An explanation for the elusive quality of the Mona Lisa's smile is advanced: "her smile is...more apparent to peripheral vision than to central vision....you can't catch her smile by looking at her mouth." **Claims that inclusion of rats, mice, and birds in the Animal Welfare Act will increase animal-care costs—a cause of panic in some sectors of the biomedical community—are countered. A call is made for more research into the global warming potential of U.S. food production systems** "to determine where the greatest reductions [in GWP] are to be found." **And the importance of understanding U.S. sediment movement and redistribution is discussed.**

Is It Warm? Is It Real? Or Just Low Spatial Frequency?

Leonardo da Vinci's portrait of the Mona Lisa is famous for her smile (Fig. 1). Perhaps it is the difference in her expression carried by high and low spatial frequency ranges (gradual versus sharp luminance gradations) that helps produce her smile's elusive quality.

Fig. 1. Mona Lisa. Leonardo da Vinci. c. 1502. Oil on wood, 77 x 53 cm, Museé du Louvre, Paris.

The spatial resolution of the human visual system changes dramatically with distance from the center of gaze (*1*), due to the fact that both the retina and the visual cortex devote disproportionately more neuronal machinery to the fovea. Acuity 6 to 7° eccentric of the center of gaze is about one-tenth the acuity at the center of gaze. This means that our central vision is dominated by significantly higher spatial frequencies than is our peripheral vision. Conversely, vision only a few degrees from the center of gaze is much blurrier than in the fovea.

To see how Mona Lisa's smile would look at different eccentricities, the image has been filtered to exaggerate selectively low or high spatial frequencies (Fig. 2). A clear smile is much more apparent in the low spatial frequency images than in the high spatial frequency image. Thus, if you look at the painting so that your gaze falls on the background or on Mona Lisa's hands, your perception of her mouth would be dominated by low spatial frequencies, so it would appear much more cheerful than when you look directly at her mouth.

Fig. 2. Face of Mona Lisa, filtered to reveal very low spatial frequencies (left), low spatial frequencies (center), and high spatial frequencies (right). The two low spatial frequency images were generated by applying a Gaussian blur to the image and then enhancing the contrast; the high spatial frequency image was generated by applying a high-pass filter and then blurring slightly (Adobe Photoshop).

This explanation goes beyond the popular idea that da Vinci blurred her mouth (*sfumato*) to make her expression ambiguous (*2*). It seems that her smile is more apparent in the low spatial frequency range, and therefore more apparent to peripheral vision than to central vision. Hence the elusive quality—you can't catch her smile by looking at her mouth. She smiles *until* you look at her mouth, and then it fades, like a dim star that disappears when you look directly at it.

Margaret S. Livingstone
Department of Neurobiology, Harvard Medical School, Boston, MA 02115, USA

References

1. T. Wertheim, *Zeit. für Psychol. Physiol. Sinnersorgen.* 7, 172 (1894).
2. E. H. Gombrich, *The Story of Art* (Phaidon, London, 1999), p. 300.

Animal Welfare Act's Changes Deserve Praise, Not Panic

David Malakoff's recent News of the Week article "Researchers fight plan to regulate mice, birds" (6 Oct., p. 23; also see the related article "Research groups win delay in rules," 13 Oct., p. 243) covers the Alternatives Research & Development Foundation's settlement with the U.S. Department of Agriculture (USDA) to provide rats, mice, and birds legal protection under the regulations of the Animal Welfare Act. The article includes claims from biomedical trade associations that the "new rules will drive up animal-care costs, force small colleges to stop using live animals in classes, and spawn more lawsuits." Such exaggerations and other distortions by the National Association for Biomedical Research, the Association of American Colleges, and related organizations has created panic within some segments of the biomedical research community. In a recent editorial in *Nature* (*1*), it was noted that "some of the research lobby's arguments verge on the reactionary."

For most currently registered research facilities that have Association for Assessment and Accreditation of Laboratory Animal Care (AAALAC) and/or National Institutes of Health certification, the inclusion of rats, mice, and birds is already a reality and has been so for decades. For other facilities, legal protection for these species will only significantly affect facilities with substandard animal care and use programs. In the interests of better science and more humane animal care, such institutions should upgrade to the minimal standards that will be promulgated by the USDA rule-making procedures—standards that, because of existing interagency agreements, are unlikely to differ significantly from those already in existence for the care of rats, mice, and birds.

AAALAC and the American Association for Laboratory Animal Science (AALAS) both supported our efforts to include rats, mice, and birds under the regulations of the Animal Welfare Act. AALAS noted that "the political and economic rationale that led to the exclusion in the [Animal Welfare Act] of the vast majority of animals used in research is ethically indefensible." AAALAC went further by stating that "we can identify no philosophical or scientific reason for excluding these species from USDA regulatory oversight." These two strongly pro-animal research organizations would not have supported our efforts if a successful settlement were a danger to research institutions, investigators, laboratory animals, or students. Misguided efforts to block our historic settlement with the USDA would force biomedical research to take a step backward.

John McArdle
Director, Alternatives Research & Development Foundation, 14280 Golf View Drive, Eden Prairie, MN 55346, USA. E-mail: ardfjmc@aol.com

References
1. Editorial, "In defence of animal research," *Nature* **407**, 659 (2000).

Agriculture, Food Systems, Energy, and Global Change

In "Greenhouse gases in intensive agriculture: Contributions of individual gases to the radiative forcing of the atmosphere" (Reports, 15 Sept., p. 1922), G. P. Robertson, E. A. Paul, and R. R. Harwood offer an excellent long-term and systems-based analysis of the relative impacts of different cropping systems upon global warming potential (GWP). They find that no-till management has the lowest net GWP, followed by organic and low input management (each with legume cover). These three all have much lower GWP than conventional tillage (Table 2, p. 1924). In concluding, they state that "[a]griculture... plays a minor role in the GWP economy of the U.S., yet net mitigation of agricultural fluxes could offset the current annual increase in fossil fuel CO_2 emissions." This kind of basic research is of great importance in setting intelligent research and policy agendas for agriculture, and it deserves further elaboration. It is also crucial that such research and analysis be placed in the larger context of food systems.

Research done in the 1960s and 1970s showed that (i) agriculture represented only about a third of the total energy used in the U.S. food system, (ii) the typical food calorie on a dinner plate required 10 calories of energy input (*1*), and (iii) the average food item was shipped some 1300 miles (*2*). Internationally, a 1993 estimate indicated that "only about 10% of the fossil fuel energy used in the world's food system is used in production" (*3*). We desperately need to update and improve the quality of these data and formulate an analysis of their GWP to determine where the greatest reductions are to be found.

Any search for more sustainable ways to structure our food systems will require more than an energy analysis of current long-distance industrial food systems. It will be necessary to review the underlying theories of social change in conventional energy approaches (*4*). In addition, the many significant social, health, and environmental externalities of industrial food systems must be included (*5*). Global warming studies should examine not only current industrial structures and food systems, but more localized alternatives—both traditional and emerging (*6*). Only with such a comprehensive and systematic approach will we be able to assess the full range of the costs and benefits of more global versus more local food systems.

Kenneth A. Dahlberg
Environmental Studies Program and Department of Political Science, Western Michigan University, 1903 Michigan Avenue, Kalamazoo, MI 49008, USA. E-mail: dahlberg@wmich.edu

References
1. J. S. Steinhart, C. E. Steinhart, *Science* **184**, 307 (1974).
2. S. L. Brown, U. F. Pilz, *U.S. Agriculture: Potential Vulnerabilities* (Stanford Research Institute, Menlo Park, CA, 1969).
3. G. Tansey, T. Worsley, *The Food System* (Earthscan, London, 1995), p. 223.
4. E. Shove, L. Lutzenhiser, S. Guy, B. Hackett, H. Wilhite, "Energy and Social Systems," in *Human Choice and Climate Change, vol. 2,* S. Rayner, E. L. Malone, Eds. (Batelle, Columbus, OH, 1998), pp. 291–325.
5. K. A. Dahlberg, Ed., *New Directions for Agriculture and Agricultural Research* (Rowman & Allanheld, Totowa, NJ, 1986).
6. United Nations Development Program (UNDP*), Urban Agriculture: Food, Jobs, and Sustainable Cities* (UNDP, New York, 1996).

Measurements and Models of Soil Loss Rates

In their Policy Forum "U.S. soil erosion rates—myth and reality" (14 Jul., p. 248), Stanley Trimble and Pierre Crosson discuss sediment budgets and call attention to the large quantitative difference that exists between upland soil erosion and downstream sediment delivery (*1*). The authors are correct in their statements regarding the universal soil loss equation (USLE) and wind erosion equation (WEE) when they state that the models "predict the amount of soil moved on a field, not necessarily the amount of soil moved from a field" (*2–4*). The USLE predicts "soil loss," which is a technical term referring to the net loss of soil over the portion of the landscape that experiences a net loss over time. Soil loss does not refer to sediment yield.

We take issue, however, with the conclusion by Trimble and Crosson that "[t]he limitations of the USLE...are such that we do not seem to have a truly informed idea of how much soil erosion is occurring in this country." Despite the limitations of the USLE and its successor, the revised USLE (RUSLE), there exists today no other environmental technology that is based on a larger and more comprehensive set of measurements. More than 10,000 plot-years of data from 50 locations in 24 states went into the development of the original USLE (*3*), and many more data sets from many types of experiments have been used since that time to either improve or test the technology (*5*). Two recent studies of measured soil loss rates (as defined above) from more than 1700 plot-years of data from 205 research plots at 20 locations in the United States showed that the USLE and RUSLE predict average erosion rates reasonably well (*6*), even on recent, post-1960 conditions. Soil loss estimates from the USLE are quite reliable measures of upland erosion rates in the United States.

The United States would benefit from a better understanding of sediment movement and sediment redistribution within agricultural fields, as implied in the Policy Forum. Work is under way to develop new tracer technologies to make these measurements (*7*). We agree with Trimble and Crosson's call for increased field studies and monitoring of sediment mass, but we disagree with the contention that ground surveys are quick, cheap, and precise. Measurements of runoff and sediment movement from fields and in streams are costly, and some of the methodologies used, particularly those for bedload (the portion of the sediment load that moves by rolling and dragging at the bottom of a stream), leave much to be desired. Data collection programs on many streams have been abandoned due to the expense involved. Solutions to these problems must be sought through improved technologies and strategies, which will require significant research investments. In any case, these studies will often have little relevance to the quantification of on-site soil loss, as defined above.

M. A. Nearing,[1*] M. J. M. Romkens,[2] L. D. Norton,[1] D. E. Stott,[1] F. E. Rhoton,[2] J. M. Laflen,[3] D. C. Flanagan,[1] C. V. Alonso,[2] R. L. Binger,[2] S. M. Dabney,[2] O. C. Doering,[3] C. H. Huang,[1] K. C. McGregor,[2] A. Simon[2]
[1]U.S. Department of Agriculture–Agricultural Research Service (USDA-ARS) National Soil Erosion Research Laboratory, West Lafayette, IN 47907–1196, USA. [2]USDA-ARS National Sedimentation Laboratory, Post Office Box 1157, Oxford, MS 38655, USA. [3]Purdue University, West Lafayette, IN 47907, USA

*To whom correspondence should be addressed at mnearing@purdue.edu

References
1. W. R. Osterkamp, T. J. Toy, *Environ. Geol.* **29**, 152 (1997).
2. W. H. Wischmeier, D. D. Smith, *Agricultural Handbook No. 282* (U.S. Government Printing Office, Washington, DC, 1965).
3. ———, *Agricultural Handbook No. 537* (U.S. Government Printing Office, Washington, DC, 1978); L. D. Meyer, *J. Soil Water Conserv.* **39**, 99 (1984); ——— and W. C. Moldenhauer, *Agric. History* **59**, 192 (1985).
4. W. H. Wischmeier, *J. Soil Water Conserv.* **31**, 5 (1976).
5. K. G. Renard *et al., J. Soil Water Conserv.* **46**, 30 (1991); K. G. Renard *et al., J. Soil Water Conserv.* **49**,