The Ins and Outs of Organic Farming

IN THEIR REPORT "SOIL FERTILITY AND BIO- diversity in organic farming," P. Mäder *et al.* (31 May, p. 1694) downplay two factors in their discussion of the relative merits of organic and conventional farming. First, because organic farming yields (per unit of land) were 20% lower than those from conventional farming, 25% more land would be required to produce the same amount of crop biomass, offsetting some of organic farming's advantage with respect to biological diversity, inputs, and soil erosion. Allowing for an increase in cultivated land and adopting the authors' results (p. 1695), organic farming would reduce overall nutrient use by 18 to 39% (not 34 to 51%), energy use by 20 to 41% (not 20 to 56%, as indicated in the text), and pesticide use by 96%. So in terms of the environment, the issue is whether reducing nutrient, energy, and pesticide inputs and impacts on biodiversity on a smaller piece of land outweighs the impacts of increasing cropland under cultivation (*1*, *2*). The answer to this question might be different if one examines what occurs "typically." If typical cereal yields under organic farming are 60 to 70% of those of conventional farming (p. 1695), then between 43 and 67% more land would be needed to keep production constant, further diminishing the environmental and biodiversity advantages of organic farming. Similarly, organic farming might require 0 to 43% more grasslands.

Second, although Europeans—being well fed and currently running unsustainably large food surpluses—might welcome reduced crop production, it could prove disastrous for those in developing countries. A 20% reduction in production from 1997–99 levels, for instance, would reduce global crop production per capita to levels not seen since at least the early 1960s (*3*). Despite improvements during the 1960s, an estimated 37% of the inhabitants of developing countries (or 956 million people) still suffered from chronic hunger and malnourishment in 1969–71 (*4*). By 1997–99, thanks in large part to conventional agriculture, these numbers had dropped to 17% (or 777 million). Therefore, a 20% drop in production would have more than doubled their numbers to at least 1700 million in 1997–99. Clearly, there are environmental and humanitarian trade-offs that should be considered before judging the overall merits of different agricultural systems.

Curiously, the authors did not discuss the difference in yields between experimental and "typical" conditions, which, according to them was 10% compared to 30 to 40% (p. 1695, paragraphs 3 and 4), particularly because the latter is more relevant to the real world. Reducing this gap, I suspect, would be welcomed by all farmers, conventional or organic, so long as they get the same or better returns on their effort and other investments.


How does an organic field (left) measure up to a conventional one (right)?

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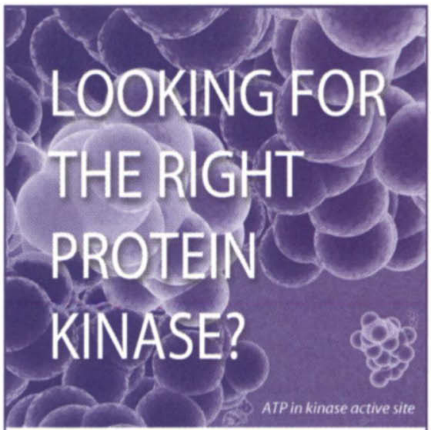
References
1. I. M. Goklany, *Technology* **6**, 107 (1999).
2. ———, *Bioscience* **48**, 941 (1998).
3. Food and Agricultural Organization (FAO), *FAOSTAT-Database* (FAO, Rome, 2002) (available at http://apps.fao.org).
4. FAO, press release 01/69 (2001), accompanying *The State of Food Insecurity in the World 2001* (available at www.fao.org/WAICENT/OIS/PRESS_NE/PRESSENG/2001/pren0169.htm).

Response

GOKLANY STATES THAT 20% LOWER CROP yields in organic farming would require 25% more land use to produce the same amount of crop biomass, offsetting some of the advantages of organic agriculture with respect to biological diversity, inputs, and soil erosion, and that the experimental yields are not typical. Furthermore, he indicates that organic farming might not be sufficient to feed the world.

Our nutrient and energy calculations in the comparison trial (known as DOK) were related to the land area. Organic systems are more efficient, both on a land unit and a crop unit base. Conventional systems clearly show highest productivity. Soil fertility and biodiversity in the organic systems of our study were significantly enhanced compared with the conventional systems, which were managed according to integrated plant production standards. In the long term, fertile soils are essential for a sustainable production. In the past three decades, agricultural yields have doubled, but worldwide, one-third of arable land has been lost to erosion (*1*), accompanied by a tremendous increase in fertilization (*2*); a dramatic decline in biodiversity of crops, weeds, birds, and insects; and immense external costs of intensive conventional agriculture (*3*). Organic farming may need more land to produce the same yield, but it maintains fertility and biodiversity of the cropped land. Conventional farming has degraded soils irreversibly in large areas of the world, and, consequently, the remaining land will be farmed as well, rather than used for ecological compensation.

Differences in crop yield of organic and conventional systems are hardly ever valid for all circumstances, because they depend on input levels and local production conditions. A satisfactory reference for productivity in system comparisons is the mean regional crop yield. Both the organic and the conventional wheat yields were similar to those of the respective farms in the region, and therefore representative (organic farms:



4.2 metric tons/ha; conventional farms: 4.8 metric tons/ha) (*4–6*). Crop yields of organic and conventional farming systems in high-intensity production regions of Europe show higher differences (*7*) than those in the United States, where yields of both systems can even be similar (*8*, *9*).

The results from our comparison trial are suitable mainly for mixed farms in central Europe. Sustainable local production is needed in developing countries to nourish the growing population. The question is whether organic or conventional farming meets this goal best. Organic farming may be applicable in developing countries because it relies mainly on local resources and combines traditional knowledge with modern agronomic techniques.

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References
1. D. C. Pimentel *et al.*, *Science* **267**, 1117 (1995).
2. D. Tilman, *Proc. Natl. Acad. Sci. U.S.A.* **96**, 5995 (1999).
3. J. Pretty *et al.*, *Agric. Syst.* **65**, 113 (2000).
4. H. P. Ryser, personal communication.
5. Agro Treuhand SO/BL, Postfach 140, CH-4533 Riedholz (Switzerland); report, data available at the Landwirtshaftliches Zentrum Ebenrain, CH-4450 Sissach/BL, P. Simon.
6. P. Mäder, A. Berner, C. Bosshard, H. R. Oberholzer, P. Fitze, paper presented at the 13th International IFOAM Scientific Conference, Basel, Switzerland, 28 to 31 August 2000.
7. F. Offermann, H. Nieberg, *Economic Performance of Organic Farms in Europe* (University of Hohenheim, Hago Druck & Medien, Karlsbad-Ittersbach, Germany, 2000), vol. 5.
8. See http://apps.fao.org/page/collections?subset=agriculture.
9. L. E. Drinkwater, P. Wagoner, M. Sarrantonio, *Nature* **396**, 262 (1998).

Organic Farming and Energy Efficiency

IN THEIR REPORT "SOIL FERTILITY AND BIODIVERSITY in organic farming" (31 May, p. 1694), P. Mäder *et al.* demonstrate that most organically grown crops in their study were more energy efficient per unit crop than conventionally grown crops. This is contrary to other research (*1*, *2*). In their study, organically grown winter wheat yields were only 10% below those of conventional crops of the region. How does this compare with Vaclav Smil's finding that worldwide output of grain would fall by at least half if grown without synthetic fertilizer (*3*)? Mäder *et al.* conclude that organic fertilizers generated on the farm itself are a realistic alternative to conventional farming systems. What