List of Issues
Current Issue
Category: BioOne.1
Aims & Scope

Print ISSN: 0044-7447

Online ISSN: 1654-7209

Current: Dec 2011 : Volume 40 Issue sp1

BioOne Member Since: 2001 *(Active through 2011)*

Frequency: Eight times per year

Impact Factor: 2.025

2011 ISI Journal Citation Reports® Rankings:

15/45 - Engineering, Environmental

76/205 - Environmental Sciences

Eigenfactor™: *Ambio: A Journal of the Human Environment*

AMBIO: A Journal of the Human Environment

Published by: **Royal Swedish Academy of Sciences**

« previous article : next article »

AMBIO: A Journal of the Human Environment
38(4):186-193. 2009
doi: http://dx.doi.org/10.1579/0044-7447-38.4.186

The Value of Producing Food, Energy, and Ecosystem Services within an Agro-Ecosystem

John Porter, Robert Costanza, Harpinder Sandhu, Lene Sigsgaard, and Steve Wratten

John Porter is a professor of agroecology at the University of Copenhagen. His address: the Department of Agricultural Sciences, Faculty of Life Sciences, University of Copenhagen (KU-LIFE), Højbakkegård Alle 9, 2630 Taastrup, Denmark. jrp@life.ku.dk

Robert Costanza is the Gund Professor of Ecological Economics and director of the Gund Institute for Ecological Economics at the University of Vermont. His address: Gund Institute for Ecological Economics, Rubenstein School of Environment and Natural Resources, University of Vermont, VT 05405-1708, USA. rcostanz@zoo.uvm.edu

Harpinder Sandhu is a research scientist (ecologist) at CSIRO Sustainable Ecosystems. His address: CSIRO Sustainable Ecosystems, Waite Road, Private Bag No. 2, Glen Osmond SA 5064, Australia. Harpinder.Sandhu@csiro.au

Lene Sigsgaard is an associate professor at KU-LIFE. Her address: Department of Ecology, KU-LIFE, Thorvaldsensvej 40, 1871 Frederiksberg, Denmark. les@life.ku.dk

Steve Wratten is a professor of ecology at Lincoln University. His address: the National Centre for Advance Bio-Protection Technologies, Lincoln University, PO Box 84, Lincoln 7647, New Zealand. Steve.Wratten@lincoln.ac.nz

Abstract

Agricultural ecosystems produce food, fiber, and nonmarketed ecosystem services (ES). Agriculture also typically involves high negative external costs associated with, for example, fossil fuel use. We estimated, via field-scale ecological monitoring and economic value-transfer methods, the market and nonmarket ES value of a combined food and energy (CFE) agro-ecosystem that simultaneously produces food, fodder, and bioenergy. Such novel CFE agro-ecosystems can provide a significantly increased net crop, energy, and nonmarketed ES compared with conventional agriculture, and require markedly less fossil-based inputs. Extrapolated to the European scale, the value of nonmarket ES from the CFE system exceeds current European farm subsidy

payments. Such integrated food and bioenergy systems can thus provide environmental value for money for European Union farming and nonfarming communities.

Received: July 16, 2008; **Accepted:** January 13, 2009

References and Notes

Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, et al. 1997. The value of the world's ecosystem services and natural capital. *Nature* 387:253–260. CrossRef

Bjorklund, J., K. E. Limburg, and T. Rydberg. 1999. Impact of production intensity on the ability of the agricultural landscape to generate ecosystem services: an example from Sweden. *Ecol. Econ.* 29:269–291. CrossRef

Economics for the Environmental Consultancy. 2005. The Economic, Social and Ecological Value of Ecosystem Services (http://jncc.gov.uk/page-4025).

Porter, J. R. 2003. Multifunctionality and ecosystem services in European agriculture. Paper presented at the International Conference on Ecosystem Services in European Agriculture: Theory and Practice in Cooperation with the Bertebos Foundation. 14–16 September,Falkenberg, Sweden.

Food and Agriculture Organization (FAO). 2007. The State of Food and Agriculture: Paying Farmers for Environmental Services. FAO Agriculture Series, No. 38. Rome. 222 pp.

Organisation for Economic Cooperation and Development (OECD). 1999. Environmental Benefits from Agriculture: Issues and Policies. OECD. Paris.

Boody, G., B. Vondracek, D. A. Andow, M. Krinke, J. Westra, J. Zimmerman, and P. Welle. 2005. Multifunctional agriculture in the United States. *BioScience* 55:27–38. BioOne

Mooney, H., A. Cropper, and W. Reid. 2005. Confronting the human dilemma. *Nature* 434:561–562. CrossRef, PubMed

Costanza, R. 2008. Ecosystem services: multiple classification systems are needed. *Biol. Conserv.* 141:350–352. CrossRef

Sandhu, H. S., S. D. Wratten, R. Cullen, and B. Case. 2008. The future of farming: the value of ecosystem services in conventional and organic arable land. An experimental approach. *Ecol. Econ.* 64:835–848. CrossRef

Pretty, J. N., A. S. Ball, and T. Lang. 2005. Farm costs and food miles: an assessment of the full costs of the UK weekly food basket. *Food Policy* 30:1–19. CrossRef

Tilman, D., J. Hill, and C. Lehman. 2006. Carbon-negative biofuels from low-input high-diversity grassland biomass. *Science* 314:1598–1600. CrossRef, PubMed

Haas, G., U. Geier, D. G. Schulz, and U. Köpke. 1995. A comparison of conventional and organic agriculture. Part I. Climate relevant carbon dioxide emission from the use of fossil energy. *Berichte über Landwirtschaft* 73:401–415.

Danish Environment Agency. 2006. Agricultural Chemical Statistics (http://www.mst.dk/udgiv/publikationer/2006/87-7052-143-3/htm/helepubl.htm).

Danish Statistical Service. 2006. Denmarks Statistics (http://www.dst.dk/nyt).

Pedersen, xÅ 2006. Summary of Agricultural Trials. Danish Agricultural Advisory Service. Århus.

McTaggart, D., C. Findlay, and M. Parkin. 2003. Economics. Pearson Education. NSW Australia.

Daily, G. C. 1997. Nature's Services: Societal Dependence on Natural Ecosystems. Island Press. Washington, DC.

Ekbom, B. S., S. Wiktelius, and P. A. Chiverton. 1992. Can polyphagous predators control the bird cherry-oat aphid (*Rhopalosiphum padi*) in spring cereals? A simulation study. *Entomol. Exp. Appl.* 65:215–223. CrossRef

Winder, L., D. J. Hirst, N. Carter, S. D. Wratten, and P. I. Sopp. 1994. Estimating predation of the grain aphid *Sitobion avenae* by polyphagous predators. *J. Appl. Ecol.* 31:1–12. CrossRef

Burn, A. J. 1982. The role of searching efficiency in carrot fly egg loss. *Ann. Appl. Biol.* 101:154–159.

Merfield, C. N., S. D. Wratten, and S. Navntoft. 2004. Video analysis of predation by polyphagous invertebrate predators in the laboratory and field. *Biol. Control* 29:5–13. CrossRef

Frank, S. D., S. D. Wratten, H. S. Sandhu, and P. M. Shrewsbury. 2007. Video analysis to determine how habitat strata affects predator diversity and predation of *Epiphyas postvittana* (Lepidoptera: Tortricidae) in a vineyard. *Biol. Control* 41:230–236. CrossRef

de Groot, R. S., M. Wilson, and R. M. J. Boumans. 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecol. Econ.* 41:393–408. CrossRef

Wilson, M., M. Troy, and R. Costanza. 2004. The economic geography of ecosystem goods and services: revealing the monetary value of landscapes through transfer methods and geographic information systems. In: Cultural Landscapes and Land Use: the Nature Conservation–Society Interface. Dieterich, M. and J. van der Straaten. Kluwer Academic Publishers. Dordrecht. pp. 69–94.

Danish Agricultural Advisory Service. 2006. (http://www.lr.dk/middeldatabasen/pricelist.asp).

Thies, C., I. Roschewitz, and T. Tscharntke. 2004. The landscape context of cereal aphid-parasitoid interactions. *Proc. R. Soc. Lond. B Biol. Sci.* 449:1–8.

Luxhøi, J., S. Bruun, B. Stenberg, T. A. Breland, and L. A. Jensen. 2006. Prediction of gross and net nitrogen mineralization—immobilization—turnover form respiration. *Soil Sci. Soc. Am. J.* 70:1121–1128. CrossRef

Eriksen, J., F. P. Vinther, and K. Soegaard. 2004. Nitrate leaching and N-2 fixation in grasslands of different composition, age and

management. *J. Agric. Sci.* 142:141–151. CrossRef

Myrold, D. D. and K. Huss-Danell. 2003. Alder and lupine enhance nitrogen cycling in a degraded forest soil in Northern Sweden. *Plant Soil* 254:47–56. CrossRef

Kratz, W. 1998. The bait-lamina test: general aspects, applications and perspectives. *Environ. Sci. Pollut. Res.* 5:94–96. CrossRef, PubMed

Torne, E. 1990. Assessing feeding activities of soil-living animals: I. Bait-lamina tests. *Pedobiologia* 34:89–101.

Helling, B., G. Pfeiff, and O. Larink. 1998. A comparison of feeding activity of collembolan and enchytraeid in laboratory studies using the bait-lamina test. *Appl. Soil Ecol.* 7:207–212. CrossRef

Weil, R. and F. Magdoff. 2004. Significance of soil organic matter to soil quality and health. In: Soil Organic Matter in Sustainable Agriculture.. Magdoff, F. and R. Weil. CRC Press. Boca Raton, Florida. pp. 1–43.

Poudel, D. D., W. R. Horwath, J. P. Mitchell, and S. R. Temple. 2001. Impacts of cropping systems on soil nitrogen storage and loss. *Agric. Sys.* 68:253–268. CrossRef

Benbi, D. K. and J. Richter. 2002. A critical review of some approaches to modelling nitrogen mineralization. *Biol. Fertil. Soils* 35:168–183. CrossRef

Hamel, C., M. P. Schellenberg, K. Hanson, and H. Wang. 2007. Evaluation of the "bait-lamina test" to assess soil microfauna feeding activity in mixed grassland. *Appl. Soil Ecol.* 36:199–204. CrossRef

Brady, N. C. 1990. The Nature and Properties of Soils. Macmillan Publishing Company. New York.

Martin, N. A. 1978. Earthworms in New Zealand agriculture. Proceedings of the 31st New Zealand Weed and Pest Control Conference. New Zealand Plant Protection Press, New Plymouth, pp 176–180.

Beare, M. 2001. Soil Quality Management System User Manual. New Zealand Institute for Crop and Food Research Limited. Christchurch.

Phillipson, J., R. Abel, J. Steel, and S. R. J. Woodell. 1978. Earthworm numbers, biomass and respiratory metabolism in a Beech Woodland—Wytham Woods, Oxford. *Oecologia* 33:291–309. CrossRef

Fraser, P. M., P. H. Williams, and R. J. Haynes. 1996. Earthworm species, population size and biomass under different cropping systems across the Canterbury Plains, New Zealand. *Appl. Soil Ecol.* 3:49–57. CrossRef

Pimentel, D., C. Harvey, P. Resosudarmo, K. Sinclair, D. Kurz, M. McNair, S. Crist, L. Shpritz, et al. 1995. Environmental and economic costs of soil erosion and conservation benefits. *Science* 267:1117–1125. CrossRef, PubMed

Johnson, J. M. F., R. R. Allmaras, and D. C. Reicosky. 2006. Estimating source carbon from crop residues, roots and rhizodeposits using the national grain-yield database. *Agron. J.* 98:622–636. CrossRef

Capoor, K. and P. Ambrosi. 2006. State and Trends of the Carbon Market 2006. The World Bank. Washington, DC.

Pimentel, D., J. Houser, E. Preiss, O. White, H. Fang, L. Mesnick, T. Barsky, S. Tariche, et al. 1997. Water resources: agriculture, the environment, and society. *Bioscience* 47:97–106. CrossRef

Allen, R. G., L. S. Pereira, D. Raes, and M. Smith. 1998. Crop evapotranspiration: guidelines for computing crop water requirements. FAO Irrigation and Drainage, Paper 56. Rome.

Drake, L. 1992. The non-market value of the Swedish agricultural landscape. *Eur. Rev. Agric. Econ.* 19:351–364. CrossRef

Willis, K. G. and G. D. Garrod. 1993. Valuing landscape: a contingent valuation approach. *J. Environ. Manage.* 37:1–22. CrossRef

Danish Beekeepers Association. 2006. (http://www.biavl.dk).

Östman, Ö, B. Ekbom, and J. Bengston. 2003. Yield increase attributable to aphid predation by ground-living polyphagous natural enemies in spring barley in Sweden. *Ecol. Econ.* 45:149–158. CrossRef

de Neve, S., R. Hartmann, and G. Hofman. 2003. Temperature effects on N mineralization: changes in soil solution composition and determination of temperature coefficients by TDR. *Eur. J. Soil Sci.* 54:49–61. CrossRef

FAO. 2007. The Statistics Division (http://www.fao.org/statistics).

European Statistical Office. 2006. Agricultural Statistics (http://epp.eurostat.ec.europa.eu).

Doornbosch, R. and R. Steenblik. 2007. Biofuels: Is the Cure Worse than the Disease. OECD. Paris.

Sandhu, H. S. 2007. Quantifying the Economic Value of Ecosystem Services on Arable Farmland: A Bottom-Up Approach. PhD thesis,. Lincoln University. New Zealand.

Organisation for Economic Cooperation and Development. 2006. (http://www.oecd.org/topicstatsportal/0,2647,en_2825_494504_1_1_1_1_1,00.html).

Reid, W. V., H. A. Mooney, A. Croppe, D. Capistrano, S. R. Carpenter, K. Chopra, P. Dasgupta, T. Dietz, et al. 2005. Millennium Ecosystem Assessment Synthesis Report. Island Press. Washington, DC.

Steinfield, H., P. Gerber, T. Wassenaar, V. Castel, M. Rosales, and C. de Haan. 2006. Livestock's Long Shadow: Environmental Issues and Options. Livestock, Environment and Development Initiative. FAO. Rome.

Kleijn, D., F. Berendse, R. Smit, and N. Gilissen. 2001. Agri-environment schemes do not effectively protect biodiversity in Dutch agricultural landscapes. *Nature* 413:723–725. CrossRef, PubMed

Foley, J. A., R. deFries, G. P. Asner, C. Barford, G. Bonan, S. R. Carpenter, F. S. Chapin, M. T. Coe, et al. 2005. Global consequences of land use. *Science* 309:570–573. CrossRef, PubMed

Luck, G. W., G. C. Daily, and P. R. Ehrlich. 2003. Population diversity and ecosystem services. *Trends Ecol. Evol.* 18:331–336. CrossRef

Schröter, D., W. Cramer, R. Leemans, I. C. Prentice, M. B. Araújo, N. W. Arnell, A. Bondeau, H. Bugmann, et al. 2005. Ecosystem service supply and vulnerability to global change in Europe. *Science*

310:1333-1337. CrossRef, PubMed

Cited by

Alonso Aguilar Ibarra, Luis Zambrano, Elsa L. Valiente, Arturo Ramos-Bueno. (2013) Enhancing the potential value of environmental services in urban wetlands: An agro-ecosystem approach. *Cities* **31**, 438-443
Online publication date: 1-Apr-2013.
CrossRef

R. Lal. (2013) Enhancing ecosystem services with no-till. *Renewable Agriculture and Food Systems*1-13
Online publication date: 11-Mar-2013.
CrossRef

Jo Smith, Bruce D. Pearce, Martin S. Wolfe. (2013) Reconciling productivity with protection of the environment: Is temperate agroforestry the answer?. *Renewable Agriculture and Food Systems* **28**:01, 80-92
Online publication date: 1-Mar-2013.
CrossRef

Joshua H. Viers, John N. Williams, Kimberly A. Nicholas, Olga Barbosa, Inge Kotzé, Liz Spence, Leanne B. Webb, Adina Merenlender, Mark Reynolds. (2013) Vinecology: pairing wine with nature. *Conservation Letters*n/a-n/a
Online publication date: 1-Mar-2013.
CrossRef

Bhim Bahadur Ghaley, John Roy Porter. (2013) Emergy synthesis of a combined food and energy production system compared to a conventional wheat (Triticum aestivum) production system. *Ecological Indicators* **24**, 534-542
Online publication date: 1-Jan-2013.
CrossRef

Xianting Wu, Jiajie Wu, Yangfan Luo, Jennifer Bragg, Olin Anderson, John Vogel, Yong Q. Gu. (2013) Phylogenetic, Molecular, and Biochemical Characterization of Caffeic Acid o-Methyltransferase Gene Family in Brachypodium distachyon. *International Journal of Plant Genomics* **2013**, 1-12
Online publication date: 1-Jan-2013.
CrossRef

Bruce A. Robertson, Patrick J. Doran. 2013. Biofuels and Biodiversity: The Implications of Energy Sprawl. , 528-539.
CrossRef

Ralf-Uwe Syrbe, Ulrich Walz. (2012) Spatial indicators for the assessment of ecosystem services: Providing, benefiting and connecting areas and landscape metrics. *Ecological Indicators* **21**, 80-88
Online publication date: 1-Oct-2012.
CrossRef

Eskild H. Bennetzen, Pete Smith, Jean-Francois Soussana, John R. Porter. (2012) Identity-based estimation of greenhouse gas emissions from crop production: Case study from Denmark. *European Journal of Agronomy* **41**, 66-72
Online publication date: 1-Aug-2012.
CrossRef

Tobias Plieninger, Christian Schleyer, Harald Schaich, Bettina Ohnesorge, Holger Gerdes, Mónica Hernández-Morcillo, Claudia Bieling. (2012) Mainstreaming ecosystem services through reformed European agricultural policies. *Conservation Letters* **5**:4, 281-288
Online publication date: 1-Aug-2012.
CrossRef

Frans J. Sijtsma, C. Martijn van der Heide, Arjen van Hinsberg. (2012) Beyond monetary measurement: How to evaluate projects and policies using

the ecosystem services framework. *Environmental Science & Policy*
Online publication date: 1-Aug-2012.
CrossRef

Mark Gillespie, Steve D. Wratten. 2012. Ecological Economics of Biodiversity Use for Pest Management. , 57-71.
CrossRef

Jo Smith, Bruce D. Pearce, Martin S. Wolfe. (2012) A European perspective for developing modern multifunctional agroforestry systems for sustainable intensification. *Renewable Agriculture and Food Systems*1-10
Online publication date: 31-Jan-2012.
CrossRef

Laura Calvet-Mir, Erik Gómez-Baggethun, Victoria Reyes-García. (2012) Beyond food production: Ecosystem services provided by home gardens. A case study in Vall Fosca, Catalan Pyrenees, Northeastern Spain. *Ecological Economics*
Online publication date: 1-Jan-2012.
CrossRef

Harpinder Sandhu, Uday Nidumolu, Sukhbir Sandhu. (2012) Assessing Risks and Opportunities Arising from Ecosystem Change in Primary Industries Using Ecosystem-Based Business Risk Analysis Tool. *Human and Ecological Risk Assessment: An International Journal* **18**:1, 47-68
Online publication date: 1-Jan-2012.
CrossRef

Niclas Bentsen, Claus Felby. (2012) Biomass for energy in the European Union - a review of bioenergy resource assessments. *Biotechnology for Biofuels* **5**:1, 25
Online publication date: 1-Jan-2012.
CrossRef

Harpinder S. Sandhu, Neville D. Crossman, F. Patrick Smith. (2011) Ecosystem services and Australian agricultural enterprises. *Ecological Economics*
Online publication date: 1-Dec-2011.
CrossRef

I. Convery, D. Robson, A. Ottitsch, M. Long. (2011) The willingness of farmers to engage with bioenergy and woody biomass production: A regional case study from Cumbria. *Energy Policy*
Online publication date: 1-Oct-2011.
CrossRef

Y Fukuda, H Moller, B Burns. (2011) Effects of organic farming, fencing and vegetation origin on spiders and beetles within shelterbelts on dairy farms. *New Zealand Journal of Agricultural Research* **54**:3, 155-176
Online publication date: 1-Sep-2011.
CrossRef

Virginia H. Dale, Keith L. Kline, Lynn L. Wright, Robert D. Perlack, Mark Downing, Robin L. Graham. (2011) Interactions among bioenergy feedstock choices, landscape dynamics, and land use. *Ecological Applications* **21**:4, 1039-1054
Online publication date: 1-Jun-2011.
CrossRef

A. L. Cowie, T. D. Penman, L. Gorissen, M. D. Winslow, J. Lehmann, T. D. Tyrrell, S. Twomlow, A. Wilkes, R. Lal, J. W. Jones, A. Paulsch, K. Kellner, M. Akhtar-Schuster. (2011) Towards sustainable land management in the drylands: Scientific connections in monitoring and assessing dryland degradation, climate change and biodiversity. *Land Degradation & Development*n/a-n/a
Online publication date: 1-Jan-2011.
CrossRef

Mark Harvey, Sarah Pilgrim. (2011) The new competition for land: Food, energy, and climate change☆. *Food Policy* **36**, S40-S51
Online publication date: 1-Jan-2011.
CrossRef

J. Dick, C. Andrews, D. A. Beaumont, S. Benham, D. R. Brooks, S. Corbett, D. Lloyd, S. McMillan, D. T. Monteith, E. S. Pilgrim, R. Rose, A. Scott, T. Scott, R. I. Smith, C. Taylor, M. Taylor, A. Turner, H. Watson. (2011) A comparison of ecosystem services delivered by 11 long-term monitoring sites in the UK environmental change network. *Environmetrics*n/a-n/a
Online publication date: 1-Jan-2011.
CrossRef

JENS DAUBER, MICHAEL B. JONES, JANE C. STOUT. (2010) The impact of biomass crop cultivation on temperate biodiversity. *GCB Bioenergy* **2**:6, 289-309
Online publication date: 1-Dec-2010.
CrossRef

Estelle Dominati, Murray Patterson, Alec Mackay. (2010) A framework for classifying and quantifying the natural capital and ecosystem services of soils. *Ecological Economics* **69**:9, 1858-1868
Online publication date: 15-Jul-2010.
CrossRef

H. Posthumus, J.R. Rouquette, J. Morris, D.J.G. Gowing, T.M. Hess. (2010) A framework for the assessment of ecosystem goods and services; a case study on lowland floodplains in England. *Ecological Economics* **69**:7, 1510-1523
Online publication date: 15-May-2010.
CrossRef

Harpinder S. Sandhu, Stephen D. Wratten, Ross Cullen. (2010) Organic agriculture and ecosystem services. *Environmental Science & Policy* **13**:1, 1-7
Online publication date: 1-Feb-2010.
CrossRef

Emma S. Pilgrim, Christopher J.A. Macleod, Martin S.A. Blackwell, Roland Bol, David V. Hogan, David R. Chadwick, Laura Cardenas, Tom H. Misselbrook, Philip M. Haygarth, Richard E. Brazier, Phil Hobbs, Chris Hodgson, Steve Jarvis, Jennifer Dungait, Phil J. Murray, Les G. Firbank. 2010. Interactions Among Agricultural Production and Other Ecosystem Services Delivered from European Temperate Grassland Systems. , 117-154.
CrossRef

Emily A. Heaton, Frank G. Dohleman, A. Fernando Miguez, John A. Juvik, Vera Lozovaya, Jack Widholm, Olga A. Zabotina, Gregory F. McIsaac, Mark B. David, Thomas B. Voigt, Nicholas N. Boersma, Stephen P. Long. 2010. Miscanthus. , 75-137.
CrossRef