tinued to grow after the banning of persistent pesticides and now pesticide resistance is the highest ever in history.

Although science and technology have helped world agricultural production and these accomplishments should be viewed as good news, at the same time we must recognize that cropland, water, and other resource shortages and serious environmental degradation exist in the world. This is bad news for agriculture in the short term, but especially in the long term (*10*).

DAVID PIMENTEL
*College of Agriculture and Life Sciences, Cornell University, Ithaca, NY 14853*
MARCIA PIMENTEL
*Division of Nutritional Sciences, Cornell University, Ithaca, NY 14853*

REFERENCES

1. M. C. Latham, in *World Food Issues* (Center for the Analysis of World Food Issues, Cornell University, Ithaca, NY, 1984), pp. 55–64.
2. D. Pimentel *et al.*, *Bioscience* **28**, 772 (1978).
3. Instituto Centro Americano de Investigacion y Technologia Industrial, *An Environmental and Economic Study of the Consequences of Pesticide Use in Central American Cotton Production* (Central American Research Institute for Industry, Guatemala City, 1977).
4. I. J. Graham-Bryce, *Proc. 8th Br. Insectic. Fungic. Conf.* **3**, 901 (1975).
5. *The State of India's Environment 1982, A Citizen's Report* (Centre for Science and Environment, New Delhi, 1982).
6. *Agricultural Almanac of China* [Zhonoggue Nongye Nianjian (Agricultural Press), Beijing, 1980].
7. *United Nations Handbook of International Trade and Development Statistics* (Publishing Division, United Nations, New York, 1983).
8. AID Energy Policy Review Panel, *AID Energy Policy Paper* (Agency for International Development, Washington, DC, 1984).
9. G. P. Georghiou and T. Saito, Eds., *Pest Resistance to Pesticides* (Plenum, New York, 1983).
10. *State of the World 1985* (Norton, New York, 1985); *State of the Environment* (Conservation Foundation, Washington, DC, 1984).

*Response*: I wholeheartedly agree with Wiles that encouraging agricultural and other types of economic growth in developing countries is the best way both to attack hunger and to further our own trade interests. I had not intended to present a "solution" to the problem of declining U.S. farm exports, but rather to warn that we are faced with a long-term problem. Since more farmers in more countries are becoming *able* to produce more farm products, how do we rationally resolve who *should*? As Wiles notes, more countries are resorting to export subsidies. There is also a strong recent trend toward increased national self-sufficiency—sometimes at high internal cost.

Obviously, climatology is Kellogg's field rather than mine. However, I have a general impression that the riskiest projection of all is the long-term straight-line projection from the current situation. Necessity has been the mother of so much invention that the history of efforts to reorganize society on the basis of perceived long-term emergencies looks like the history of crying "Wolf!" We may very well have a serious problem with the greenhouse effect and its implications—if nothing major in the equation changes over time. If so, it is proper and important to warn that changes are needed. It is probably not correct, however, to fault a sectoral analysis for not including a particular concept of emergency that is probably going to be headed off. For one thing, I wonder if the burning of fossil fuels that has lent the greenhouse effect most of its power may not be displaced by new technologies that will be even more efficient and have less impact on the environment? Might not the pace or even nature of the greenhouse effect be altered by new corrective techniques?

In the next decade or so, it does not seem likely that the greenhouse effect will push much of the world's agriculture beyond the current range of rainfall or temperature variability.

The Pimentels are correctly concerned about the long-term maintenance of our resources and food productivity. However, they appear to have missed the point of my article. I was attempting to show that the *process* of agricultural research is successfully dealing with a broad range of agricultural constraints in ways that the limits-to-growth projections did not foresee. Furthermore, we can count on the process to make further progress so long as we continue to seek new knowledge.

I made no claim that science has eliminated our insect problems. I doubt that permanent total victory over insects is possible. But science has given us more potent, less persistent insecticides, integrated pest management, evolved a fascinating technique that may work against tse-tse flies, and developed methods of propagating millions of insect predators. Soil erosion is still a serious problem, but U.S. use of minimum tillage has doubled in a decade, "no-till" agriculture has tripled, alley cropping is proving a stable long-term system for West Africa, and the use of higher yielding seeds is taking pressure off fragile lands by making it possible to raise more food on stable lands. The worst erosion problems are, and will be, in the "low-tech" agricultures.

Fertilizer use in the LDC's doubled in the last, high-cost decade because more powerful seeds and farming systems cut real fertilizer costs per ton of food. Now, oil prices have fallen nearly 50 percent, and fertilizer use in the LDC's may increase even more rapidly.

The Pimentels say the world has 1 billion malnourished people. Alternatively, the World Bank says the proportion of the world's population whose health is at risk because of lack of food has declined significantly, to 6 percent in 1980. Another 6 percent of the world's population may have lacked enough calories for an active working life, but that proportion has declined despite enormous increases in population. It should also be recognized that most "hunger" estimates are soft numbers. Thomas Poleman of Cornell University has carefully documented the tendency to underestimate LDC food production and to overestimate the calories needed by "small but healthy" people.

Data from the Food and Agricultural Organization shows that LDC's raised their farm output 4.4 percent annually from 1979 through 1984 compared with a 2.4 percent annual rate a decade earlier. Their per capita food production increased 1.6 percent annually from 1979 through 1984, compared with a decline of 0.6 percent annually in the previous decade.

Something has given agricultural productivity enormous speed and momentum in recent years. I contend it has been the agricultural research process embodied in the new international research centers. This process has contributed untold benefits to human health and well-being, lessening the effect of population growth rates that are still too high and raising millions from abject poverty.

There are still real problems. The Pimentels are right to be concerned about them. But too many people have relied on "what ifs" and scare tactics to get support for the efforts they believed were necessary for the future. I have even heard it said that it was all right if the report of the Global 2000 Task Force was too pessimistic, since that would simply stimulate more output.

These scare tactics have led us into enormous mistakes. Much of the current U.S. farm crisis was precipitated by unrealistic expectations about a world food shortage and the consequent bid-up of land values. The "land and buildings" segment of U.S. farm costs rose from 16 percent of all farm costs in 1960 to 41 percent in 1982. Now, when U.S. land values have dropped 50 percent and the world has a structural farm surplus equal to more than 100 million metric tons of grain a year, payment for bad advice is being extracted from U.S. farmers, their creditors, and the taxpayers. What does a limits-to-growth philosopher say to a farmers' meeting these days?

Realism is the best basis for public policy. The world has made major progress against hunger and is likely to make more—if it continues to invest in research.

DENNIS T. AVERY
*Bureau of Intelligence and Research, U.S. Department of State, Washington, DC 20520*