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Dialog on the Future of Agriculture

Most of the future-oriented discussion of prospects for world food have been conducted either by rosy optimists or gloom and doomsayers. An exception has been a series of dialogs organized by Vernon Ruttan of the University of Minnesota and supported by The Rockefeller Foundation. In this series an interdisciplinary group of experts has presented a substantial body of information and conducted lively discussions. Reports from two of the sessions have been printed by the University's Institute of Agriculture, Forestry and Home Economics. A third report is in press.

The discussions have centered around the factors that will determine that level of sustainable growth of agricultural production. These include biological, technological, and societal constraints. Of these, the most fundamental and enduring is biological. Plant breeders have devoted an enormous and successful effort over many years to improve yields of major crops. Much progress has been made in the breeding for pathogen resistance. However, new pests or variants of older ones keep appearing. As a result, a large fraction of plant research now must be devoted to maintenance research.

A secure food supply requires eternal vigilance. In the United States, the annual rate of improvements for yields of corn now is about 1%. In parts of Southeast Asia where much of the world's population lives, the rate for rice on experimental plots is now zero or slightly negative. During the Green Revolution, annual rates of increase of more than 4% were common on farmers' fields. In the discussions, it was pointed out that the big increases in yield did not come from an enhanced production of photosynthate. Rather they came from a redistribution of it in which seeds received more and stalks less.

In the United States, solar energy is not used very efficiently. About 12% of it could be devoted to photosynthesis. On average, the net amount captured is 0.5%. In part, the low rate reflects the fact that plant coverage of ground is partial during the growing season which, in turn, is only part of the year. A major challenge is to bio-engineer plants with a higher photosynthate efficiency of carbon capture and retention. That will not be easy.

Water pollution is now one of the major public concerns. Targets include fertilizers and eroded soil. It is not possible to attain zero pollution. Nature will not allow it. Soils will erode. Fertilizers must be used if people are to have food. When grain is harvested, it carries with it fixed nitrogen, phosphate, potassium, and other elements. If production is to be maintained, the amount withdrawn must be replaced. If not, yields could drop to as little as one fourth. Part of the fertilizer could be supplied by animal and green manures but not enough is available. However, excessive amounts of fertilizer can be applied. This is particularly true of fixed nitrogen compounds which are soluble and hence leak into ground water. The typical farmer attempts to optimize gains from a larger yield against costs of fertilizer. In Europe, where crop subsidies are high, the applications of fertilizers are about 2 to 4 times those of the United States. Pollution problems there are correspondingly acute.

Computers applied to agriculture may help alleviate the tendency toward inappropriate use of fertilizers. Soils differ in their yield potential and hence in the proper levels of input to them. A soil expert cited a 54-acre field on which there were seven mappable units. The field is typical of the glaciated agricultural soils of North America. The yield potential of the units varied from 112 to 162 bushels of corn per acre. Correspondingly, the recommended amount of nitrogen fertilizer ranges from 88 to 132 pounds per acre per year. Farmers usually fertilize their farms at levels corresponding to their best soils. Thus part of the land would receive excessive inputs. The phosphorus need based on soil tests ranged from 10 to 35 pounds of P_2O_5 per year. Soil surveys and production data are becoming available on floppy disks. A new model of a fertilizer spreader is equipped with a microprocessor that controls the appropriate distribution of fertilizer as the machine proceeds across a field. The technology and the machinery are only in their infancy, but it is likely that the technology will have a substantial future role in reducing pollution.

Low-value crop residues constitute about half of the agricultural yield. Their conversion into animal products is an important goal worldwide. In this effort, ability to genetically engineer animals will be important. Already, disease-resistant animals have been created, and there is optimism about achieving more efficient animals for use of farm residues.

The above presentation merely samples a few of the topics discussed in the dialog. The reports make good and informative reading.—PHILIP H. ABELSON

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