Land," *Eco-Economy Update* (Washington, DC: Earth Policy Institute, 14 February 2001).
33. For more information, see Lester R. Brown, *World on the Edge* (New York: W. W. Norton & Company, 2011).

Chapter 5. Eroding Soils Darkening Our Future

1. Walter C. Lowdermilk, *Conquest of the Land Through 7,000 Years*, USDA Bulletin No. 99 (Washington, DC: U.S. Department of Agriculture (USDA), Natural Resources Conservation Service, 1939).
2. Lowdermilk, op. cit. note 1, p. 10.
3. One third is author's estimate.

4. David R. Montgomery, *Dirt: The Erosion of Civilizations* (London: University of California Press, Ltd., 2007), p. 23.
5. U.N. Food and Agriculture Organization (FAO), *FAOSTAT*, electronic database, at faostat.fao.org, updated 23 February 2012.
6. USDA, *Summary Report: 2007 Natural Resources Inventory* (Washington, DC: 2009).
7. Asmat Raza, *Pakistan Grain and Feed Annual Report 2011* (Islamabad, Pakistan: USDA Foreign Agricultural Service, 2011), p. 3.
8. Yang Youlin, Victor Squires, and Lu Qi, eds., *Global Alarm: Dust and Sandstorms from the World's Drylands* (Bangkok: Secretariat of the U.N. Convention to Combat Desertification, 2002), pp. 15–45.
9. John Steinbeck, *The Grapes of Wrath* (New York: The Viking Press, 1939).
10. FAO, *The State of Food and Agriculture 1995* (Rome: 1995), p. 175.
11. *Ibid.*; USDA, *Production, Supply, and Distribution*, electronic database, at www.fas.usda.gov/psdonline/, updated 12 June 2012.
12. Laurie J. Schmidt, "From the Dust Bowl to the Sahel," *NASA Earth Observatory*, 18 May 2001; Reggie Royston, "China's Dust Storms Raise Fears of Impending Catastrophe," *National Geographic News*, 1 June 2001.
13. Organisation for Economic Co-Operation and Development (OECD), "Agricultural Policy Reform in China," policy brief (Paris: 2005); FAO, op. cit. note 5; FAO, "Country Pasture/Forage Resource Profiles," at www.fao.org/countryprofiles/index.asp?lang=en&iso3=CHN&subj=4, updated 2006.
14. Wang Tao et al., "A Study on Spatial-temporal Changes of Sandy Desertified Land During Last 5 Decades in North China," *Acta Geographica Sinica*, vol. 59 (2004), pp. 203–12.

15. U.S. Embassy in Beijing, "Desert Mergers and Acquisitions," *Beijing Environment, Science, and Technology Update* (Beijing: 19 July 2002), p. 2.
16. Cara Anna, "Huge Sandstorm Covers Beijing, Turns Sky Orange," *Associated Press*, 20 March 2010; Christopher Bodeen, "China's Sandstorms Blast Beijing with Dust, Sand," *Associated Press*, 22 March 2010.
17. Ibid.
18. Lee Eun-joo and Kang Chan-su, "Yellow Dust Season to be Longer, More Severe," *Korea JoongAng Daily*, 2 April 2012; Song Sang-ho, "Nation Hit by Worst-Ever Yellow Dust Storm," *Korea Herald*, 21 March 2010.
19. Howard W. French, "China's Growing Deserts Are Suffocating Korea," *New York Times*, 14 April 2002.
20. Lee and Kang, op. cit. note 18.
21. Ann Schrader, "Latest Import from China: Haze," *Denver Post*, 18 April 2001.
22. Economic impacts from Ning Ai, "Integrated Impact of Yellow-dust Storms: A Regional Case Study in China," *Massachusetts Institute of Technology Department of Urban Studies and Planning*, September 2003; dust in Caribbean from Paul Brown, "4x4s Replace the Desert Camel and Whip Up a Worldwide Dust Storm," (London) *Guardian*, 20 August 2004.
23. Brown, op. cit. note 22.
24. Ibid.
25. U.N. Population Division, *World Population Prospects: The 2010 Revision*, electronic database, at esa.un.org/unpd/wpp/index.htm, updated 3 May 2011; Government of Nigeria, *Combating Desertification and Mitigating the Effects of Drought in Nigeria*, National Report on the Implementation of the United Nations Convention to Combat Desertification (Nigeria: November 1999).

26. U.N. Population Division, op. cit. note 25; Figure 5–1 from FAO, op. cit. note 5.
27. FAO, "Nigeria Overview," *FAOSTAT*, electronic database, at faostat.fao.org, updated 21 July 2011.
28. FAO, op. cit. note 5.
29. Ibid.
30. African Development Bank and Organisation for Economic Co-operation and Development, *African Economic Outlook 2007* (Tunis and Paris: 2007), p. 386; Bouteflika in Kaci Racelma, "Algeria Worries over Desertification," *Africa News*, 3 January 2007; USDA, op. cit. note 11; "Algeria to Convert Large Cereal Land to Tree Planting," *Reuters*, 8 December 2000.
31. Land from U.N. Food and Agriculture Organization (FAO), *FAOSTAT*, electronic database, at faostat.fao.org, updated 21 July 2011; livestock from FAO, op. cit. note 5; U.N. Population Division, op. cit. note 25; A. S. Ajai et al., "Desertification/Land Degradation Status Mapping of India," *Current Science*, vol. 97, no. 10 (25 November 2009), pp. 1,478–83.
32. U.N. Environment Programme, *Afghanistan: Post-Conflict Environmental Assessment* (Geneva: 2003), p. 52.
33. "Afghanistan: Environmental Crisis Looms as Conflict Goes On," *Integrated Regional Information Networks (IRIN) News*, 30 July 2007.
34. Liz Sly, "Iraq in Throes of Environmental Catastrophe, Experts Say," *Los Angeles Times*, 30 July 2009.
35. NASA, "Dust Storm Over Iraq," *Earth Observatory*, 7 July 2009; NASA, "Dust Storm Over Iran," *Earth Observatory*, 23 July 2009.
36. U.N. Population Division, op. cit. note 25; FAO, op. cit. note 5; Iranian News Agency, "Official Warns of Impending Desertification Catastrophe in Southeast Iran," *BBC International Reports*, 29 September 2002.

37. FAO and U.N. World Food Programme (WFP), *Special Report: FAO/WFP Crop and Food Security Assessment Mission to Lesotho* (Rome: May 2002); U.N. Population Division, op. cit. note 25.
38. Michael Grunwald, "Bizarre Weather Ravages Africans' Crops," *Washington Post*, 7 January 2003; USDA, op. cit. note 11; WFP, "Lesotho," at www.wfp.org/countries, viewed 10 May 2012.
39. USDA, op. cit. note 11.
40. Ibid.; FAO, *Global Forest Resources Assessment 2005* (Rome: 2006), p. 193; WFP, "Haiti," at www.wfp.org/countries, viewed 10 May 2012.

Chapter 6. Peak Water and Food Scarcity

1. Jacob W. Kijne, *Unlocking the Water Potential of Agriculture* (Rome: U.N. Food and Agriculture Organization (FAO), 2003), p. 26; calculation based on 1,000 tons of water for 1 ton of grain from FAO, *Yield Response to Water* (Rome: 1979).
2. Agricultural water use from I. A. Shiklomanov, "Assessment of Water Resources and Water Availability in the World," *Report for the Comprehensive Assessment of the Freshwater Resources of the World* (St. Petersburg, Russia: State Hydrological Institute, 1998), cited in Peter H. Gleick, *The World's Water 2000–2001* (Washington, DC: Island Press, 2000), p. 53; FAO, *AQUASTAT: Review of Agricultural Water Use per Country*, at www.fao.org/nr/water/aquastat/water_use_agr/index.stm, viewed 13 April 2012.
3. Agricultural timeline from Sandra Postel, *Pillar of Sand* (New York: W. W. Norton & Company, 1999), p. 5; civilizations from Mohamed El-Ashry, Najib Saab, and Bashar Zeitoon, eds., *Arab Environment: Water—Sustainable Management of a Scarce Resource* (Beirut, Lebanon: Arab Forum for Environment and Development, 2010), p. xi.
4. Irrigated area from FAO, FAOSTAT, electronic database, at faostat.fao.org, updated 21 July 2011, with 1950 estimate from Earth Policy Institute.

5. FAO, op. cit. note 4; U.N. Population Division, *World Population Prospects: The 2010 Revision*, electronic database, at esa.un.org/unpd/wpp/index.htm, updated 3 May 2011.
6. World grain from irrigation from Mark W. Rosegrant, Ximing Cai, and Sarah A. Cline, *Food Policy Report: Global Water Outlook to 2025: Averting an Impending Crisis* (Washington, DC: International Food Policy Research Institute, A 2020 Vision for Food, Agriculture, and the Environment Initiative, 2002), p. 24; China irrigation from Jian Xie et al., *Addressing China's Water Scarcity: Recommendations for Selected Water Resource Management Issues* (Washington, DC: World Bank, 2009), p. 21; India and United States irrigation figures are author's estimates.
7. World Commission on Dams, *Dams and Development: A New Framework for Decision-Making* (London: Earthscan, 2000), pp. xxix, 8–13.
8. John Opie, *Ogallala: Water for a Dry Land*, 2nd ed. (Lincoln, NE: University of Nebraska Press, 2000), p. 3; Michael Ma, "Northern Cities Sinking as Water Table Falls," *South China Morning Post*, 11 August 2001; Craig S. Smith, "Saudis Worry as They Waste Their Scarce Water," *New York Times*, 26 January 2003.
9. World Commission on Dams, op. cit. note 7, pp. 8–13; FAO, *Summary Report: State of the World's Land and Water Resources for Food and Agriculture* (Rome: 2011), p. 16; Tushaar Shah, *Taming the Anarchy: Groundwater Governance in South Asia* (Washington, DC: RFF Press, 2009); Sanjay Pahuja et al., *Deep Wells and Prudence: Towards Pragmatic Action for Addressing Groundwater Overexploitation in India* (Washington, DC: World Bank, January 2010).
10. Table 6–1 from Lester R. Brown, *Plan B 2.0: Rescuing a Planet Under Stress and a Civilization in Trouble* (New York: W. W. Norton & Company, 2006), p. 43; from Isam E. Amin et al., "Major Problems Affecting the Principal Aquifers in Lebanon," in Geological Society of America, *Abstracts with Programs*, vol. 40, no. 6 (2008), p. 471; from Dale Lightfoot,

- Survey of Infiltration Karez in Northern Iraq: History and Current Status of Underground Aqueducts* (Paris: UNESCO, September 2009); from "Afghanistan: Groundwater Overuse Could Cause Severe Water Shortage," *Integrated Regional Information Networks (IRIN) News*, 14 September 2008; and from U.N. Population Division, op. cit. note 5.
11. Postel, op. cit. note 3, pp. 77–78; Smith, op. cit. note 8; U.S. Department of Agriculture (USDA), *Production, Supply and Distribution*, electronic database, at www.fas.usda.gov/psdonline, updated 12 June 2012.
 12. Andrew England, "Saudis to Phase Out Wheat Production," *Financial Times*, 10 April 2008; Summer Said and Tim Falconer, "A Desert Kingdom's Quest for Food Security," *Wall Street Journal*, 16 May 2010; Souhail Karam, "Saudi Arabia Scraps Wheat Growing to Save Water," *Reuters*, 8 January 2008; USDA, op. cit. note 11; U.N. Population Division, op. cit. note 5.
 13. Shawki Barghouti, "Water Sector Overview," in El-Ashry, Saab, and Zeitoon, op. cit. note 3, pp. 11–12; Javid Hassan, "Kingdom Leads in Desalination, But Needs More to Meet Demand," *Arab News* (Riyadh), 22 March 2006.
 14. Javier Blas, "Saudis Get First Taste of Foreign Harvest," *Financial Times*, 4 March 2009; Said and Falconer, op. cit. note 12.
 15. Aquifer depletion from FAO, "Yemen," *AQUASTAT Country Profile*, at www.fao.org/nr/water/aquastat/countries/yemen/index.stm, updated 2009, and from Mario Zappacosta, Tayeb El Hassani, and Jan Delbaere, *Special Report: FAO/WFP Crop and Food Security Assessment Mission to Yemen* (Rome: FAO and U.N. World Food Programme, December 2009), p. 5; tap water availability from Keith Oblitas, *Project Performance Assessment Report: Yemen* (Washington, DC: World Bank, 22 February 2006), p. 1; Sana'a population from U.N. Population Division, *World Urbanization Prospects: The 2011 Revision Population Database*, at esa.un.org/unpd/wup/unup, updated 5 April 2012.

16. USDA, op. cit. note 11; U.S. Department of Energy, Energy Information Administration, *Country Analysis Briefs: Yemen* (Washington, DC: February 2012); UNICEF, *Tracking Progress on Child and Maternal Nutrition: A Survival and Development Priority* (New York: November 2009), p. 10; International Monetary Fund, *World Economic Outlook Database*, at www.imf.org/external/data.htm, updated April 2012.
17. Fund for Peace and Foreign Policy, "Failed States," *Foreign Policy*, July/August 2012, pp. 85–99; Barak A. Salmoni, Bryce Loidolt, and Madeleine Wells, *Regime and Periphery in Northern Yemen: The Huthi Phenomenon* (Arlington, VA: RAND Corporation, 2010).
18. U.N. Population Division, op. cit. note 5; FAO, "Syrian Arab Republic," "Iraq," and "Turkey," *AQUASTAT Country Profiles*, at www.fao.org/nr/water/aquastat/countries/index.stm, updated 2009; Theib Oweis, "Rethinking Water Use," *Syria Today*, January 2010; Republic of Turkey, General Directorate of State Hydraulic Works, *Turkey Water Report 2009* (Ankara: 2009), pp. 36–50; Missy Ryan, "Drought Takes Toll on Iraq Revival Effort," *Reuters*, 23 July 2009; Christina Leb, *SHARE Case Studies: The Tigris-Euphrates Joint Technical Committee—Deadlocked* (Gland, Switzerland: International Union for Conservation of Nature, Water Programme, 2008).
19. Harald D. Frederiksen, "The World Water Crisis and International Security," *Middle East Policy Council*, vol. 16, no. 4 (Winter 2009), pp. 76–89.
20. Syria well drilling from Oweis, op. cit. note 18; overpumping in Syria from Francesca de Châtel, "Mining the Deep," *Syria Today*, January 2010; Iraq well drilling from Lightfoot, op. cit. note 10, pp. 21–27, 30, and from NGO Coordination Committee for Iraq (NCCI), "Water Scarcity in the Land of Two Ancient Rivers," NCCI op-ed, at www.ncciraq.org, 3 August 2010; USDA, op. cit. note 11.

21. U.N. Population Division, op. cit. note 5; USDA, op. cit. note 11; Hashemite Kingdom of Jordan, Ministry of Water and Irrigation, "Ground Water Policy," at mwi.gov.jo/sites/en-us/SitePages/WaterPolicies/GroundWaterPolicy.aspx, viewed 7 May 2012; FAO, "Jordan," *AQUASTAT Country Profile*, at www.fao.org/nr/water/aquastat/countries/jordan/index.stm, updated 2009.
22. USDA, op. cit. note 11; U.N. Population Division, op. cit. note 5.
23. Michael Ma, op. cit. note 8; Jian Xie et al., op. cit. note 6, pp. xix–xxiii, 9; share of China's grain harvest from the North China Plain based on Hong Yang and Alexander Zehnder, "China's Regional Water Scarcity and Implications for Grain Supply and Trade," *Environment and Planning A*, vol. 33 (2001), p. 83, and on "Output of Major Farm Products," in National Bureau of Statistics of China, *China Statistical Yearbook 2011* (Beijing: China Statistics Press, 2011), at www.stats.gov.cn/english.
24. Figure of 130 million is author's estimate, based on World Bank, *China: Agenda for Water Sector Strategy for North China* (Washington, DC: April 2001), pp. vii, xi; U.N. Population Division, op. cit. note 5; USDA, op. cit. note 11; Ma, op. cit. note 8.
25. Ma, op. cit. note 8.
26. Steven Mufson, "As Economy Booms, China Faces Major Water Shortage," *Washington Post*, 16 March 2010; World Bank, op. cit. note 24, pp. vii, xi.
27. Fred Pearce, "Asian Farmers Sucking the Continent Dry," *New Scientist*, 25 August 2004; Indian wells from P. S. Thenkabil et al., "Irrigated Area Maps and Statistics for India Using Remote Sensing Techniques: A Significant Breakthrough," *Remote Sensing*, vol. 50 (2009) pp. 50–67; top stressed states and subsidized electricity from Somini Sengupta, "India Digs Deeper, but Wells Are Drying Up," *New York Times*, 30 September 2006.

28. Census of India, "Provisional Population Totals Paper 1 of 2011—Tamil Nadu," at censusindia.gov.in, updated 2011; Pearce, op. cit. note 27.
29. Pearce, op. cit. note 27; Sengupta, op. cit. note 27.
30. Historical U.S. irrigated area compiled by Earth Policy Institute from USDA, *1987 Census of Agriculture: Farm and Ranch Irrigation Survey (1988)* (Washington, DC: 1989), p. 1, and from USDA, *2007 Census of Agriculture: Farm and Ranch Irrigation Survey (2008)* (Washington, DC: November 2009), pp. 3–4.
31. Ibid.; Colorado area loss from Colorado Water Conservation Board, *Statewide Water Supply Initiative 2010 Report* (Denver, CO: January 2011), section 4, p. 26; Bridget R. Scanlon et al., "Groundwater Depletion and Sustainability of Irrigation in the U.S. High Plains and Central Valley," *Proceedings of the National Academy of Sciences*, vol. 109, no. 24 (12 June 2012), pp. 9,320–25.
32. U.N. Population Division, op. cit. note 5; Guanajuato groundwater from Tushaar Shah et al., *The Global Groundwater Situation: Overview of Opportunities and Challenges* (Colombo, Sri Lanka: International Water Management Institute (IWMI), 2000), pp. 1–2; Hermosillo aquifer from U.N. Development Programme, *Human Development Report 2006* (Gordonsville, VA: Palgrave Macmillan, 2006), p. 146; percent of aquifers overpumped from National Water Commission of Mexico, *Statistics on Water in Mexico, 2010 Edition* (Coyoacán: June 2010); Mexico's grain situation from Benjamin Juarez and Erik Hansen, *Mexico Grain and Feed Annual Report Update* (Mexico City: USDA, Foreign Agricultural Service, 23 April 2012).
33. Nile as a source of conflict in National Intelligence Council, *Global Water Security: Intelligence Community Assessment* (Washington, DC: 2012); U.N. Population Division, op. cit. note 5; Egypt grain imports from USDA, op. cit. note 11; Egypt precipitation in FAO, "Egypt," *AQUASTAT Country*

- Profile*, at www.fao.org/nr/water/aquastat/countries/egypt/index.stm, updated 2009.
34. Nile Waters Agreement from Postel, *op. cit.* note 3, pp. 141–49; entities acquiring land from GRAIN, *Seized! The 2008 Land Grab for Food and Financial Security* (Barcelona: October 2008), and from John Vidal, “How Food and Water are Driving a 21st-Century African Land Grab,” (London) *Observer*, 7 March 2010.
 35. Vidal, *op. cit.* note 34; South Sudan from David K. Deng, *The New Frontier: A Baseline Survey of Large-scale Land-based Investment in Southern Sudan* (New York: Norwegian People’s Aid, March 2011); Nile flow from Postel, *op. cit.* note 3, pp. 71, 141–49.
 36. “A Dam Nuisance: Egypt and Ethiopia Quarrel over Water,” *Economist*, 20 April 2011; “Egypt: Water Challenges Forcing a Rethink on Usage,” *IRIN News*, 18 October 2011.
 37. USDA, *op. cit.* note 11; U.N. Population Division, *op. cit.* note 5.
 38. *Ibid.*
 39. Tom Yulsman and Brendon Bosworth, “Running Toward Empty?” *Climate Central*, 18 January 2011; Peter Gleick and Matthew Heberger, “The Coming Mega Drought,” *Scientific American*, vol. 306, no. 1 (2 January 2012), p. 14.
 40. Richard Stone, “Mayhem on the Mekong,” *Science*, vol. 333 (12 August 2011), pp. 814–18; Tom Fawthrop, “Mekong River Hydroelectric Dam Threatens Livelihoods and Endangered Species in Landlocked Laos,” (London) *Guardian*, 13 March 2009.
 41. FAO, *op. cit.* note 2; Postel, *op. cit.* note 3, pp. 44, 57–58, 71–73; Indus flow from Peter Bosshard, “The Forgotten Downstream Victims of Large Dams,” *International Rivers Blog*, at www.internationalrivers.org/en/blog/peter-bosshard, 21 June 2010.
 42. U.N. Population Division, *op. cit.* note 5; John Briscoe and

- Usman Qamar, *Pakistan’s Water Economy Running Dry* (Oxford: World Bank, 2009), p. xiv.
43. Noel Gollehon and William Quinby, “Irrigation in the American West: Area, Water and Economic Activity,” *Water Resources Development*, vol. 16, no. 2 (2000), pp. 187–95; Patrick O’Driscoll, “Dry West Sends Out for Water,” *USA Today*, 27 July 2004.
 44. Zack Donohew and Gary Libecap, “Water Transfer Data: Water Strategist Transactions,” *UCSB Bren School of Environmental Science and Management*, updated February 2010; Felicity Barringer, “Empty Fields Fill Urban Basins and Farmers’ Pockets,” *New York Times*, 23 October 2011.
 45. Joey Bunch, “Cities’ Water Needs Uprooting Colorado Farms,” *Denver Post*, 11 July 2004; Bruce Finley, “Colorado Farmland Goes Dry as Suburbs Secure Water Supplies,” *Denver Post*, updated 22 February 2012.
 46. U.N. World Water Assessment Programme, *The United Nations World Water Development Report 3: Water in a Changing World* (Paris: UNESCO and Earthscan, 2009), p. 99; R. Srinivasan, “The Politics of Water,” *Info Change Agenda*, issue 3 (October 2005); U.N. Population Division, *op. cit.* note 15.
 47. Srinivasan, *op. cit.* note 46; Pearce, *op. cit.* note 27; Minister’s quip from John Briscoe and R. P. S. Malik, *India’s Water Economy: Bracing for a Turbulent Future* (Washington, DC: World Bank, 2006), p. xix.
 48. Water to grain ratio from FAO, *op. cit.* note 1.

Chapter 7. Grain Yields Starting to Plateau

1. World grain from U.S. Department of Agriculture (USDA), with data for 1950–59 from Worldwatch Institute, *Signposts 2002*, CD-ROM (Washington, DC: 2001), and data for 1960–2011 from USDA, *Production, Supply and Distribution*, electronic database, at www.fas.usda.gov/psdonline, updated 10 May 2012.

2. Ibid.
3. Lester R. Brown, *Increasing World Food Output: Problems and Prospects* (Washington, DC: USDA, Economic Research Service, 1965), pp. 13–16; USDA, op. cit. note 1.
4. USDA, with 1950 from Worldwatch Institute, op. cit. note 1; USDA, op. cit. note 1; USDA, National Agricultural Statistics Service (NASS), *Quick Stats 2.0*, electronic database, at quickstats.nass.usda.gov, downloaded 24 May 2012.
5. David B. Lobell, Kenneth G. Cassman, and Christopher B. Field, “Crop Yield Gaps: Their Importance, Magnitudes, and Causes,” *Annual Review of Environment and Resources*, vol. 34 (2009), pp. 179–204; USDA, op. cit. note 1; Iowa from USDA, op. cit. note 4.
6. U.N. Food and Agriculture Organization (FAO), *FAOSTAT*, electronic database, available at faostat.fao.org, updated 26 September 2011.
7. North China Plain production based on Hong Yang and Alexander Zehnder, “China’s Regional Water Scarcity and Implications for Grain Supply and Trade,” *Environment and Planning A*, vol. 33 (2001).
8. USDA, “Common Wheat: Plant Profile,” at plants.usda.gov, viewed 27 July 2012; USDA, op. cit. note 1; FAO, *FAOSTAT*, electronic database, available at faostat.fao.org, updated 23 February 2012.
9. Wheat yields from FAO, op. cit. note 8.
10. Mir B. Ali, Nora L. Brooks, and Robert G. McElroy, *Characteristics of U.S. Wheat Farming: A Snapshot* (Washington, DC: USDA, June 2000), pp. 3–9; S. P. Wani et al., “Rainfed Agriculture – Past Trends and Future Prospects,” in Suhas P. Wani, Johan Rockström, and Theib Oweis, eds., *Rainfed Agriculture: Unlocking the Potential* (Oxfordshire, U.K.: Centre for Agricultural Bioscience International, 2009), p. 3; USDA, op. cit. note 1; FAO, op. cit. note 8.

11. Surajit K. De Datta, *Principles and Practices of Rice Production* (Los Baños, Philippines: International Rice Research Institute, 1981).
12. Stefan Siebert et al., “Global Patterns of Cropland Use Intensity,” *Remote Sensing*, vol. 2, no. 7 (24 June 2010), pp. 1,625–43; USDA, op. cit. note 1.
13. De Datta, op. cit. note 11, pp. 12–14; USDA, op. cit. note 1; USDA, op. cit. note 4.
14. Brown, op. cit. note 3, pp. 13–16; Dana G. Dalrymple, *Development and Spread of Semi-dwarf Varieties of Wheat and Rice in the United States: An International Perspective* (Washington, DC: USDA, 1980), pp. 2–3.
15. David Biello, “Norman Borlaug: Wheat Breeder Who Averted Famine with a ‘Green Revolution,’” *Scientific American News Blog*, at www.scientificamerican.com/blog, 14 September 2009; Dalrymple, op. cit. note 14, p. 31; Louis P. Reitz, “New Wheats and Social Progress,” *Science*, vol. 169, no. 3949 (4 September 1970), pp. 952–55; USDA, op. cit. note 1.
16. Robert Chandler, *An Adventure in Applied Science: A History of the International Rice Research Institute* (Manila, Philippines: International Rice Research Institute, 1992), pp. xv, 103, 145, 175.
17. Chandler, op. cit. note 16, pp. 103, 109, 113, 145; Reitz, op. cit. note 15.
18. Paul W. Heisey, “Science, Technology, and Prospects for Growth in U.S. Corn Yields,” *Amber Waves* (Washington, DC: USDA, December 2009); USDA, op. cit. note 4.
19. History of corn hybrids from Heisey, op. cit. note 18; hybrids and crowding from Graeme L. Hammer, “Can Changes in Canopy and/or Root System Architecture Explain Historical Maize Yield Trends in the U.S. Corn Belt?” *Crop Science*, vol. 49, no. 1 (January/February 2009), pp. 299–312; plants per acre from USDA, *Crop Production: 1965 Annual Survey* (Washington, DC: 20 December 1965), p. 106, and from

- USDA, *Crop Production: 2010 Annual Survey* (Washington, DC: 9 November 2010), p. 26.
20. Lobell, Cassman, and Field, op. cit. note 5.
 21. Irrigation from Lester R. Brown, "Eradicating Hunger: A Growing Challenge," in *State of the World 2001* (New York: W. W. Norton & Company, 2001), pp. 52–53, and from FAO, *FAOSTAT*, electronic database, at faostat.fao.org, updated 21 July 2011.
 22. Justus von Liebig from J. R. McNeill and Verena Winiwarter, "Breaking the Sod: Humankind, History, and Soil," *Science*, vol. 304, no. 5677 (11 June 2004), pp. 1,627–29; grain production from USDA, with data for 1950–59 from Worldwatch Institute, op. cit. note 1, and data for 1960–2011 from USDA, op. cit. note 1; fertilizer data from FAO, *FAOSTAT*, electronic database, at faostat.fao.org, updated 26 July 2011, from FAO, *Fertilizer Yearbook* (Rome: various years), from International Fertilizer Industry Association (IFA), *IFADATA*, electronic database, at www.fertilizer.org/ifa/ifadata/search, downloaded 18 August 2010, from Patrick Heffer and Michel Prud'homme, *Fertilizer Outlook 2010–2014* (Paris: IFA, June 2010), p. 5, and from Patrick Heffer, *Medium-Term Outlook for World Agriculture and Fertilizer Demand 2011/12–2016/17* (Paris: IFA, June 2012), p. 4.
 23. U.N. Population Division, *World Urbanization Prospects: The 2011 Revision Population Database*, electronic database, at esa.un.org/unpd/wup/unup/index_panel1.html, updated 2011; fertilizer data from IFA, op. cit. note 22, from Heffer and Prud'homme, op. cit. note 22, p. 5, and from IFA, *Fertilizer Consumption 2009/10–2014/15 Country Reports* (Paris: June 2010), pp. 2, 3, 6, 7, 15–17, 26, 30, 31.
 24. USDA, op. cit. note 1; fertilizer data from IFA, op. cit. note 22, from Heffer, op. cit. note 22, p. 28, from IFA, *Fertilizer Consumption 2010/11 – 2015/16 Country Reports* (Paris: June 2011), p.23, and from IFA, *Fertilizer Consumption 2011/12 – 2016/17 Country Reports* (Paris: June 2012), pp. 9, 21.

25. USDA, op. cit. note 1; IFA, *Fertilizer Consumption 2011/12 – 2016/17*, op. cit. note 24, pp. 9, 21; Peter Vitousek et al., "Nutrient Imbalances in Agricultural Development," *Science*, vol. 324, no. 5934 (19 June 2009), pp. 1,519–20; crop rotation systems from Carmen Sandretto and James Payne, "Soil Management and Conservation," in Keith Wiebe and Noel Gollehon, eds., *Agricultural Resources and Environmental Indicators* (Washington, DC: USDA, 2006), pp. 97–100; W. C. Lindemann and C. R. Glover, "Nitrogen Fixation by Legumes," *New Mexico State University Cooperative Extension Service* (Las Cruces, NM: May 2003).
26. USDA, op. cit. note 1; agriculture in Africa from Marco A. Quifiones, Norman E. Borlaug, and Christopher R. Dowswell, "A Fertilizer-Based Green Revolution for Africa," in Roland J. Buresh, Pedro A. Sanchez, and Frank Calhoun, eds., *Replenishing Soil Fertility in Africa* (Madison, WI: Soil Science Society of America and American Society of Agronomy, 1997), pp. 81–95; soil quality in Africa from Natasha Gilbert, "Dirt Poor," *Nature*, vol. 483 (29 March 2012), pp. 525–27.
27. Celia W. Dugger, "Ending Famine, Simply by Ignoring the Experts," *New York Times*, 2 December 2007; United Nations Development Programme, Regional Bureau for Africa, *Africa Human Development Report 2012: Towards a Food Secure Future* (New York: May 2012); USDA, op. cit. note 1.
28. USDA, op. cit. note 1; Brown, op. cit. note 3, pp. 13–16.
29. Worldwatch Institute, op. cit. note 1; USDA, op. cit. note 1.
30. Growth rates calculated from 1950–59 data from Worldwatch Institute, op. cit. note 1, with 1960–2011 data from USDA, op. cit. note 1.
31. Brown, op. cit. note 3, pp. 13–16; USDA, op. cit. note 1; International Monetary Fund, *International Financial Statistics*, electronic database, at www.imfstatistics.org/imf, various years; and FAO, *FAOSTAT*, electronic database, available at faostat.fao.org, updated 5 August 2011.

32. USDA, op. cit. note 1.
33. Figure 7–1 data from FAO, op. cit. note 8.
34. Kenneth G. Cassman, “Meeting Cereal Demand While Protecting Natural Resources and Improving Environmental Quality,” *Annual Review of Environmental Resources*, vol. 28 (2003), pp. 315–58.
35. USDA, op. cit. note 1.
36. Figure 7–2 data from *ibid.*
37. USDA, op. cit. note 1; IFA, *Fertilizer Consumption 2009/10–2014/15*, op. cit. note 23, pp. 2, 3, 6, 7, 15–17, 26, 30, 31.
38. FAO, op. cit. note 8.
39. USDA, op. cit. note 1.

Chapter 8. Rising Temperature, Rising Food Prices

1. Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge, U.K.: Cambridge University Press, 2007), p. 107.
2. IPCC, *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the IPCC* (Cambridge, U.K.: Cambridge University Press, 2012), pp. 111–14.
3. Figure 8–1 from National Aeronautics and Space Administration (NASA), Goddard Institute for Space Studies (GISS), “Global Land-Ocean Temperature Index in 0.01 Degrees Celsius,” at data.giss.nasa.gov/gistemp/taledata/GLB.Ts+dSST.txt, updated May 2012; projections from James Hansen et al., “Global Surface Temperature Change,” *Reviews of Geophysics*, vol. 48, no. RG4004 (14 December 2010); IPCC, op. cit. note 1, pp. 237, 749; Cecilia Bitz, “Polar Amplification,” *Real Climate*, blog, at www.realclimate.org, 2 January 2006.
4. Pedro Sanchez, “The Climate Change–Soil Fertility–Food Security Nexus,” speech, Sustainable Food Security for All by 2020, Bonn, Germany, 4–6 September 2002.
5. Mohan K. Wali et al., “Assessing Terrestrial Ecosystem Sustainability,” *Nature & Resources*, vol. 35, part 4 (October–December 1999), pp. 21–33.
6. Shaobing Peng et al., “Rice Yields Decline with Higher Night Temperature from Global Warming,” *Proceedings of the National Academy of Sciences*, vol. 101, no. 27 (6 July 2004), pp. 9,971–75; National Academy of Sciences, “Warmer Evening Temperatures Lower Rice Yields,” press release (Washington, DC: 29 June 2004); U.N. Environment Programme (UNEP), “Climate Change: Billions Across the Tropics Face Hunger and Starvation as Big Drop in Crop Yields Forecast,” press release (Nairobi: 8 November 2001); Wolfram Schlenker and Michael Roberts, “Nonlinear Temperature Effects Indicate Severe Damages to U.S. Crop Yields Under Climate Change,” *Proceedings of the National Academy of Sciences*, vol. 106, no. 37 (15 September 2009), pp. 15,594–98; Liangzhi You et al., “Impact of Growing Season Temperature on Wheat Productivity in China,” *Agricultural and Forest Meteorology*, vol. 146, no. 6–7 (15 June 2009), pp. 1,009–14.
7. David Lobell and Gregory Asner, “Climate and Management Contributions to Recent Trends in U.S. Agricultural Yields,” *Science*, vol. 299, no. 5609 (14 February 2003), p. 1,032; John E. Sheehy, International Rice Research Institute, e-mail to Janet Larsen, Earth Policy Institute, 1 October 2002.
8. World Glacier Monitoring Service, “Preliminary Glacier Mass Balance Data 2009/2010,” at www.geo.uzh.ch/microsite/wgms/mbb/sum10.html, updated 28 March 2012; World Glacier Monitoring Service, “Glacier Mass Balance Data 2006 and 2007,” at www.geo.uzh.ch/wgms/mbb/mbb10/sum07.html, updated 30 January 2009.
9. Lester R. Brown, “Melting Mountain Glaciers Will Shrink Grain Harvests in China and India,” *Plan B Update*

- (Washington, DC: Earth Policy Institute, 20 March 2008).
10. Clifford Coonan, "China's Water Supply Could be Cut Off as Tibet's Glaciers Melt," (London) *The Independent*, 31 May 2007; UNEP, *Global Outlook for Ice and Snow* (Nairobi: 2007), p. 131; population figures from Walter W. Immerzeel, Ludovicus P. H. van Beek, and Marc F. P. Bierkens, "Climate Change Will Affect the Asian Water Towers," *Science*, vol. 328, no. 5984 (11 June 2010), pp. 1,382–85.
 11. Yao Tandong, Institute of Tibetan Plateau Research, Chinese Academy of Sciences, e-mail to Alexandra Giese, Earth Policy Institute, 8 September 2010; "Glacier Study Reveals Chilling Prediction," *China Daily*, 23 September 2004; "China Warns of 'Ecological Catastrophe' from Tibet's Melting Glaciers," *Agence France-Presse*, 5 October 2004.
 12. U.S. Department of Agriculture (USDA), *Production, Supply and Distribution*, electronic database, at www.fas.usda.gov/psdonline, updated 12 June 2012.
 13. UNEP, op. cit. note 10, pp. 103–31; Mehrdad Khalili, "The Climate of Iran: North, South, Kavir (Desert), Mountains," *San'ate Hamlo Naql*, March 1997, pp. 48–53.
 14. James Painter, "Huge Bolivian Glacier Disappears," *BBC News*, 12 May 2009; Walter Vergara et al., "The Potential Consequences of Rapid Glacier Retreat in the Northern Andes," *LCR Sustainable Development Working Paper No. 32* (Washington, DC: World Bank, 2009).
 15. Leslie Josephs, "Global Warming Threatens Double-Trouble for Peru: Shrinking Glaciers and a Water Shortage," *Associated Press*, 12 February 2007; *Citation World Atlas* (Union, NJ: Hammond World Atlas Corporation, 2004); Lonnie Thompson, "Receding Glaciers Erase Records of Climate History," *Science News*, 14 February 2009.
 16. Josephs, op. cit. note 15; U.N. Population Division, *World Population Prospects: The 2010 Revision*, electronic database, at esa.un.org/unpd/wpp, updated 3 May 2011.

17. Barbara Fraser, "Glaciers Go, Leaving Drought, Conflict, and Tension in Andes," *The Daily Climate*, 19 May 2009.
18. Michael Kiparsky and Peter Gleick, *Climate Change and California Water Resources: A Survey and Summary of the Literature* (Oakland, CA: Pacific Institute, 2003); Timothy Cavagnaro et al., *Climate Change: Challenges and Solutions for California Agricultural Landscapes* (Sacramento, CA: California Climate Change Center, 2006).
19. Pacific Northwest National Laboratory, "Global Warming to Squeeze Western Mountains Dry by 2050," press release (Richland, WA: 16 February 2004); L. Ruby Leung et al., "Mid-Century Ensemble Regional Climate Change Scenarios for the Western United States," *Climatic Change*, vol. 62, no. 1–3 (January 2004), pp. 75–113; Michael J. Scott et al., "Climate Change and Adaptation in Irrigated Agriculture—A Case Study of the Yakima River," in *UCOWR/NIWR Conference, Water Allocation: Economics and the Environment* (Carbondale, IL: Universities Council on Water Resources, 2004).
20. UNEP, op. cit. note 10, pp. 100, 103; Martin Vermeer and Stefan Rahmstorf, "Global Sea Level Linked to Global Temperature," *Proceedings of the National Academy of Sciences*, vol. 106, no. 51 (22 December 2009), pp. 21,527–32; W. T. Pfeffer, J. T. Harper, and S. O'Neel, "Kinematic Constraints on Glacier Contributions to 21st-Century Sea-Level Rise," *Science*, vol. 321, no. 5894 (5 September 2008), pp. 1,340–43; U.N. Population Division, op. cit. note 16; World Bank, *World Development Report 1999/2000* (New York: Oxford University Press, 2000), p. 100; IPCC, *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge, U.K.: Cambridge University Press, 2007), p. 485; U.N. Development Programme, *Human Development Report 2007/2008: Fighting Climate Change* (New York: 2007), p. 100; USDA, op. cit. note 12.

21. IPCC, op. cit. note 20, p. 485.
22. Aiguo Dai, "Characteristics and Trends in Various Forms of the Palmer Drought Severity Index During 1900–2008," *Journal of Geophysical Research*, vol. 116, no. D12 (29 June 2011); Aiguo Dai, National Center for Atmospheric Research, e-mail to Emily Adams, Earth Policy Institute, 13 June 2012.
23. Susan Solomon et al., "Irreversible Climate Change Due to Carbon Dioxide Emissions," *Proceedings of the National Academy of Sciences*, vol. 106, no. 6 (10 February 2009), pp. 1,704–09; National Oceanic and Atmospheric Administration/Earth System Research Laboratory, "Atmospheric Carbon Dioxide—Mauna Loa," at www.esrl.noaa.gov/gmd/ccgg/trends/co2_data_mlo.html, updated 5 June 2012; Joseph Romm, "Desertification: The Next Dust Bowl," *Nature*, vol. 478, no. 7370 (27 October 2011), pp. 450–51; Richard Seager et al., "Model Projections of an Imminent Transition to a More Arid Climate in Southwestern North America," *Science*, vol. 316, no. 5828 (25 May 2007), pp. 1,181–84.
24. A. L. Westerling et al., "Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity," *Science*, vol. 313 (18 August 2006), pp. 940–43; Donald McKenzie et al., "Climate Change, Wildfire, and Conservation," *Conservation Biology*, vol. 18, no. 4 (August 2004), pp. 890–902.
25. USDA, op. cit. note 12.
26. Janet Larsen, "Setting the Record Straight: More than 52,000 Europeans Died from Heat in Summer," *Plan B Update* (Washington, DC: Earth Policy Institute, 28 July 2006); Peter Griffiths, "Record Heatwave Bakes Britain," *Reuters*, 12 August 2003; Peter Talks, *European Union Grain and Feed Semi-Annual 2003* (Washington, DC: USDA, Foreign Agricultural Service, 11 December 2003).
27. Jeff Masters, "Colin Takes Aim at Bermuda; the Great Russian Heat Wave of 2010: 102°F in Moscow," *Dr. Jeff Masters' WunderBlog, Weather Underground*, at www.wunderground.com/blog/JeffMasters, 6 August 2010; Anna Smolchenko,

- "Fires Cost Russia '300 Billion Dollars' in Deforestation," *Agence France-Presse*, 26 August 2010; Debby Guha-Saspir et al., *Annual Disaster Statistical Review 2010: The Numbers and Trends* (Louvain-la-Neuve, Belgium: Center for Research on the Epidemiology of Disasters, 2011), p. 12; USDA, op. cit. note 12; Catherine Belton, Jack Farchy, and Javier Blas, "Russia Grain Export Ban Sparks Price Fears," *Financial Times*, 5 August 2010; Yelena Vassilieva and Mary Ellen Smith, *Ban on Grain Exports from Russia Come to Force on August 15* (Moscow: USDA, Foreign Agricultural Service, 6 August 2010).
28. Heather Buchman, "Some 100-Degree Heat Streaks Still Going in Texas," *AccuWeather News*, 12 August 2011; Bill Zeeble, "Texas Ag Commissioner: 'Pray for Rain,'" *KERA News*, 10 August 2011; Blair Fannin, "Updated 2011 Texas Agricultural Drought Losses Total \$7.62 Billion," *AgriLife Today*, 21 March 2012; Kate Galbraith, "As Drought Intensifies, Texas Ranchers Sell Cattle," *Texas Tribune*, 19 July 2011; U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center, "State of the Climate National Overview—Annual 2011," at www.ncdc.noaa.gov/sotc/national/2011/13, updated 19 January 2012.
29. IPCC, op. cit. note 2, p. 13.
30. Albert Keidel, *China's Looming Crisis—Inflation Returns*, Policy Brief 54 (Washington, DC: Carnegie Endowment for International Peace, September 2007).
31. USDA, op. cit. note 12; U.N. Population Division, op. cit. note 16.
32. "Cereal Offenders," *The Economist*, 27 May 2008; Fred H. Sanderson, "The Great Food Fumble," *Science*, vol. 188 (9 May 1975), pp. 503–09; U.S. Department of the Treasury, "Major Foreign Holders of Treasury Securities," current and historical data tables, at www.ustreas.gov/tic/mfh.txt, updated 30 April 2012.

Chapter 9. China and the Soybean Challenge

1. T. Hymowitz and W. R. Shurtleff, “Debunking Soybean Myths and Legends in the Historical and Popular Literature,” *Crop Science*, vol. 45 (2005), pp. 473–76; W. J. Morse et al., *Soybeans: Culture and Varieties*, Farmers’ Bulletin 1520 (Washington, DC: U.S. Department of Agriculture (USDA), August 1949), p. 2.
2. Theodore Hymowitz, “Soybeans: The Success Story” in Jules Janick and James Simon, eds., *Advances in New Crops* (Portland, OR: Timber Press, 1990), pp. 159–63; production data from USDA, National Agricultural Statistics Service, *Quick Stats 2.0*, electronic database, at quickstats.nass.usda.gov, downloaded 29 March 2012.
3. Lester R. Brown, “Meat Production Rises,” in Worldwatch Institute, *Vital Signs 2002* (New York: W. W. Norton & Company, 2002), pp. 28–29; H. J. Dutton, “History of the Development of Soy Oil for Edible Uses,” *Journal of the American Oil Chemists Society*, vol. 58, no. 3 (1981), pp. 234–36; Ray Hansen, “Soyfood Profile,” Iowa State University Agricultural Marketing Resource Center, at agmrc.org, updated May 2011.
4. Figure 9–1 data from USDA, *Production, Supply, and Distribution*, electronic database, at www.fas.usda.gov/psdonline, updated 10 May 2012; D. H. Baker, “D.E. (Gene) Becker and the Evolution of the Corn-Soybean Meal Diet for Pigs,” *Illinois Swine Research Reports* (2003), pp. 101–04; Jack Cook, *An Introduction to Hog Feeding Spreads* (Chicago: Chicago Mercantile Exchange, 2009), p. 3.
5. Hymowitz and Shurtleff, op. cit. note 1.
6. USDA, op. cit. note 2; USDA, op. cit. note 4.
7. Grain and soybean prices from International Monetary Fund, *International Financial Statistics*, electronic database, at www.imfstatistics.org/imf, various years; Fred H. Sanderson, “The Great Food Fumble,” *Science*, vol. 188 (9 May 1975), pp. 503–09; Marty McVey, Phil Baumel, and Bob Wisner, “Brazilian Soybeans—What is the Potential?” *AgDM Newsletter*, October 2000; USDA, op. cit. note 4.
8. USDA, op. cit. note 4.
9. Ibid.
10. Ibid.
11. U.N. Food and Agriculture Organization, *FAOSTAT*, electronic database, at faostat.fao.org, updated 21 December 2011; USDA, op. cit. note 4; “China Increasing Soybean Imports Due to Record Pig Numbers,” *WATT AgNet*, 21 April 2011; Mindi Schneider, *Feeding China’s Pigs* (Washington, DC: Institute for Agriculture and Trade Policy, 2011); Tony C. Dreibus, “China Soybean Imports Jump 6.3% as South America Shipments Rise,” *Bloomberg News*, 17 January 2012; United Soybean Board, *Market View Database*, electronic database, at usb.adayana.com:8080/usb/jsp/login.jsp, downloaded 14 June 2012.
12. Figure 9–2 data from USDA, op. cit. note 4.
13. China’s self-sufficiency goals discussed in Cheng Fang and John C. Beghin, *Food Self-Sufficiency, Comparative Advantage, and Agricultural Trade: A Policy Analysis Matrix for Chinese Agriculture*, working paper (Ames, IA: Center for Agricultural and Rural Development and Department of Economics, Iowa State University, October 2000); Lester R. Brown, *Who Will Feed China* (New York: W. W. Norton & Company, 1995).
14. USDA, op. cit. note 4; U.N. Population Division, *World Population Prospects: The 2010 Revision*, electronic database, at <http://esa.un.org/unpd/wpp/index.htm>, updated 3 May 2011.
15. USDA, op. cit. note 4.
16. Ibid.
17. Ibid.; U.N. Population Division, op. cit. note 14; “Biofuel Blending Targets and Production in Selected Countries,”

- in Keith L. Kline et al., *Biofuel Feedstock Assessment For Selected Countries* (Oak Ridge, TN: Oak Ridge National Laboratory, February 2008).
18. USDA, op. cit. note 4.
 19. Figure 9–3 data from *ibid.*
 20. W. C. Lindemann and C. R. Glover, “Nitrogen Fixation by Legumes,” New Mexico State University Cooperative Extension Service Guide A-129 (Las Cruces, NM: May 2003).
 21. USDA data from 1950–1963 in Worldwatch Institute, *Signposts 2001*, CD-ROM (Washington, DC: 2001); 1964–2011 from USDA, op. cit. note 4.
 22. WWF-UK, *Soya and the Cerrado: Brazil’s Forgotten Jewel* (Godalming, U.K.: 2011).
 23. Rudi J. van der Ent, “Origin and Fate of Atmospheric Moisture over Continents,” *Water Resources Research*, vol. 46 (2010); WWF-Brazil, “Cerrado: Birthplace of the Waters,” fact sheet (Brasilia: 2012); Eneas Salati and Peter B. Vose, “Amazon Basin: A System in Equilibrium,” *Science*, vol. 225 (13 July 1984), pp. 129–38.
 24. WWF-UK, op. cit. note 22; WWF-Brazil, op. cit. note 23; Rhett A. Butler, “Calculating Deforestation Figures for the Amazon,” Mongabay.com, viewed 27 June 2012; Brazil’s National Institute for Space Research, “Projeto Prodes: Monitoramento Da Floresta Amazônica Brasileira Por Satélite,” at obt.inpe.br/prodes, viewed 27 June 2012.
 25. WWF-UK, op. cit. note 22; Lester R. Brown, “Growing Demand for Soybeans Threatens Amazon Rainforest,” *Plan B Update* (Washington, DC: Earth Policy Institute, 30 December 2009).
 26. Marcia N. Macedo et al., “Decoupling of Deforestation and Soy Production in the South Amazon During the Late 2000s,” *Proceedings of the National Academy of Sciences*, vol.

- 109, no. 4 (24 January 2012), pp. 1,341–46; Rhett A. Butler, “As Amazon Deforestation Falls, Food Production Rises,” Mongabay.com, 9 January 2012.
27. Butler, op. cit. note 26; Rhett A. Butler, “Monitoring Deforestation: an Interview with Gilberto Camara, Head of Brazil’s Space Agency INPE,” Mongabay.com, 8 February 2011.
28. USDA, Economic Research Service, “Food Availability: Spreadsheets,” at www.ers.usda.gov/Data/FoodConsumption/FoodAvailSpreadsheets.htm, updated 1 February 2011; USDA, op. cit. note 4; Janet Larsen, “Peak Meat: U.S. Meat Consumption Falling,” *Data Highlight* (Washington, DC: Earth Policy Institute, 7 March 2012).

Chapter 10. The Global Land Rush

1. Chicago Board of Trade futures data from TradingCharts.com, Inc., “Oilseed & Grain Futures/Commodities Charts/Quotes,” at futures.tradingcharts.com/grains_oilseeds.html, viewed 5 June 2012; International Monetary Fund, “IMF Primary Commodity Prices,” at www.imf.org/external/np/res/commod/index.aspx, updated 6 July 2012; U.N. Food and Agriculture Organization (FAO), “Soaring Food Prices: Facts, Perspectives, Impacts and Actions Required,” paper presented at High-level Conference on World Food Security: The Challenges of Climate Change and Bioenergy, Rome, 3–5 June 2008; Javier Blas, “Nations Make Secret Deals Over Grain,” *Financial Times*, 10 April 2008; GRAIN, *Seized! The 2008 Land Grab for Food and Financial Security* (Barcelona: October 2008).
2. Derek Byerlee, “Are We Learning from History?” in Michael Kugelman and Susan L. Levenstein, eds., *The Global Farms Race: Land Grabs, Agricultural Investment, and the Scramble for Food Security* (Washington, DC: Island Press, 2012).
3. “Buying Farmland Abroad: Outsourcing’s Third Wave,” *The Economist*, 21 May 2009; John Vidal, “How Food and Water are Driving a 21st-Century African Land Grab,” (London)

- Observer*, 7 March 2010; George C. Schoneveld, *The Anatomy of Large-scale Farmland Acquisitions in Sub-Saharan Africa*, Working Paper 85 (Bogor, Indonesia: Center for International Forestry Research, 2011); Fred Pearce, *The Land Grabbers: The New Fight over Who Owns the Earth* (Boston: Beacon Press, 2012); FAO, “Saudi Arabia,” *AQUASTAT Country Profile*, at www.fao.org/nr/water/aquastat/countries/saudi_arabia/index.stm, updated 2008; U.S. Department of Agriculture (USDA), *Production, Supply and Distribution*, electronic database, at www.fas.usda.gov/psdonline, updated 10 May 2012.
4. USDA, op. cit. note 3; Sungwoo Park, “South Korea to Expand Overseas Farming on Rising Food Costs,” *Bloomberg*, 9 July 2011.
 5. USDA, op. cit. note 3.
 6. Schoneveld, op. cit. note 3, p. 6; Sanjay Pahuja et al., *Deep Wells and Prudence: Towards Pragmatic Action for Addressing Groundwater Overexploitation in India* (Washington, DC: World Bank, January 2010); U.N. Population Division, *World Population Prospects: The 2010 Revision*, electronic database, at esa.un.org/unpd/wpp/index.htm, updated 3 May 2011.
 7. Vidal, op. cit. note 3; Shaimaa Fayed, “Sudan Eyes \$6 Bln – \$7 Bln Investment in 2010,” *Reuters*, 15 December 2009; Joanne Bladd, “ME’s Farmland Buys in Africa Seen as ‘a Win-Win Partnership,’” *Arabian Business*, 15 April 2010; Deena Kamel Yousef, “Al Ghurair to Seal 99-year Farmland Lease in Sudan,” *Gulf News*, 20 February 2012.
 8. GRAIN, op. cit. note 1; GRAIN, “About Us,” at www.grain.org/pages/about-us, viewed 29 May 2012; Joachim von Braun and Ruth Meinzen-Dick, “Land Grabbing” by Foreign Investors in Developing Countries, Policy Brief No. 13 (Washington, DC: International Food Policy Research Institute, April 2009); Shepard Daniel with Anuradha Mittal, *The Great Land Grab: Rush for World’s Farmland Threatens Food Security for the Poor* (Oakland, CA: Oakland Institute, 2009); World Bank,

- Rising Global Interest in Farmland: Can It Yield Sustainable and Equitable Benefits?* (Washington, DC: September 2010), pp. 33–36; Klaus Deininger and Derek Byerlee, *Rising Global Interest in Farmland: Can It Yield Sustainable and Equitable Benefits?* (Washington, DC: World Bank, January 2011), pp. 49–53. Note: Another highly-anticipated effort to compile information on large-scale land acquisitions, called the Land Matrix, was launched in April 2012 (landportal.info/landmatrix). This was a joint effort by the International Land Coalition, Centre de Coopération Internationale en Recherche Agronomique pour le Développement, Centre for Development and Environment, German Institute for Global and Area Studies, and Deutsche Gesellschaft für Internationale Zusammenarbeit to make data and descriptions of verified foreign land deals more accessible to research organizations, academics, and the general public. While the project launch generated heavy media coverage, it soon became clear that the database had some of the same drawbacks as previous attempts. For example, certain large deals known for some time to have been cancelled were still listed. The Land Matrix is an ongoing effort, accepting user feedback and submissions of new land acquisition examples, so it may prove a valuable tool as it is improved.
9. Deininger and Byerlee, op. cit. note 8, pp. xiv, 4, 50–52.
 10. *Ibid.*, p. 51; USDA, op. cit. note 3.
 11. Deininger and Byerlee, op. cit. note 8, pp. 51–52; Schoneveld, op. cit. note 3, pp. 1, 4, 6, 9–12; lease costs from Lorenzo Cotula, “The International Political Economy of the Global Land Rush: A Critical Appraisal of Trends, Scale, Geography, and Drivers,” *The Journal of Peasant Studies*, vol. 39, nos. 3–4 (July–October 2012), pp. 649–80, and from Jason McLure, “Ethiopian Farms Lure Investor Funds as Workers Live in Poverty,” *Bloomberg*, 31 December 2009.
 12. Deininger and Byerlee, op. cit. note 8, pp. 51–52; Zhong Nan, “Growing in Greener Pastures,” *China Daily*, 8 June 2012; “Grupo Chongqing Assina Protocolo de Intenções

- com Governo Baiano para Investir R\$ 4 Bilhões na Bahia,” *Imprensa Seagri*, 12 April 2011; currency conversion from www.bloomberg.com/personal-finance/calculators/currency-converter, 11 June 2012.
13. Schoneveld, op. cit. note 3, pp. 5, 13–15; Cotula, op. cit. note 11, pp. 649–80; U.N. World Food Programme, “Countries,” at www.wfp.org/countries, viewed 29 May 2012.
 14. Schoneveld, op. cit. note 3, pp. 1, 7–9; European Commission, “Biofuels and Other Renewable Energy in the Transport Sector,” at ec.europa.eu/energy/renewables/biofuels/biofuels_en.htm, viewed 23 May 2012.
 15. Schoneveld, op. cit. note 3, p. 10; GEM BioFuels Plc, “Investors Update,” press release (Douglas, Isle of Man: 12 April 2012); Carol Matlack, “Jatropha: A Green Fuel Awash in Red Ink,” *BusinessWeek*, 15 March 2012; Promode Kant and Shuirong Wu, “The Extraordinary Collapse of Jatropha as a Global Biofuel,” *Environmental Science & Technology*, vol. 45 (August 2011), pp. 7, 114–15.
 16. Schoneveld, op. cit. note 3, p. 11; Tamasin Ford, “Liberia Land Deals with Foreign Firms ‘Could Sow Seeds of Conflict,’” (London) *Guardian*, 29 February 2012; Sime Darby Plantation, “Sime Darby Plantation in Liberia,” at www.simedarbyplantation.com/Sime_Darby_Plantation_in_Liberia.aspx, viewed 5 June 2012; Sime Darby, “Sime Darby to Set Roots in Liberia,” press release, at www.simedarby.com/Sime_Darby_To_Set_Roots_In_Liberia.aspx, 19 May 2011.
 17. GRAIN, op. cit. note 1; John Vidal, “Fears for the World’s Poor Countries as the Rich Grab Land to Grow Food,” (London) *Guardian*, 3 July 2009; ActionAid, “Biofuel Land Grabs Spell Disaster for Poor, Says ActionAid,” at www.actionaid.org, 1 April 2010.
 18. Oakland Institute, “Understanding Land Investment Deals in Africa: FAQs on Food Security & Western Investors,” fact sheet (Oakland, CA: 8 June 2011); Abbi Buxton, Mark Campanale,

- and Lorenzo Cotula, “Farms and Funds: Investment Funds in the Global Land Rush,” briefing (London: International Institute for Environment and Development, January 2012); Black Sea Agriculture, “Charts & Data,” at www.blackseaagriculture.com/charts_data.html, viewed 5 June 2012.
19. Deininger and Byerlee, op. cit. note 8, p. 4; Organisation for Economic Co-operation and Development and FAO, *OECD-FAO Agricultural Outlook 2011–2020* (Paris and Rome: 2011); InvestAg Savills, *International Farmland Market Bulletin 2011* (London: 2011).
 20. Deborah Bossio et al., “Water Implications of Foreign Direct Investment in Ethiopia’s Agricultural Sector,” *Water Alternatives*, vol. 5, no. 2 (June 2012), pp. 223–42.
 21. FAO, *Irrigation Potential in Africa: A Basin Approach* (Rome: 1997), at www.fao.org/docrep/w4347e/w4347e00.htm; USDA, op. cit. note 3; see also Lester R. Brown, “When the Nile Runs Dry,” *Plan B Update* (Washington, DC: Earth Policy Institute, 7 June 2011).
 22. Von Braun and Meinzen-Dick, op. cit. note 8.
 23. William Davison, “Ethiopia to Accelerate Land Commercialization Amid Opposition,” *Bloomberg*, 23 March 2012; Oakland Institute, *Understanding Land Investment Deals in Africa—Country Report: Ethiopia* (Oakland, CA: 2011).
 24. Vidal, op. cit. note 3.
 25. “Memorandum of Understanding on Construction of Agriculture Technology Transfer Center and Grain Production and Processing Base in the Philippines,” at www.newsbreak.com.ph, signed 15 January 2007; “China: ‘Going Outward’ for Food Security,” *Stratfor*, 30 April 2008; Luzi Ann Javier, “China’s Appetite for Filipino Paddies Breeds Farmer Opposition,” *Bloomberg*, 21 February 2008; Tom Burgis and Javier Blas, “Madagascar Scraps Daewoo Farm Deal,” *Financial Times*, 18 March 2009.

26. Celia W. Dugger, "Ending Famine, Simply by Ignoring the Experts," *New York Times*, 2 December 2007; Marco A. Quiñones, Norman E. Borlaug, and Christopher R. Dowsell, "A Fertilizer-Based Green Revolution for Africa," in Roland J. Buresh, Pedro A. Sanchez, and Frank Calhoun, eds., *Replenishing Soil Fertility in Africa*, SSSA Special Publication Number 51 (Madison, WI: Soil Science Society of America and American Society of Agronomy, 1997), pp. 81–95.
27. Deininger and Byerlee, op. cit. note 8; Saleh Al-Zahrani, "Report Plays up Challenges in Agriculture Investment Abroad," *Saudi Gazette*, 5 October 2011.
28. Al-Zahrani, op. cit. note 27; Rajeev Dubey, "Indian Farmer's African Safari," *Businessworld* (New Delhi), 2 June 2012.
29. Hussein Mousa, *Saudi Arabia Grain and Feed Annual 2012* (Riyadh: USDA, Foreign Agricultural Service, 26 March 2012); Abdullah A. Al-Obaid, "King Abdullah's Initiative for Saudi Agricultural Investment Abroad: A Way of Enhancing Saudi Food Security," presentation at Islamic Development Bank Expert Group Meeting on Achieving Food Security in Member Countries in Post-crisis World, Jeddah, 2–3 May 2010; Al-Zahrani, op. cit. note 27.
30. Karuturi Global Limited, "Welcome to Karuturi Global Limited," at www.karuturi.com, viewed 12 June 2012; Nilav Bose and Sanjeev Mehra, "Largest Cut Flower Exporter Karuturi Global Ventures into Food Business," *Business Today* (New Delhi), 28 March 2012; Pearce, op. cit. note 3, p. 8.
31. Deininger and Byerlee, op. cit. note 8; Kingdom of Saudi Arabia, Ministry of Foreign Affairs, "Custodian of the Two Holy Mosques Receives Minister of Commerce and Industry," press release (Riyadh: 27 January 2009).
32. "Hyundai Heavy Reaps Corns, Soybeans at its Russian Farmland," *Yonhap News Agency*, 15 April 2010; Hyundai Heavy Industries Co., Ltd., "Hyundai Heavy Harvests Beans and Corns from its Russian Farm," press release (Ulsan, Republic of Korea: 16 April 2010); Hyundai Heavy Industries

- Co., Ltd., "Hyundai Heavy to Set up New Russian Farmland Project," press release (Ulsan, Republic of Korea: 20 September 2011); USDA, op. cit. note 3.
33. Katrina Manson, "South Sudanese Fear Impact of Farming Deals," *Financial Times*, 6 November 2011.
34. Fund for Peace and *Foreign Policy*, "Failed States," *Foreign Policy*, July/August 2012, pp. 85–99; Kendall Lawrence, "The Failed States Index: Welcome to South Sudan," at www.fundforpeace.org/global/?q=node/231, 18 June 2012.
35. William Davison, "Saudi Star Offers Jobs to Overcome Criticism of Ethiopia Project," *Bloomberg*, 30 May 2012; "Official: Gunmen Kill 5 Farmworkers in Ethiopia," *Associated Press*, 29 April 2012; "Land Rent Contractual Agreement Made between Ministry of Agriculture and Saudi Star Agricultural Development Plc," 25 October 2010, at www.moa.gov.et/node/150&hl=en&gl=us&prmd=imvns&strip=1; Davison, op. cit. note 23.
36. FAO et al., *Principles for Responsible Agricultural Investment that Respects Rights, Livelihoods and Resources*, discussion note (Washington, DC: 25 January 2010); World Bank, FAO, U.N. Conference on Trade and Development, and International Fund for Agricultural Development, "Principles for Responsible Agricultural Investment (RAI) that Respects Rights, Livelihoods and Resources," at www.responsibleagroinvestment.org/rai/node/256, viewed 30 May 2012.
37. GRAIN, "Global Uprising Against Land Grabbing," at www.grain.org, 22 April 2010; GRAIN, "Stop Land Grabbing Now," at www.grain.org, 22 April 2010.

Chapter 11. Can We Prevent a Food Breakdown?

1. U.S. Department of Agriculture (USDA), *Production, Supply and Distribution*, electronic database, at www.fas.usda.gov/psdonline, updated 12 June 2012.
2. U.N. Food and Agriculture Organization (FAO), "FAO Food

- Price Index,” at www.fao.org/worldfoodsituation/wfs-home/foodpricesindex/en, updated 5 July 2012; food expenditures from USDA, “Table 7: Food Expenditures by Families and Individuals as a Share of Disposable Personal Income,” at www.ers.usda.gov/briefing/cpifoodandexpenditures/data/Expenditures_tables/table7.htm, updated 13 July 2011; International Food Policy Research Institute (IFPRI), “Food Price Crisis and Financial Crisis Present Double Threat for Poor People,” press release (Washington, DC: 1 December 2008); Joachim von Braun, *Food and Financial Crises: Implications for Agriculture and the Poor* (Washington, DC: IFPRI, 2008), p. 5; GlobeScan Inc., “Multi-country Nutrition Poll 2011 Topline Report,” as commissioned by Save the Children (London: 17 February 2012), p. 11.
3. Population Reference Bureau, *2011 World Population Data Sheet* (Washington, DC: 2011); International Monetary Fund, *World Economic Outlook Database*, at www.imf.org/external/pubs/ft/weo/2012/01/weodata/index.aspx, updated April 2012.
 4. Jeffrey D. Sachs and Commission on Macroeconomics and Health, *Macroeconomics and Health: Investing in Health for Economic Development* (Geneva: World Health Organization, 2001); Gene Sperling, “Toward Universal Education,” *Foreign Affairs*, September/October 2001, pp. 7–13; Jeffrey D. Sachs, *The End of Poverty: Economic Possibilities for Our Time* (New York: Penguin Group, 2005); George McGovern, *The Third Freedom: Ending Hunger in Our Time* (New York: Simon & Schuster, 2001), chapter 1.
 5. GlobeScan Inc., op. cit. note 2, p. 12.
 6. Meat consumption data from USDA, op. cit. note 1; Janet Larsen, “Peak Meat: U.S. Meat Consumption Falling,” *Data Highlight* (Washington, DC: Earth Policy Institute, 7 March 2012).
 7. Michael B. McElroy, “Time to Electrify: Reducing Our Dependence on Imported Oil—While Addressing the

- Threat of Climate Change,” *Harvard Magazine* (July/August 2011), pp. 36–39; U.S. Department of Energy (DOE), Energy Information Administration (EIA), “U.S. All Grades All Formulations Retail Gasoline Prices,” at www.eia.gov/petroleum/data.cfm#prices, viewed 6 June 2012.
8. For a detailed explanation of the climate stabilization goal, see Lester R. Brown, *Plan B 4.0: Mobilizing to Save Civilization* (New York: W. W. Norton & Company, 2009), available at www.earth-policy.org/books/pb4, as well as the book’s supporting datasets at www.earth-policy.org/books/pb4/pb4_data.
 9. Nicholas Stern, *The Stern Review on the Economics of Climate Change* (London: HM Treasury, 2006); Alison Benjamin, “Stern: Climate Change a ‘Market Failure,’” (London) *Guardian*, 29 November 2007.
 10. Information on fossil fuel subsidies from International Energy Agency (IEA), *World Energy Outlook 2011* (Paris: 2011), pp. 507–40.
 11. Germany wind and Europe solar from REN21, *Renewables 2012 Global Status Report* (Paris: 2012), pp. 47, 59; Denmark from European Wind Energy Association, *Wind in Power: 2011 European Statistics* (Brussels: February 2012), p. 11, and from Danish Wind Industry Association, “The Danish Market,” at www.windpower.org/en/knowledge/statistics/the_danish_market.html, viewed 18 June 2012; states from American Wind Energy Association, “Top 10 for 2011: Wind Power Achieves Many Milestones,” *Wind Energy Weekly*, vol. 29, no. 1465 (6 January 2012), pp. 6–9; Kenya geothermal calculated from Ruggero Bertani, “Geothermal Power Generation in the World 2005–2010 Update Report,” *Geothermics*, vol. 41 (January 2012); Indonesia’s goal from Hillary Brenhouse, “Indonesia Seeks to Tap its Huge Geothermal Reserves,” *New York Times*, 26 July 2010; with percent of electricity calculated using a 90 percent capacity factor typical of new geothermal plants and consumption

- from IEA, *Countries Beyond the OECD*, electronic database, at www.iea.org/stats/index.asp, viewed 20 June 2012.
12. IEA, *Transport, Energy, and CO₂: Moving Toward Sustainability* (Paris: 2009), p. 232; size of U.S. motor vehicle fleet based on Polk Company data cited in National Automobile Dealers Association, *NADA DATA 2012* (McLean, VA: 2012); U.S. automotive fuel from DOE, EIA, “U.S. Product Supplied of Finished Motor Gasoline (Thousand Barrels),” at eia.gov/petroleum/data.cfm, updated 28 June 2012; gasoline consumption compiled from IEA, *IEA Oil Information Statistics*, electronic database, at stats.oecd.org, retrieved 16 September 2011, with conversion factors from IEA, *Oil Information 2011* (Paris: 2011), p. I.31.
 13. USDA, op. cit. note 1.
 14. I. A. Shiklomanov, “Assessment of Water Resources and Water Availability in the World,” *Report for the Comprehensive Assessment of the Freshwater Resources of the World* (St. Petersburg, Russia: State Hydrological Institute, 1998), cited in Peter H. Gleick, *The World’s Water 2000–2001* (Washington, DC: Island Press, 2000), p. 53; Peter H. Gleick, *The World’s Water Volume 7* (Washington, DC: Island Press, 2012), p. 4; FAO, *Crops and Drops* (Rome: 2002), p. 17; Sandra Postel, *Last Oasis*, rev. ed. (New York: W.W. Norton & Company, 1997), pp. 101–104, 106.
 15. Cynthia Guven and Sherif Ibrahim, *Egypt Grain and Feed Annual 2009* (Cairo: USDA, Foreign Agricultural Service, March 2009); “Rice Cropped for Water,” *China Daily*, 9 January 2002; “Output of Major Farm Products,” in National Bureau of Statistics of China, *China Statistical Yearbook* (Beijing: China Statistics Press, various years), at www.stats.gov.cn/english.
 16. PUB, Singapore’s National Water Agency, “Water Tariff,” at www.pub.gov.sg/general/Pages/WaterTariff.aspx, updated 27 February 2012, U.N. Population Division, *World Population Prospects: The 2010 Revision*, electronic database, at esa.un.org/unpd/wpp, updated 3 May 2011.

17. Postel, op. cit. note 14, pp. 166–67.
18. Laurie J. Schmidt, “From the Dust Bowl to the Sahel,” *NASA Earth Observatory*, 18 May 2001; Reggie Royston, “China’s Dust Storms Raise Fears of Impending Catastrophe,” *National Geographic News*, 1 June 2001.
19. “The Great North American Dust Bowl: A Cautionary Tale,” in Secretariat of the U.N. Convention to Combat Desertification, *Global Alarm: Dust and Sandstorms from the World’s Drylands* (Bangkok: 2002), pp. 77–121; Douglas Helms, *History of the Natural Resources Conservation Service* (Washington, DC: Natural Resources Conservation Service, 31 May 2001).
20. Theodor Friedrich, Rolf Derpsch, and Amir Kassam, “Global Overview of the Spread of Conservation Agriculture,” *Field Actions Science Reports*, in press.
21. Conservation Technology Information Center, “National Crop Residue Management Survey,” *Crop Residue Management*, electronic database, at www.ctic.org/CRM/crm_search, viewed 18 June 2012; FAO, “Conservation Agriculture,” *AQUASTAT*, electronic database, at www.fao.org/nr/water/aquastat/data/query/index.html?lang=en, updated 9 December 2011; Friedrich, Derpsch, and Kassam, op. cit. note 20.
22. Historical stock minimum in Brian Wright, *International Grain Reserves and Other Instruments to Address Volatility in Grain Markets*, Working Paper presented at the World Grain Forum 2009, St. Petersburg, Russia, 6–7 June 2009, p. 22.
23. To read more about this mobilization, see Lester R. Brown, *World on the Edge* (New York: W. W. Norton & Company, 2011), available on-line at www.earth-policy.org/books/wote, with supporting datasets at www.earth-policy.org/books/wote/wote_data.
24. Franklin Roosevelt, “State of the Union Address,” 6 January 1942, at www.ibiblio.org/pha/7-2-188/188-35.html; Harold

- G. Vatter, *The US Economy in World War II* (New York: Columbia University Press, 1985), p. 13; Alan L. Gropman, *Mobilizing U.S. Industry in World War II* (Washington, DC: National Defense University Press, August 1996).
25. Jared Diamond, *Collapse: How Societies Choose to Fail or Succeed* (New York: Penguin Group, 2005).