Agricultural productivity: On borrowed time?

Agricultural productivity may be peaking out, according to a report by the National Academy of Sciences. Increasing crop yields resulting from additional fertilizer appear to be tapering off, as are the increasing yields per acre that have become an expected part of the continuing "Green Revolution." The results will be higher food prices and ultimately food shortages, unless agricultural research finds even more imaginative ways of increasing productivity and population pressures are finally brought under control, the report concludes. Summarizing these findings during a press briefing, Sylvan H. Wittwer, chairman of the academy's Board on Agriculture and Renewable Resources, said: "We could be living on borrowed time."

After studying the agricultural records of the United States and five European countries, the board's Committee on Agricultural Production Efficiency found that the rate of increase of total farm production was slowing, as was the increase of productivity per farm worker. The committee calls these findings "warning signals" that require immediate attention, and it addressed its report "to the nation," in the hopes that laymen will join in discussions of policy changes now necessary.

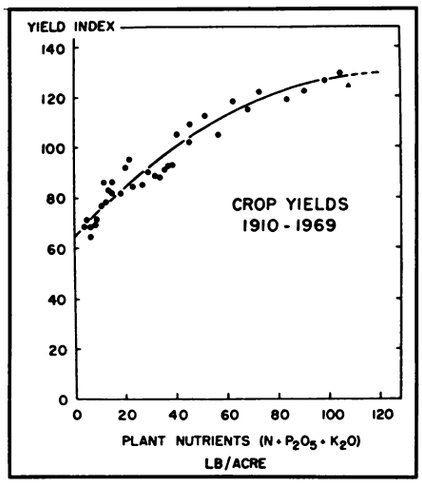
Policy areas cited as needing particular attention include land-use planning to restrain the loss of productive agricultural lands to other uses; environmental protection, with its sometimes incomplete analysis of the tradeoffs involved in protecting public health, and especially research, which now holds several exciting possibilities for increasing production.

At first glance, Federal and state support for agricultural research seems solid enough—having increased an average of almost nine percent a year for the last two decades. But the committee found several changes have occurred in the emphasis of that support, away from basic research and productivity studies toward consumer- and environment-oriented programs. While not criticizing these programs, as such, the committee warns that support for basic agricultural research may be in jeopardy and that any reduction in the backlog of available production technology could result in higher prices and shortages. Specifically, the proportion of university research funds spent on agricultural research has fallen by half since the late 1950's; yet if the same farming methods had been used in the 1970's as were common two decades earlier, the committee estimates that prices for the same quantity of goods would have doubled or tripled, instead of remaining relatively stable.

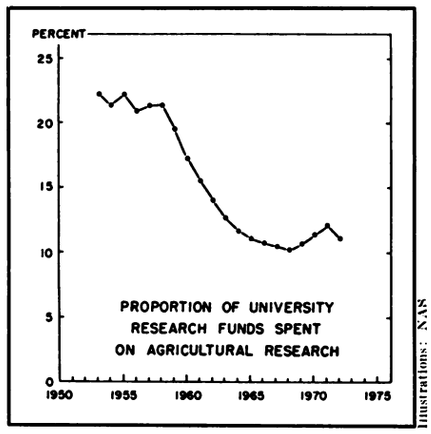
Productivity in agriculture is tapering off and new research is needed to assure future food supplies.

Though biological limits to the productivity of some crops may be in sight, much room still remains for innovation. To make more efficient use of sunlight, plant "architecture" is being modified to increase leaf area per acre. Plants using a chain of 4-carbon organic acids rather than the usual 3-carbon acids in photosynthesis promise a more efficient use of sunlight, especially in tropical countries. Atmospheric nitrogen utilization—important in reducing the amount of increasingly expensive fertilizer—is being improved through work on legumes, establishment of nitrogen-fixing ability in cereals and work with catalysts that promise to improve nitrogen utilization by nonbiological means. Plant breeding is taking another dramatic turn with development of asexual seed production, computerized "fingerprinting" of isoenzyme patterns in seedlings in order to rapidly select those with desirable characteristics and the birth of "quantitative genetics" to predict breeding patterns through mathematical models.

Animal husbandry did not keep pace with the first "Green Revolution," but hybrid cattle production is slowly improving. New techniques for transplanting fertilizer ova and young embryos and for causing cows to bear twins are being explored. Epidemiologists now have the means to make a substantial economic impact on livestock production through disease prevention, and the report recommends an intensive new program to provide trained personnel to put these tools to use. To increase the efficiency of feed utilization, new breeds may be introduced to the remaining open ranges of the Western states, and new techniques are being explored that may greatly



Crop yields are no longer on increase.



Agricultural research loses priority.

increase the amount of feed available from each acre of land. For example, ammonia may be added to silage where it reacts with organic acids in the material to form stable salts. These salts, in turn, can be transformed to useful protein in a cow's stomach through the fermenting action of microorganisms present there. The process would mean that whole corn stalks could be used to produce animal feed.

As the rest of the world struggles to increase food production, American research will gain in importance, notes Marion Clawson, a committee member. "Basic science is universal, technology is not," so the United States should begin emphasizing this aspect of its achievements, exporting the knowledge and techniques of basic agricultural science, rather than food or advanced farm technology. This will require a new national commitment, says Wittwer, who called for a "Manhattan Project" to improve plant efficiency.

Concludes the report: "There is an urgent need for agricultural research to receive increasing emphasis and much greater support. The future well-being of mankind could be at stake." □

Human cancer viruses: Search is still on

Three scientists at the National Cancer Institute announced last week that they have isolated a virus from the blood of a woman dying with a rare form of cancer of the white blood cells. This evidence strengthens the posture that viruses with cores of RNA as their genetic material cause some kinds of human cancers. Whether it is the strongest evidence so far that an RNA virus causes human cancer, however, is open to some conjecture.

The scientists are Robert Gallo, Robert E. Gallagher and S. Zaki Salahuddin. Their findings will appear in a forthcoming issue of SCIENCE.

The NCI scientists took blood from a woman dying with acute myelogenous leukemia, a rare form of cancer of the white blood cells. They mixed this blood with fluid from human embryo cells grown in the laboratory. The fluid contained a factor that was needed for the leukemia cells to grow. Five weeks later, a C-type RNA virus appeared in the culture. The scientists took more of the patient's blood and repeated the experiment twice. Each time again the cultured blood gave rise to a C-type RNA virus. Biochemical and immunological tests showed that the virus was similar to viruses that cause myelogenous leukemia in apes.

Scientists who are closely following the research of Gallo and his colleagues are enthusiastic, yet cautious. After all, a hunt for a human cancer virus has been on for years now. Says Raymond Gilden of Flow Laboratories in Rockville, Md.: "It sounds reasonably good, but I think it will require some time, really, to work out how significant it really is." Robert Huebner, a noted cancer virologist at the NCI, agrees. He, Gilden and George Todaro of the NCI have received some of the material from Gallo and his co-workers. They are now applying various techniques to confirm what Gallo and his colleagues have found.

Thus it is premature to say whether the virus Gallo and his team have found is the strongest candidate yet for a human RNA cancer virus. Certainly some others are also in the running. For instance, Elizabeth Priori of the M.D. Anderson Hospital in Houston discovered a putative human RNA cancer virus three-and-a-half years ago (SN: 9/18/71, p. 185). Although scientists at the NCI are fairly sure that Priori's virus is a mouse virus that made its way into human cancer tissue in the laboratory, recent studies by Robert Eckner of Roswell Park Memorial Institute in Buffalo suggest that it is not. Priori candidly admits, however, that the one scientist in the country who she thinks "has found a virus closest to a human cancer virus" is Elwin Frayley of the University of Minnesota.

And indeed, the virus that Frayley has found is provocative. First he found particles of an RNA virus in cancerous human bladder tissue. He took fluid from these tissues and passed it through a filter so that nothing larger than a virus could slip through with the fluid. He placed the fluid in the presence of other human cells. The fluid made the cells cancerous, suggesting that the fluid indeed contained a cancer-causing virus. But what is even more interesting, in Frayley's opinion, and what has never been shown before, "is that when these cells were transformed, they expressed an antigen, which was then recognized by the serum and lymphocytes of patients with bladder tumors." Other putative human RNA cancer viruses remain to be linked back immunologically to the cancers they are supposed to cause.

Two challenges, essentially, face scientists looking for human RNA cancer viruses: deciding exactly what such viruses should be compared with animal RNA cancer viruses, and proving that such viruses truly cause human cancer. Although Frayley's findings are perhaps the strongest to date that a RNA virus causes human cancer, he believes that "there is a long, difficult haul ahead before we have any idea of whether there is a human RNA cancer virus." □

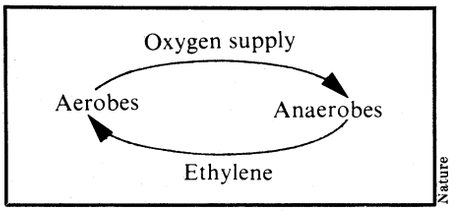
A new soil cycle: A basic link

The beginning of agriculture about 10,000 years ago signaled the beginning of human culture. Nomads became city builders, and architecture and science began to develop. Agriculture, unfortunately, also brought the depletion and sometimes destruction of the soil and an increase in root diseases. Advances have been made in restoring depleted soils and controlling root diseases, but the underlying causes of the problems are not completely known.

A basic discovery about the natural balance of soil microbes now promises to explain the link between cultivation and soil depletion and may lead to less damaging agricultural practices. A. M. Smith of the Biological and Chemical Research Institute in Rydalmere, Australia, and R. James Cook of the USDA's Agricultural Research Service in Pullman, Wash., report the discovery in the Dec. 20/27 NATURE. They describe a new soil cycle involving ethylene (C_2H_4), oxygen, aerobic soil microbes (those that use oxygen for respiration) and anaerobic soil microbes (those that do not use oxygen for respiration).

It was observed three years ago that the "seeds" of some fungi fail to germinate under apparently favorable soil conditions. Smith reported in late 1973 that the production of the volatile gas ethylene by soil microbes was responsible for the inhibition. The current paper goes on to explain the conditions under which ethylene is produced and its relationship to aerobes and anaerobes.

The main producers of ethylene in soil are spore-forming anaerobic bacteria, probably members of the genus *Clostridium*. These live in small pockets devoid of oxygen. The pockets are formed near bits of organic material after aerobic microbes have consumed some of the matter and the available oxygen. As the anaerobes proliferate, they produce ethylene which diffuses through the soil and stops the growth of the aerobes, including fungi, bacteria, actinomycetes and nematodes. But the mechanism is cyclical and self-regulatory. Air eventually seeps back into the pockets of anaerobic activity, shutting it off. Ethylene levels decrease



Cycle prevents microbial imbalances.