October 2008

Local Foods Program
Rural Communities Program

Institute for Agriculture and Trade Policy

Local Foods and Climate Change: An Annotated List of Resources

Research Organizations

- Leopold Center for Sustainable Agriculture, Iowa State University
  http://www.leopold.iastate.edu/index.htm
  The center is funded through a tax on nitrogen fertilizer and pesticide sales, and conducts research and outreach related to sustainable agriculture, with a focus on Iowa farms. Most research on food and climate change relates to transportation and food miles impacts.

- UC Davis Agricultural Sustainability Institute Farm-to-Fork Climate Studies
  http://www.asi.ucdavis.edu/research/energy_food_system.htm
  UCD has outlined a multi-year research effort to conduct an LCA of food systems, which is specific to California. Their research prospectus is a good reference for current research, and they have also put together a useful literature review of existing LCA studies of the food system.

- The Land Institute, Salina, Kansas
  www.landinstitute.org
  The Land Institute pioneers research and education in "Natural Systems Agriculture," such as symbiotic crop production, perennialization of annual grain crops and closed-loop practices. Their research is useful for defining and quantifying sustainable agriculture. The Institute does have a spin-off Climate and Energy Project, focused on the connection between farming, energy and climate.

- Food Climate Research Network
  www.fcrn.org.uk
  This is a mailing list with useful food and climate news, sent in digest form every few days. It is led by Tara Garnett and based out of the University of Surrey, so a lot of news and research is specific to the UK. The online archives also have relevant information.

Life Cycle and Carbon Footprint Studies

- Brodt, Sonja. Assessment of Energy Use and Greenhouse Gas Emissions in the Food System: A Literature Review. Agricultural Sustainability Institute, University of California Davis (2007). Available online at http://asi.ucdavis.edu/Research/Literature_Review_-_Assessment_of_Energy_Use_and_Greenhouse_Gas_Emissions_in_the_Food_System_Nov_2007.pdf
  This is a useful overview of findings from numerous life cycle studies to date (although the review was done in 2007 so it misses some recent reports). It also includes a thorough list of relevant research publications on the food and climate topic. This review was completed as part of UC Davis' Farm-to-Fork Climate Studies.

- Garnett, Tara. The World on a Plate: Food and its Contribution to Climate Changing Emissions. Climate Action (2007). Available online at http://www.climateactionprogramme.org/features/article/the_world_on_a_plate_food_and_its_contribution_to_climate_changing_emission/
  This is a summary of the information that has come out of recent life cycle studies of food, a "what we know" review that breaks down the different stages of food production. Tara Garnett heads the Food Climate Research Network and is therefore very familiar with the state of the research. The FCRN Web site includes a presentation of the same name with comprehensive overview of the issues.

- Steinfeld, H., P. Gerber, T. Wassenaar, V. Castel, M. Rosales, and C. de Haan. Livestock's Long Shadow: Environmental Issues and Options. Livestock, Environment, and Development Initiative. Published by the UN Food and Agriculture Organization (2006).
  This is a frequently cited report that is one of the few to try and quantify the full global life cycle impact of live stock on the climate. The report concludes that extensive and intensive livestock production is responsible for an estimated 18 percent of anthropogenic emissions worldwide, largely from deforestation, methane emissions and atmospheric N_2O uptake from the use of nitrogen-based feedstock fertilizers.

- Morgan, Daniel, Stephanie Renzi, Richard Cook, and Heidi Radenovic. Seattle Food System Enhancement Project: Greenhouse Gas Emissions Study. University of Washington (2007).
  This study compared the life cycle carbon impact of two different hypothetical meals that could be obtained in the Seattle area, each composed of asparagus, potato, apple and salmon. The foods are compared based on where they came from (local vs. imported) and how they were produced (organically or conventionally). The study concludes that transportation is less than 10 percent of the food's carbon impact, in all cases. While organic foods have a lower carbon impact per unit of food, the study assumes that organic practices result in lower yields, which gives organic foods a slight carbon hit from what they otherwise would be. While it is hard to generalize these findings to some aggregate conclusion about the food industry, the assumptions are well documented and the methods repeat able for similar foods grown in different regions.

- Saunders, Caroline and Andrew Barber. Comparative Energy and Greenhouse Gas Emissions of New Zealand's and the UK's Dairy Industry. Agribusiness and Economics Research Unit of Lincoln University. Research Re port No. 297. Lincoln, New Zealand (July 2007).
  This study calculates the greenhouse gas (GHG) impact of milk produced in New Zealand and shipped to the UK versus milk produced and sold domestically. The study concludes that UK domestic milk is about 30 percent more GHG intensive (inclusive of CO2, N2O, and methane), despite the travel savings. The largest differences result from the energy intensity of UK animal feeds compared to New Zealand's grazing system, the fuel requirements of on-farm machinery in the UK and the greater use of nitrogen fertilizers in the UK. Data sources for farming practices in the two countries were different, and there may be some discrepancies in data collection or assumptions that haven't been accounted for.

- Weber, Christopher and H. Scott Matthews. Food Miles and the Relative Climate Impacts of Food Choices in the United States. Environmental Science and Technology 42(10): 3508-3513 (2008).
  This research was conducted through Carnegie Mellon's Green Design Institute using a life cycle analysis input-output model. The authors calculate the average climate impact of different food categories in the U.S., broken into the component parts of production and transport. Major findings show that red meat (including pork) has the highest carbon intensity across the board, followed by other animal products. Eighty-three percent of the aver age household's carbon budget for food comes from its production—primarily on-farm energy use and nitrogen fertilizer—while a small portion comes from transport (using average food miles numbers for different food groups). This is a useful study and one of a handful to do macro-level calculations for the U.S.

◆ Van Hauwermeiren, Annelies, H. Coene, G. Engelen, and E. Mathijs. Energy Lifecycle Inputs in Food Systems: A Comparison of Local versus Mainstream Cases. Journal of Environmental Policy and Planning. Volume 9:1; 31-51 (2007).

Abstract from the report: "There is increasing interest from consumers in local food systems (LFS) in which consumers purchase their food from predominantly local sources. This paper investigates the claim that LFS use less energy and emit less greenhouse gasses than mainstream food systems (MFS), such as supermarkets. We calculated the energy required during part of the lifecycle of a selected number of food items sourced by different food supply systems and their resulting greenhouse gas emissions. Data were collected from literature, interviews with producers and suppliers of food, experts, and internet. Our results show that in the base simulation of full summer season and only inland, open-air production, energy uses and carbon dioxide emissions are slightly higher in LFS compared to the MFS, but in the same order of magnitude. LFS can be more sustainable by optimizing their transport and storage through minimizing the transport distance and by increasing the stored and traded quantities. Supermarkets could be more sustainable through choosing in-season food products that are homegrown in open air as well and by minimizing distances and storage times. Also consumers could have a large impact through a consistent choice for these in-season, inland products and through their shopping trips."

◆ Carlsson-Kanyama, Annika, Marianne Pipping Ekström, and Helena Shanahan. "Food and Life Cycle Energy Inputs: Consequences of Diet and Ways to Increase Efficiency." Ecological Economics 44: 293-307 (2003).

Abstract from the report: "Here, we present an inventory of life cycle energy inputs for 150 food items available in Sweden and discuss how energy efficient meals and diets can be composed. Energy inputs in food life cycles vary from 2 to 220 MJ per kg due to a multitude of factors related to animal or vegetable origin, degree of processing, choice of processing and preparation technology and transportation distance. Daily total life cycle energy inputs for diets with a similar dietary energy consumed by one person can vary by a factor of four, from 13 to 51 MJ. Current Swedish food consumption patterns result in life cycle energy inputs ranging from 6900 to 21,000 MJ per person and year. Up to a third of the total energy inputs is related to snacks, sweets and drinks, items with little nutritional value."

◆ Carlsson-Kanyama, Annika and Kerstin Bostrom-Carlsson. Energy Use for Cooking and Other Stages in the Life Cycle of Food. Stockholm University, Stockholm, Sweden (2001).

The authors calculate the energy requirements of different cooking methods for a handful of foods: wheat, spaghetti, barley, rice, potatoes and couscous. The cooking energy can be comparable or greater than the production and processing energy requirements of these foods, depending on the cooking method. This analysis is done for Sweden, where most cooking is electric.

◆ Kramer, Klaas Jan, Henri Moll, Sanderine Nonhebel, and Harry Wilting. "Greenhouse Gas Emissions Related to Dutch Food Consumption." Energy Policy 27: 203-216 (1999).

The authors look at approximately 100 different food products that make up the Dutch diet and quantify their life cycle GHGs, not including consumer impacts. Their methodology combines an input-output model and a process-based model. Results are based on annual expenditures in the average Dutch household.

◆ Büsser, Sybille, Roland Steiner, and Niels Jungbluth. LCA of Packed Food Products: The Function of Flexible Packaging. ESU Services Ltd. Uster, Switzerland (2008).

This study was funded by the packaging industry to determine the life cycle impact of food packaging. It doesn't consider waste or disposal issues, which is an obvious consideration for different types of packaging material. However, the study is worth noting because it carried the LCA into the food prep stage.For the three items included in the study (coffee, frozen spinach and butter) the GHG contribution of refrigeration and cooking is over 50% for the first two.

- Favoino, Enzo and Dominic Hogg. The Potential Role of Compost in Reducing Greenhouse Gases. Waste Management and Research 26, pgs 61-69 (2008).
  The authors quantify the GHG benefits of food compost programs. They examine the impact and opportunity for compost to offset the use of synthetic nitrogen fertilizers. However, they don't examine the impact of methane from landfill decomposition.

- Yakovleva, Natalia. Measuring the Sustainability of the Food Supply Chain: A Case Study for the UK. Journal of Environmental Policy and Planning. Volume 9:1, 75-100 (2007). (Available for purchase.)
  Abstract from the report: "This paper provides a critical analysis of the UK food supply chain and its implications for the economy, society and the environment, using a sustainability assessment model. A set of sustainability indicators is proposed to measure the effects of the food supply chain, comprising stages of agriculture, food processing, food wholesaling, food retailing and food catering. The paper tests the assessment model using the empirical data for chicken and potato supply chains in the UK; indicators are scored and presented using spider diagrams to illustrate the sustainability effects within these supply chains. The paper also analyses the chicken and potato supply chains using the proposed assessment and discusses the implications of its application."

Sustainable Food Systems

- Hawken, Paul, Amory Lovins, and L Hunter Lovins. Natural Capitalism. Chapter 10: Food for Life. Rocky Mountain Institute, Snowmass, CO (2000).
  This book is frequently referenced in modern environmental and sustainability debates around consumption patterns. The authors offer big-picture thinking about ways to organize business and industry around principles of sustainability that mimic nature. From the text, these principles are: radically increased resource productivity; redesigning industry on biological models with closed loops and zero waste; shifting from the sale of goods (for example, light bulbs) to the provision of services (illumination); and reinvesting in the natural capital that is the basis of future prosperity. Their emphasis is on simple, low-tech solutions. Chapter 10 discusses options for a sustainable food system including passive heating and drying, efficient greenhouse design, reusing wastes downstream, etc. The authors are not agriculture experts, but the book is a useful reference for guiding principles on environment and climate sustainability.

- Pretty, Jules. Agroecological Approaches to Agricultural Development. Background paper for the World Bank Development Report 2008.
  This paper is a vision piece for what a sustainable food system might look like. The approach is that of "agroecology," which encourages an integrated holistic approach to farming systems. It is more qualitative than quantitative, and approaches the issues from a development perspective.

- Bender, Marty. Energy in Agriculture and Society: Insights from the Sunshine Farm. Published through The Land Institute, Salina KS (March 2001).
  Available at http://www.landinstitute.org/vnews/display.v/ART/2001/03/28/3accb0712
  This report examines efforts by the Sunshine Farm, a project of The Land Institute, to quantify and reduce their life cycle energy inputs to farming. It uses the concept of the energy ratio of various farms and farming practices, defined as the ratio of the caloric energy of marketed products to the embodied energy of the purchased inputs. i.e., excluding solar energy and animal labor. It provides a useful accounting method for on-farm energy use, and describes some of the tradeoffs inherent to energy production. One conclusion is that biofuels will not be an efficient source of exported farm energy, from a life cycle perspective.

- Pimentel, David, Sean Williamson, Courtney Alexander, Omar Gonzalez-Pagan, Caitlin Kontak, Steven Mulkey. Reducing Energy Inputs in the U.S. Food System. Human Ecology 36: 459-471 (2008).
  This report estimates the current quantity of fossil fuel energy that is used during various stages of food's production, and offers steps for reduction. The report examines farming systems, processing and distribution.

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- Dairy Supply Chain Forum Sustainable Consumption and Production Taskforce. The Milk Roadmap. UK Department for Environment, Food, and Rural Affairs. London, UK (May 2008).
  This study was conducted jointly by the UK Dairy Industry and the Department for Environment Food and Rural Affairs (DEFRA). The study suggests practical climate mitigation measures in the milk industry, with a focus on cost-effectiveness. Suggested measures include increasing animal longevity, shifts in diet to reduce enteric fermentation, centralized anaerobic digesters, more efficient use of nitrogen in crop production, and reducing packaging. This is an interesting multi-stakeholder process that engaged industry representatives from different parts of the milk supply chain (producers, processors and retailers), each with a separate set of opportunities and constraints. The milk roadmap is the first of 10 DEFRA studies on different consumer products. It is part of the larger move by UK trade groups to form Climate Change Agreements in response to the UK energy levy. Information at http:// www.defra.gov.uk/foodrin/milk/supplychainforum/index.htm

- Unger, Serena and Heather Wooten. A Food Systems Assessment for Oakland, CA: Toward a Sustainable Food Plan. Oakland Mayors Office of Sustainability and University of California Berkeley (2006). Available at http://oaklandfoodsystem.pbwiki.com/
  This is a comprehensive study of the opportunities and barriers for Oakland, Calif. to develop a sustainable food system, conducted by two UC Berkeley planning students. The report does not focus on specific agriculture practices, but details the steps of the food supply chain and offers recommendations at each level for non-industrial strategies, including large-scale urban gardens, nonprofit food distribution networks, market locations and composting infrastructure. Recommendations are specific to existing businesses and organizations in the Bay Area. Could serve as a model for similar work in the Upper Midwest.

- The Vivid Picture Project: Envisioning a Sustainable Food System in California http://www.vividpicture.net/
  EcoTrust of Portland conducted this collaborative endeavor to gather a variety of progressive California food folks (farmers, consultants, professors, advocates) to define the big picture concept of a sustainable food system, devise a blueprint for achieving it, and develop indicators to measure success. From the project's Web site, some examples of the new system could include "community food planning departments and policy councils, farmers as managers of open spaces, new market makers—not only CSAs and farmers markets, but also buying clubs, local restaurants, and an increased number of independent grocers; new on farm, non-food revenue streams, new business models that maintain local control even when a business is sold, a farmland retirement program, etc." There are a number of documents that were produced as part of this project, including vision documents, California-specific data, useful modeling tools, proposed indicators, etc.

Local Food/Food Miles

- Pirog, Rich and Rebecca Rasmussen. Assessing Fuel Efficiency and CO2 Emissions of Two Local Food Distribution Options in Iowa. Leopold Center for Sustainable Agriculture (2008).
  This study compares the transportation impacts between two CSA distribution options: home delivery or centralized customer pickup. The study has fairly specific applications, but is possibly useful for a comparison of the climate impact of different local food transport options.

- Pirog, Rich, Timothy Van Pelt, Kamyar Enshayan, and Ellen Cook. Food, Fuel, and Freeways: An Iowa Perspective on How Far Food Travels, Fuel Usage, and Greenhouse Gas Emissions. Leopold Center for Sustainable Agriculture (2001).
  The authors compare the CO_2 emissions of food transport through a conventional, regional and local food system. They assume the conventional system is made up of long-distance trucks, the regional system is midsize trucks and semi-trailers, and the local system is pickup trucks. They calculate that the conventional system used 4 to 17 times more fuel that the regional or local systems, depending on the route and truck type. The study looks at a representative yet hypothetical transport route, and does not characterize the actual US food distribution system.

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- Born, Branden and Mark Purcell. Avoiding the Local Trap: Scale and Food Systems in Planning Research. Journal of Planning Education and Research 26:2, p. 195-206 (2006).
  Branden Born was also the academic advisor for the Seattle plate study at UW. The article cautions against planners (and others) thinking local is inherently and consistently the best option for sustainability, equity, etc. Their basic argument is that scale is a social construct, and its benefit will depend on the groups that are empowered by the chosen scale of influence. Their argument is theoretical, not empirical.

- Rosenthal, Elisabeth. Environmental Cost of Shipping Groceries Around the World. The New York Times, April 26, 2008.

General Information on Agriculture and Climate

- Smith, Pete. Greenhouse Gas Mitigation in Agriculture. Encyclopedia of Earth. Available online at http://www.eoearth.org/article/Greenhouse_gas_mitigation_in_agriculture
  This is a broad overview of global emissions from the agriculture sector, written by a soils scientist. There is some discussion of agriculture mitigation and policy options that dovetail with other environmental management options.

- Pimentel, D. Livestock Production and Energy Use. Encyclopedia of Energy, Vol. 3, p 671-676 (2004). -AND- Dutilh, Chris and Anita Linnemann. Energy Use in the Food System. Encyclopedia of Energy Vol. 2, p 719-726 (2004).
  These are short introductions to the energy use throughout the food and livestock production chains. Some of the numerical estimates have been improved upon in more recent life cycle studies, but these are relevant for thinking specifically about energy use in food. The articles also look at consumption as well as production (e.g. customer retail travel and cooking).

- Bellarby, Jessica, Bente Foereid, Astley Hastings, and Pete Smith. Cool Farming: Climate Impacts of Agriculture and Mitigation Potential. Greenpeace International (2008).

- US Environmental Protection Agency. 2008 Inventory of U.S. Greenhouse Gas Emissions and Sinks. EPA 430-R-08-005 (April 2008). Available online at http://www.epa.gov/climatechange/emissions/index.html
  Reference for estimates of U.S. greenhouse gas sources, updated annually by the U.S. EPA. The sections on methane and nitrogen are especially relevant to agriculture.

- Muller, Mark, Catherine Hoffman and Paul Hodges. Addressing Climate Change and Providing New Opportunities for Farmers. Institute for Agriculture and Trade Policy (September 2000).
  This frames the climate problem in a way that corresponds with the work at IATP, namely, what are ways that small independent farmers can benefit from national or global climate mitigation efforts? The topics that are covered include opportunities for providing revenue through carbon sequestration practices, promoting alternatives to industrial agriculture, and access to new markets for renewable fuels. Some references and numbers are now a bit outdated.

- Shrybman, Steven. Trade, Agriculture, and Climate Change: How Agricultural Trade Policies Fuel Climate Change. Institute for Agriculture and Trade Policy (November 2000).
  This is an overview of the ways that the global trade in agriculture encourages energy intensity in production, processing, packaging, and travel. A primer on some of the issues, but more quantitative studies are now available about the contribution of various parts of the agriculture chain.

- Specter, Michael. Big Foot. The New Yorker, A Reporter at Large, February 25, 2008.
  This article describes recent interest by consumers and companies to calculate and label a product's carbon footprint, and the difficulty of making those life cycle calculations. The focal point is food labeling efforts in the UK.

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- Weiss, Rick. Firms Seek Patents on 'Climate Ready' Altered Crops. Washington Post. May 13, 2008. –and- ETC Group, Patenting the 'Climate Genes' and Capturing the Climate Agenda. Communiqué, Issue #99 May/June 2008. Available at http://www.etcgroup.org/en/materials/publications.html?pub_id=687
  Report on recent patent filings by BASF, Syngenta and Monsanto for engineered crops to withstand effects of climate change like drought and heat spells. The ETC document gives details of the patents that have been filed by each company.

- Bittman, Mark. Rethinking the Meat Guzzler. The New York Times. January 27, 2008.
  The high impact of the livestock industry on global warming.

- The Hill Online. In Curbing Global warming, the Devil is in the Offsets. April 19, 2007. Available at http://thehill.com/business--lobby/in-curbing-global-warming-the-devil-is-in-the-offsets-2007-04-19.html
  News report on some of the issues surrounding carbon offsets: what should be counted and how much replacement should be allowed. Focus is on soil sequestration.

Additional Resources

- Bon Appetit's Low Carbon Diet. http://www.bamco.com/Pressroom/lcd_program_overview.htm

- Take a Bite out of Climate Change http://www.takeabite.cc
  This is a resource site for information related to food and climate started by Anna Lappé via the Small Planet Institute.

- Carbon Farmers of America. http://www.carbonfarmersofamerica.com/index.htm
  A coalition of Vermont and Massachusetts farmers that practice holistic ecological farming, geared toward building topsoil and capturing carbon. The farmers are developing new practices and are engaged in education efforts, and the coalition is designed to take money for carbon offsets. The organization currently offsets one ton of CO_2 for $25.

- Chicago Climate Exchange Offsets Program http://www.chicagoclimatex.com/content.jsf?id=23
  This voluntary U.S. carbon market, based in Chicago, allows offsets from agricultural methane and soil sequestration.

- National Carbon Offset Coalition. http://www.ncoc.us/

- Food Security and Environmental Change Conference. April 2-4, 2008, Oxford, UK. Organized by the Global Environmental Change and Food Systems Project. http://www.gecafs.org/FoodConferencePresentations.htm.

- The Frank Arden Memorial Study: The Carbon Footprint of British Agriculture http://www.thecarbonfootprintofbritishagriculture.com/conference.php

- DEFRA Food Chain Programme: Measuring Embedded Greenhouse Gases. http://www.defra.gov.uk/foodrin/fcp/ghg.htm

- Minnesota Climate Change Advisory Group, Agriculture, Forestry, and Waste Management Working Group. http://www.mnclimatechange.us/MCCAG.cfm

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Federal Climate Legislation

◆ Boxer-Liberman-Warner Climate Security Act (S. 3036); most recent vote in June 2008. Amalgam of Sanders-Boxer (Jeffords) and Liberman-Warner.

◆ Global Warming Pollution Reduction Act of 2006 (Introduced by Jeffords in 2006, and reintroduced by Bernard Sanders VT, S. 309. Amy Klobuchar is co-sponsor). Target to reduce emissions to 1990 levels by 2020, and 80% below 1990 levels by 2050, but this can be accelerated if science shows we need stronger targets to keep levels below 450 ppm. Does not mandate a cap-and-trade but allows for it. Also has vehicle standard, power plant standard, RPS, renewable fuels standard and low carbon portfolio standard.

◆ Safe Climate Act 2007 (H.R. 1590), Rep. Waxman, introduced 3/20/07. http://www.house.gov/waxman/safeclimate/. Freezes emissions in 2010, reduces at 2% per year to 2020 (reaching 1990 levels) and then at 5% per year through 2050. Economy-wide cap-and-trade system, with emissions allowances distributed according to the president (with congressional approval).

◆ McCain–Lieberman Climate Stewardship Act (first introduced in 2003). Target is 2000 levels by 2010 and 1990 levels by 2020. Cap-and-trade mechanism where 15% can be met through offsets. (Reintroduced in 2005 as Climate Stewardship and Innovation Act that adds incentives for low-carbon technologies.)

For more on local foods, go to IATP's Agriculture Observatory at www.agobservatory.org.

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