

ANTHONY F. TURHOLLOW, JR.

ADDRESS: Environmental Sciences Division, Oak Ridge National Laboratory
PO Box 2008, Oak Ridge, TN 37831
e-mail: turhollowaf@ornl.gov

EDUCATION: Ph.D. in Agricultural Economics, Iowa State University, Ames, Iowa,
1982
M.S. in Environmental Engineering, Utah State University, Logan,
Utah, 1998
B.S. in Mathematics, Loyola Marymount University, Los Angeles,
California, 1977

PRIMARY AREAS OF RESEARCH INTEREST:

Biomass energy from agriculture and short rotation woody crops, CO₂
and other greenhouse gases, oilseed crops as diesel fuel substitutes,
transportation, air quality, energy and natural resource use in agriculture

EMPLOYMENT HISTORY

Research Staff, October 1984 to August 1993, October 1998 to present, Oak Ridge National
Laboratory.

June 2007-June 2008: on assignment to the Office of the Biomass Program, US Department
of Energy, Washington, DC. Assist in development of Regional Biomass Feedstock
Partnerships under the Sun Grant Initiative, long-term planning for energy crop development.

Selected research activities: 1) estimate costs of collecting corn residues and energy crops for
use as energy, and investigate economics of logistics, handling, transport, and storage, 2)

evaluate cost estimates for new pesticide products, 3) energy and greenhouse balances for corn to ethanol and energy crops. U.S. Department of Energy's Biofuels Feedstock Development Program as program manager and economic and research analyst, 1983-1993. Task manager for oilseed crops development, 1984-1990.

Biomass Consultant, 1993 to 1998. Estimate cost of harvesting sugar cane residues, cost of herbaceous energy crop harvest, cost of wood transport, CO₂ and other greenhouse gases from energy crops, costs and quantities of crop residues for energy, and impacts of increased oilseed production in the Southeast.

Detailer, May 1992 to September 1992, Office of Technology Assessment (OTA), Congress of the United States. Research on chapter on biomass for OTA report on renewable energy.

Research Associate, October 1982 to September 1984, Oak Ridge National Laboratory. Department of Energy's Biomass Energy Program in Herbaceous Crops, evaluation of the Headwater Benefits Energy Gain (HWBEG) Model and cost allocation methods, residential and commercial end-use modeling, Uranium Industry Viability Study, Petroleum Allocation (PAL) Model documentation, FEMA projects.

Resident Student Associate, June 1982 to September 1982, Argonne National Laboratory. Impact of large-scale energy crop production on U.S. agriculture.

Research Assistant, September 1978 to September 1982, Center for Agricultural and Rural Development, Iowa State University. Research under the direction of Dr. Earl O. Heady including investigations into agricultural water resources, energy prices and agriculture, and alcohol production from grains and crop residues.

PUBLICATIONS

Turhollow, Anthony F., Erin G. Webb, and Mark E. Downing. 2010. *Review of sorghum production practices: Applications for bioenergy*, ORNL/TM-2010/7, Oak Ridge National Laboratory, Oak Ridge, TN, 2010.

Eaton, Laurence M., Erin Webb, Anthony F Turhollow Jr., and Robert D. Perlack. 2010. "A comparative cost analysis of perennial herbaceous energy crops and short rotation woody crops," poster presented at: 32nd Symposium on Biotechnology for Fuels and Chemicals, Clearwater, FL, 19-23 April 2010.

Wright, L. and A. Turhollow, "Switchgrass selection as a 'model' bioenergy crop: A history of the process," *Biomass and Bioenergy* doi:10.1016/j.boimbioe.2010.01.030.

Sokhansanj, S., S. Mani, S. Tagore, and A.F. Turhollow, "Techno-economic analysis of using corn stover to supply heat and power to a corn ethanol plant – Part 2: Cost of heat and power generation systems," *Biomass and Bioenergy* 34(3):356-364, March 2010, doi:10.1016/j.boimbioe.2009.11.007.

Sokhansanj, S., S. Mani, S. Tagore, and A.F. Turhollow, "Techno-economic analysis of using corn stover to supply heat and power to a corn ethanol plant – Part 1: Cost of feedstock supply logistics," *Biomass and Bioenergy* 34(1): 75-81, January 2010, doi:10.1016/j.boimbioe.2009.10.001.

Turhollow, Anthony, Erin Wilkerson, and Shahab Sokhansanj, *Cost methodology for biomass feedstocks: Herbaceous crops and agricultural residues*, ORNL/TM-2008/105, Oak Ridge National Laboratory, Oak Ridge, TN, 2009.

Hess, J. Richard, Kevin L. Kenney, Christopher T. Wright, Robert Perlack, and Anthony

Turhollow, "Corn stover availability for biomass conversion: Situation analysis," *Cellulose* 16(4):599-619, August 2009 DOI 10.1007/s10570-009-9323-z.

Sokhansanj, Shahab, Sudhagar Mani, Anthony Turhollow, Amit Kumar, D. Bransby, Lee Lynd, and Mark Laser, "Large scale production, harvest and logistics of switchgrass (*Panicum virgatum*) – Current technology and visioning a mature technology," *Biofuels, Bioproducts & Biorefining*, 3(2):124-141, 2009.

Turhollow, Anthony, *Corn-to-Ethanol Energy Balance*, ORNL/TM-2009/089, Oak Ridge National Laboratory, Oak Ridge, TN, 2009.

Sokhansanj, S., A.F. Turhollow, J. Stephen, M. Stumburg, J. Fenton, and S. Mani, "Analysis of five simulated straw harvest scenarios," *Canadian Biosystems Engineering Journal* 50 (2008):2.27-2.35.

Sokhansanj, S., A. Turhollow, and E.G. Wilkerson, *Integrated Biomass Supply and Logistics: A modeling environment for designing feedstock supply systems for biofuel production*. IN Resource Engineering and Technology for a Sustainable World, ASABE, St. Joseph, MI, 2008.

Sokhansanj, Shahab, Anthony Turhollow, and Erin Wilkerson, *Development of the Integrated Biomass Supply and Logistics Model (IBSAL)*, ORNL/TM-2006/57, Oak Ridge National Laboratory, Oak Ridge, TN, 2008.

Turhollow, A. F. and S. Sokhansanj, "Costs of harvesting, storing in a large pile, and transporting corn stover in a wet form," *Applied Engineering in Agriculture* 23(4):439-448, 2007.

Sokhansanj, S., A. F. Turhollow, and Sam Tagore, Logistics of high moisture stover storage and transport. ASABE paper 076153. Presented at the International Meeting of the ASABE, Minneapolis, MN July 17-20, 2007.

Sokhansanj, S., A. Kumar, and A. F. Turhollow, "Development and implementation of integrated biomass supply analysis and logistics (IBSAL) model," *Biomass and Bioenergy*, 30:838-847, 2006.

Mani, S., Sokhansanj, A. Bi, and A. F. Turhollow, "Economics of producing fuel pellets from biomass," *Applied Engineering in Agriculture* 22(3):421-426, 2006.

Perlack, Robert D., Lynn L. Wright, Anthony F. Turhollow, Robin L. Graham, Bryce J. Stokes, and Donald C. Erbach, *Biomass as feedstock for a bioenergy and bioproducts industry: the technical feasibility of a billion-ton annual supply*, ORNL/TM-2005/66, Oak Ridge National Laboratory, Oak Ridge, TN, 2005.

Sokhansanj, S. and A. F. Turhollow, "Biomass densification-cubing operations and costs for corn stover," *Applied Engineering in Agriculture* 20(4):495-499, July 2004.

Perlack, R.D. and A.F. Turhollow, "Feedstock cost analysis of corn stover residues for further processing," *Energy* 28(14):1395-1403, 2003.

Sokhansanj, S. and A. F. Turhollow, "Baseline cost for corn stover collection," *Applied Engineering in Agriculture* 18(5):525-530, 2002.

Sokhansanj, S., A. F. Turhollow, J. H. Cushman, and J. Cundiff, "Engineering aspects of collecting corn stover for bioenergy," *Biomass and Bioenergy* 23(5):347-355, 2002.

Perlack, Robert D. and Anthony F. Turhollow, *Assessment of options for the collection*,

handling, and transport of corn stover, ORNL/TM-2002/44, Oak Ridge National Laboratory, Oak Ridge, TN, 2002.

Sokansanj, S, A. Turhollow, K. Kadam, and J. McMillan, "Stalking a new fuel source: leftover corn plants can be turned into ethanol," *Resource* May 2001:11-12.

Turhollow, A., *Costs of producing biomass from riparian buffer strips*, ORNL/TM-1999/146, Oak Ridge National Laboratory, Oak Ridge, TN, 2000.

Turhollow, A., M. Downing, and J. Butler, *Forage harvest and transport costs*, ORNL/TM-13724, Oak Ridge National Laboratory, Oak Ridge, TN, 1998.

Turhollow, A., M. Downing, and J. Butler, "The Cost of Silage Harvest and Transport Systems for Herbaceous Crops," IN *Bioenergy '96*, Proceedings of the Seventh National Bioenergy Conference, September 15-20, 1996, Nashville, TN, Southeast Regional Biomass Energy Program, Muscle Shoals, AL, 451-458, 1996.

Turhollow, A., "The Economics of Energy Crop Production," *Biomass and Bioenergy* 6(3):229-241, 1994.

Turhollow, A. F., S. M. Cohn, T. R. Curlee, and D. A. Trumble, *Data and Sources: Biomass Supply*, report prepared for Energy Information Administration, U.S. Department of Energy, 1994.

Turhollow, A. F. and S. Kanhouwa, "Factors Affecting the Market Penetration of Biomass-derived Liquid Transportation Fuels," *Applied Biochemistry and Biotechnology* 39/40:61-70, 1993.

Wright, L. L., J. H. Cushman, A. R. Ehrenshaft, S. B. McLaughlin, W. A. McNabb, J. W. Ranney, G. A. Tuskan, and A. F. Turhollow, *Biofuels Feedstock Development Program Annual Progress Report for 1991*, ORNL-6742, Oak Ridge National Laboratory, Oak Ridge, TN, 1992.

Wright, L. L., R. L. Graham, A. F. Turhollow, and B. C. English, "Opportunities to Mitigate Carbon Dioxide Buildup Using Short-Rotation Woody Crops," IN R. N. Sampson and D. Haire (eds.), *Forests and Global Warming*. Vol. 1, American Forestry Association, Washington, D.C., 123-156, 1992.

Wright, L. L., R. L. Graham, and A. F. Turhollow, "The Potential for Short Rotation Woody Crop to Reduce U.S. CO₂ Emissions," *Climate Journal*, 22:223-238, 1992.

Turhollow, A. F. and R. D. Perlack, "Emissions of CO₂ from Energy Crop Production," *Biomass and Bioenergy*, 1(3):129-135, 1991.

Marland, G. and A. F. Turhollow, "CO₂ Emissions from the Production and Combustion of Fuel Ethanol from Corn," *Energy*, 16(11/12):1307-1316, 1991.

Turhollow, A. F., "Emissions of CO₂ from Energy Crop Production," abstract, Southern Biomass Conference, January 7-11, Baton Rouge, LA, p. IV.B.1, 1991.

Cushman, J. H. and A. F. Turhollow, "Selecting Herbaceous Energy Crops for the Southeast and Midwest/Lake States," IN D. L. Klass (ed.), *Energy from Biomass and Wastes XIV*, Institute of Gas, Technology, Chicago, 465-480, 1991.

Turhollow, A. F., "Screening Herbaceous Lignocellulosic Energy Crops in Temperate Regions of the United States," *Bioresource Technology*, 36:247-252, 1991.

Turhollow, A. F., J. H. Cushman, and J. W. Johnston, *Herbaceous Energy Crops Program: Annual Progress Report for FY 1988*, ORNL-6639, Oak Ridge National Laboratory, Oak Ridge, TN, November, 1990.

Ranney, J. W., R. J. Dinus, and A. F. Turhollow, "Manipulation of Wood Chemical Traits for Energy: An Assessment," IN W. A. Kenney, R. L. Gambles, and L. Zsuffa (eds.) *Proceedings IEA/BA Task 5 Workshop*, Toronto, Canada, June 28-29, 1989. Information report 89:2, 1990.

Marland, G. and A. Turhollow, *CO₂ Emissions from Production and Combustion of Fuel Ethanol from Corn*, ORNL/TM-11180, Oak Ridge National Laboratory, Oak Ridge, TN, 1990.

Layton, P. A., L. L. Wright, T. W. Doyle, J. W. Ranney, J. H. Cushman, A. F. Turhollow, and J. W. Johnson, "Accelerating Energy Crop Growth via Genetic Techniques," IN D. L. Klass (ed.), *Energy from Biomass and Wastes XIII*, Institute of Gas Technology, Chicago, 397-424, 1990.

Cushman, J. H., A. F. Turhollow, and J. W. Johnston, *Herbaceous Energy Crops Program Annual Progress Report for FY 1987*, ORNL-6514, Oak Ridge National Laboratory, Oak Ridge, TN, January 1989.

Turhollow, A. F., J. W. Johnston, and J. H. Cushman, "Linking Energy Crop Production to Conversion: The Case of Lignocellulosic Crops to Ethanol," *RERIC International Energy Journal*, 10(2):41-49, 1988.

Turhollow, A. F., *Second-Year Growth and Productivity for Potential Herbaceous Energy*

Crops in the Southeast and Midwest/Lake States, ORNL/TM-10626, Oak Ridge National Laboratory, Oak Ridge, TN, July 1988.

Curlee, T. R., A. F. Turhollow, and S. Das, "Oil Supply Disruptions and Modeling Methodologies: The Role of LP Models," *Energy Economics*, 10(2):147-154, 1988.

Turhollow, A., *Rapeseed: An Opportunity to Produce a Diesel Fuel Substitute*, working paper for Biofuels Feedstock Development Program, U.S. Department of Energy, Washington, D.C., 1987.

Ranney, J. W., B. A. Barkley, A. F. Turhollow, and C. Granger, "Short Rotation Intensive Culture Economics for Energy in North America," IN proceedings of International Energy Agency Workshop, Economic Evaluations of Short Rotation Biomass Energy Systems, August 11-13, 1987, Duluth, NM, USDA Forest Service, North Central Experiment Station.

Cushman, J. H., A. F. Turhollow, and J. W. Johnston, *Herbaceous Energy Crops Program: Annual Progress Report for FY 1986*, ORNL-6369, Oak Ridge National Laboratory, Oak Ridge, TN, May 1987.

Turhollow, Anthony F. and Earl O. Heady. "Large-Scale Ethanol Production from Corn and Grain Sorghum and Improving Conversion Technology," *Energy in Agriculture*, 5:309-316, 1987.

Cushman, J. H., A. F. Turhollow, and J. W. Johnston, *Herbaceous Energy Crops Program: Annual Progress Report for FY 1985*, ORNL-6263, Oak Ridge National Laboratory, Oak Ridge, TN, April 1986.

Turhollow, Anthony R., "Macro Modeling of Energy from Agriculture," IN *Modeling and*

Simulation, Vol. 16, Part 4: Energy, Power and Environment, proceedings of the 16th Annual Pittsburgh Conference, Instrument Society of America, 1375-1379, 1986.

Cushman, J. H., J. L. Elmore, and A. F. Turhollow, *Herbaceous Energy Crops Program Annual Progress Report for 1984*, ORNL-6221, Oak Ridge National Laboratory, Oak Ridge, TN, November 1985.

Turhollow, Jr., Anthony F., Sinyan Shen, George E. Oamek, and Earl O. Heady, *The Impacts of Large-Scale Biomass Production on U.S. Agriculture*, CARD Report 130, Center for Agricultural and Rural Development, Iowa State University, Ames, Iowa, May 1985.

Turhollow, A. F., S. Das, D. M. Flanagan, R. D. Perlack, and H. Tsao, *An Evaluation of the Headwater Benefits Energy Gains Model*, ORNL/TM-8726, Oak Ridge National Laboratory, Oak Ridge, TN, February 1985.

Perlack, R. D., A.F. Turhollow, and D. L. Johnson, *The Allocation of Joint-Use Costs of Power: A Report on the Assessment of Headwater Benefits Charges*, ORNL/TM-9165, Oak Ridge National Laboratory, Oak Ridge, TN, October 1984.

Turhollow, Jr., Anthony F., Douglas A. Christensen, and Earl O. Heady, *The Potential Impacts of Large-Scale Fuel Alcohol Production from Corn, Grain Sorghum, and Crop Residues Under Varying Technologies and Crop Export Levels*, CARD Report 126, Center for Agricultural and Rural Development, Iowa State University, Ames, Iowa, March 1984.

Perlack, R. D., A. F. Turhollow, S. M. Cohn, S. Das, C. G. Rizy, H. Tully, and R. D. Kraemer, *The Headwater Benefits Energy Gains Model Description*, ORNL/TM-8395, Oak Ridge National Laboratory, Oak Ridge, TN, January 1984.

Hamblin, Daniel M., Anthony Turhollow, et al., *Clinch River Breeder Reactor: An Assessment of Need for Power and Regulatory Issues*, ORNL/TM-8892, Oak Ridge National Laboratory, Oak Ridge, TN, September 1983.

Shen, S. Y., and A. F. Turhollow, "Regional Impacts of Herbaceous and Woody Biomass Production on U.S. Agriculture," IN D.L. Klass (ed.), *Energy From Biomass and Wastes VII*, Institute of Gas Technology, Chicago, Illinois, 207-234, June 1983.

Turhollow, Jr., Anthony F., Cameron Short, and Earl O. Heady, *Potential Impacts of Future Energy Price Impacts on U.S. Agricultural Production*, CARD Report 116, Center for Agricultural and Rural Development, Iowa State University, Ames, Iowa, April 1983.

Christensen, Douglas A., Anthony F. Turhollow, Jr., Earl O. Heady, and Burton C. English, *Soil Loss Associated with Alcohol Production from Corn Grain and Corn Residue*, CARD Report 115, Center for Agricultural and Rural Development, Iowa State University, Ames, Iowa, January 1983.

Weinblatt, Herbert, T. S. Reddy, and Anthony F. Turhollow, Jr., *Energy and Precious Fuels Requirements of Fuel Alcohol Production, Vol. II - Appendices A and B: Ethanol from Grain*, NASA CR-168091, National Technical Information Service, Springfield, Virginia, December 1982.

Turhollow, Jr., Anthony F., Cameron Short, and Earl O. Heady, "Rising Energy Prices and Their Impacts on U.S. Agriculture," *International Journal of Energy Systems*, 2(1):17-22, 1982.

Turhollow, Jr., Anthony F., and Earl O. Heady, "Technological Change and the Impacts of Large Scale Alcohol Production on U.S. Agriculture," IN *Advances in Energy Technology*,

Eighth Annual UMR-DNR Conference on Energy, Rolla, Missouri, 147-151, November 1981.

Short, Cameron, Anthony F. Turhollow, Jr., Earl O. Heady, and Kun C. Lee, *Regional Impacts of Groundwater Mining from the Ogallala Aquifer with Increasing Energy Prices 1990 and 2000*, CARD Report 98, Center for Agricultural and Rural Development, Iowa State University, Ames, Iowa, April 1981.