Letter from the Desk of David Challinor
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By the 1960's, the consciousness of many consumers was raised concerning the amount of chemicals being sprayed on the plants (or parts thereof) that we eat. In 1962 Rachel Carson's *Silent Spring* clearly delineated the costs to our health and well-being of the indiscriminate use of the insecticide DDT and its derivatives. Since then, we have drastically curtailed, and sometimes even banned, the use of that family of pesticides in the United States, although I understand its manufacturer freely exports it to Third World countries abroad where stringent controls either do not exist or are not enforced. Pesticides and chemical fertilizers are frequently derived from carbon petroleum products and can indeed increase crop production. This month's letter will discuss just how much they improve yields while also considering the arguments against their use.

In the past few decades in the United States and elsewhere in Europe, food shoppers have increasingly been willing to pay a premium for organically grown vegetables, fruit, meat and dairy products. Initially, most "organically grown" labels were merely a statement by the grower that he/she did not use chemical fertilizers. Later, as competition increased in the organic food market, the states stepped in to set regulations and standards for what could legally be sold as "organically grown."

Today, it is still somewhat difficult to grow one hundred percent organic fruits and vegetables. Experience with my own vegetable garden illustrates the dilemma faced by well-intentioned but practical backyard gardeners. The two small plots in my backyard total 300 square feet, and I have cultivated them for more than 30 years. Every February I have added decomposed leaves and lawn clippings to what was initially tight, yellowish clay soil. Now the plots contain friable, dark brown loam about eighteen inches deep. Over the years, I have also applied several bags of sand to ensure proper drainage in the raised beds, but I do not normally spread commercial fertilizer or spray insecticides on the growing crops. However, whenever the applied mulch has a high component of oak leaves, which tends to make the newly tilled soil too acidic, I will broadcast powdered lime to raise the pH to a more neutral level (about seven). Furthermore, this spring I bought a few tomato plants from a garden center so as to enjoy their fruit earlier, rather than waiting for the ones I had grown from seed. The plants I bought have dark green foliage and had clearly been socked with a strong dose of nitrogen before being sold—so much for my 100% organic garden! With even the best intent, therefore, I am a bit skeptical of just how "organic" some of the food thus labeled actually is.

There have been endless arguments about the nutritional superiority of organically produced food crops; my impression is that other than the risk of consuming pesticide residue from inadequately rinsed fruits or vegetables, the nutrient content of both

organically and commercially grown crops does not vary significantly. The principal benefit of the former system, however, is the allegedly greater energy saving. A recent article in *SCIENCE* (vol.296, 31 May '02, pp.1694-7) should settle the argument, at least for the two basic systems used in Switzerland. A long-term experiment there was set up to determine the measurable differences in crop yields between organically grown and conventionally grown food crops. The two techniques were compared over a 21 year period on 1.5 ha (3.75 acres) at an agricultural facility near Basel, a major Swiss city on the German border. The project started in 1978 and sought to compare four different farming systems:

I. Conventional 1) conventional plot - using chemical pesticides and herbicides and soluble nitrogen as fertilizer
2) an integrated system that used manure plus conventional practices
II. Organic 3) strictly organic plot that used manure and mechanical weeding as opposed to herbicides
4) a special system called biodynamic farming, which used special ingredients to compost manure

The goal was to try to answer the questions: how sustainable is organic farming, and can the benefits be measured? Clearly, the results apply only to this experimental site where the soil—a loess—is fine clay, buff to grey-colored and the product of millennia of wind-blown dust deposit. The same crops, rotation and tillage were used throughout the experiment.

The twenty-one year results showed that nutrient input (nitrogen, phosphorous, potassium) in the organic plots was from 34 to 51% lower than in the conventional ones, but that organic crop yield was only 20% lower over that period. This was an amazing result, for it demonstrated the efficiency of organic farming in that it took only about half as much energy to produce a crop dry-matter unit as the conventional system. Potato production in the organic plots was about a third less than in the conventional plots because of a shortage of potassium, but in the third rotation of winter wheat, the organic plots produced only about 10% less than the conventional ones. Yields from clover and grass plots were almost exactly the same in both systems.

In the long run, the organically farmed plots had greater soil stability, microbial biomass and earthworm density. Nutrients were less dissolved in the soil solution in the organic system and soil microbes, therefore, played a larger role in transferring phosphorus to the growing plants. In the organic plots, roots colonized by mycorrhizae were almost double that of the roots in the conventional plots. Mycorrhizae are fungi that grow on or in plant roots and increase their absorptive ability to take in mineral nutrients. As already mentioned, earthworm biomass was up to three times higher in the organic plots.

Perhaps the most noteworthy result of this long-term study was the significant increase in microbial activity in the organic plots over the conventional ones. The high microbe count allowed plants in the organic plots to use the soil's organic matter more for growth than for maintenance. Thus, under these controlled experimental conditions, the plots with high microbial populations decomposed organic matter more completely and rapidly than the conventional plots, thereby transforming the carbon in the organic matter into plant biomass at a much lower energy cost. This favorable condition illustrates that the more diverse the soil community (microbes, fungi, invertebrates), the more efficient it is in resource use. In this experiment then, plots that received manure as fertilizer and used legumes in crop rotations to replenish soil nitrogen are, as the authors conclude, a "realistic alternative to conventional farming systems."

I should point out that Switzerland and most of the rest of western Europe subsidize organic farming, which the United States does not. Given the powerful farm lobby and the extremely protectionist farm subsidy bill just passed by Congress, it is extremely unlikely that large-scale organic farming will ever be practiced here. The enormous feed lots of the Midwest have to incinerate their manure because the cost of hauling and spreading it on farmers' fields far exceeds the current cost of commercial fertilizer. In our country, we will have to wait until the end of the petroleum age before it will pay to use this gigantic source of nutrients. Meanwhile, we continue to be profligate with our use of cheap energy, as well as heavily subsidized water,[*] in producing our food crops. Local organic farmers are, therefore, left with no choice but to charge more for their produce than for the conventionally grown. Customers, however, are willing to pay a premium for fresh, organically grown and naturally (as opposed to chemically) ripened fruits and vegetables. I am sure we all agree that the difference in taste is easily recognizable. Furthermore, for a "grower" like me, the delight in eating what you have carefully tended for months is the ultimate reward.

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[*] Farmers in the west receive federal allotments of irrigation water released from the amount stored behind government built dams. The fees paid by farmers for acre/feet of irrigation water are only a fraction of its actual cost, thus establishing a government water subsidy to farmers.