LETTERS

The Rem

Eliot Marshall (News and Comment, 26 June, p. 1484) states that "On average, the stack [of the UCLA Argonaut reactor] emits 100 millirems of radiation annually." This is nonsensical. The rem (roentgen equivalent man), or its subunit, the millirem, is a unit of delivered dose adjusted for the relative biological damage to tissue from various types of ionizing radiation, not a quantity of emitted radiation. The emission must be described in curies, specifying the nuclides emitted and amounts of each. A summation of the exposure caused by the emitted radioactive source materials could be indicated by stating that at some specified location an average exposure rate of a certain number of rems (or millirems) *per unit time* exists or that at that location the total exposure annually or for some other time period amounts to x rems.

Either statement, however, has meaning only for a specific location, and is a measure of the radiation that would be received by a person (or measured by a suitable detector) at that site; it is not a measure of the amount of emitted radioactive material.

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Organic Farming

Lockeretz *et al.* (6 Feb., p. 540) make a comparison of "organic" and conventional farming, based in part on mail surveys and personal interviews. Such anecdotal methods are inadequate by comparison with those used by agronomists, in which an investigator typically makes side-by-side comparisons of two or more experimental units, such as plots, with measurements of yield, and chemical analyses of soils and of crops produced. The distinction between organic and conventional farming drawn by Lockeretz *et al.* is unclear; for example, they mention occasional use of herbicides by organic farmers. No analyses for pesticide content of organic crops are given, although in another report (*1*) organic foods were found to contain pesticide residues more frequently than did the average of all foods analyzed.

Organic farming is defined as including no use of urea, but organic farmers "frequently added an 'organic fertilizer,' " that is, manure, which inevitably contains urea. Organic farmers hence imply a nonexistent difference between synthetic and natural urea, shown by Wöhler 152 years ago to be identical (*2*). His experiment is commonly cited as erasing the "vital force" concept of biochemical synthesis. No single example is a clearer illustration than this of the unreality of "organic farming" ideas about fertilizers.

The adjective "organic" properly refers to compounds of carbon, as in "organic chemistry." Its neologic application to food and farming, introduced in 1942 (*3*), was, and is, accompanied by the allegation that food produced without chemical fertilizers is "more healthful" than food conventionally produced (*1*). This claim cannot be substantiated (*4*).

Lockeretz *et al.* state that the protein from organically grown corn was higher in lysine, methionine, histidine, threonine, and glycine, but lower in leucine and phenylalanine than that from "conventional" corn and that this difference could have been caused by "inadequate nitrogen availability." The customary belief is that the amino acid distribution in proteins is controlled genetically by nucleotide sequences in DNA molecules.

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References

1. *New York State Public Hearing in the Matter of Organic Foods* (State of New York, 1 December 1972).
2. F. Wöhler, *Ann. Phys.* **12**, 243 (1828).
3. C. Jackson and J. I. Rodale, *Apostle of Nonconformity* (Pyramid, New York, 1974), p. 63.
4. R. M. Leverton, *J. Am. Diet. Assoc.* **62**, 501 (1973).

Although the article by Lockeretz *et al.* makes a contribution to the comparison of organic and conventional farming, the study on which it is based is seriously flawed in several respects. This article should, therefore, be examined in conjunction with earlier reports from the study.

In a previous publication (*1*), the study team acknowledged that the organic farms were selected after "a preliminary judgment of each organic farmer's competency as a farm manager." The conventional farmers were reported to be "top management" farmers, but their yields were only slightly above county average, and fertilizer applications were no more than the state average. Some bias in favor of the organic group seems likely.

The data for 14 paired farms from 1974 to 1976 are all farmers' estimates rather than carefully measured yields. The first-year data are thus farmers' recollections of fertilizer, manure, and pesticide applications; days and number of livestock grazed; and crop yields in the preceding year. Such data are highly unreliable.

In an earlier publication (*2*), the organic farms are reported to have a 2 percent advantage in soil productivity potential.

On the eight farms for which soil maps were available, the conventional farms had 9 percent more of their land in harvested crops (of land that was deemed suitable). Because the Washington University team presents "economic performance" data on a per hectare of cropland basis, this considerable advantage for conventional farms is lost. The authors state, however, that if land in permanent pasture on organic farms is credited with production value equivalent to hay and rotation pasture the advantage for conventional farming as a result of more harvested cropland falls to only 3 percent. It would be more accurate to credit permanent pasture with no more than one half as much productive value because of the lower productivity of native pasture species and typically fewer fertility treatments. The disadvantage of the organic farms for this factor would then stand at 6 percent.

The economic performance of organic farms in 1974 and 1975 would have been considerably less favorable if the prices in those years had not been atypically high and the estimated hay yields unrealistically high (47 percent above conventional in 1974 and 15 percent in 1975). The likely explanation for the high hay yields is that farmers have less precise bases for estimating hay yields than grain yields and simply overestimated them. Although the hay yields averaged 31 percent higher on organic farms from 1974 to 1975, Lockeretz *et al.* state that "The two groups were about the same for oats and hay."

When appropriate adjustments based upon the preceding paragraphs are made with data from earlier publications, the real "economic performance" for organic farms is at least 20 percent less than for conventional farms.

To replace 20 percent lost production on present cropland would require at least 30 percent additional land because the available land is much less productive (*3*). Furthermore, much of this land, which is now idle, in permanent pasture, or forested, is relatively steep, hence highly erosive. Consequently, although erosion on individual farms is calculated by Lockeretz *et al.* to be less in cropping systems characteristic of organic farming