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by

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U. S. agriculture has gone through several stages in its development. For example, the period from 1920 to 1950 can be characterized as a "mechanical era", in which the transition was made from horsepower to mechanical power. That period was followed by the "chemical era" of 1950 to 1980, in which farmers dramatically increased their use of chemical fertilizers and chemicals for pest and disease control. The 1980s mark the beginning of yet another era in U.S. agriculture -- what has been labeled the "biotechnology and information technology era".

Each previous era has brought marked increases in agriculture's productive capacity, as well as major changes in the structure of agriculture. The "biotechnology and information technology" era is also likely to be accompanied by significant economic changes. To anticipate these changes and suggest policy responses, the U.S. Congress's Office of Technology Assessment (OTA) recently undertook a major study of technological and structural forces facing U.S. agriculture during the remainder of this century. The findings of OTA's study were released this March in a report entitled Technology, Public Policy, and the Changing Structure of American Agriculture (Wash., D.C.: U.S. Govt. Printing Office, 374 pages, $13.00). Highlights of that report are presented in this Newsletter.

Emerging Technologies for Agriculture

Emerging technologies expected to have major impacts on U.S. agriculture are grouped by OTA into biotechnology and information technology categories. The first, biotechnology, "includes any technique that uses living organisms or processes to make or modify products, to improve plants or animals, or to develop micro-organisms for specific uses". Recombinant deoxyribonucleic acid (rDNA) and cell fusion are the two molecular genetic techniques driving modern biotechnology. Use of these techniques enhances the prospects for some major productivity increases in both animal and plant agriculture.

In animal agriculture , biotechnology advances may increase productivity in such ways as the following: (1) mass production of biological products to be used in the detection, prevention, and treatment of infectious and genetic livestock diseases; (2) injection of growth hormones to increase productivity (for example, trials indicate that hormones can increase the milk production of cows by 20 to 30%, with only a modest increase in feed intake); (3) insertion of genes with different traits into the reproductive cells of livestock, allowing future animals to be endowed permanently with traits of other animals; and (4) embryo transfers, coupled with prior treatment of the embryos for such purposes as creating twins and sexing.

The OTA report indicates that the near future impacts of biotechnology breakthroughs may be greater for animal than for plant agriculture, though in the long term the impacts may be greater in plant agriculture. Potential applications of biotechnology in plant agriculture include these: (1) development of new microbial inocula, for such purposes as producing naturally occurring insecticides capable of protecting plant roots against soil-dwelling insects; (2) expanded use of cell culture methods for plant propagation; and (3) plant genetic engineering, applications of which are presently only in early stages but have major potential impacts.

The second major area covered in the OTA report encompasses information technology, described as "the use of computer- and electronic-based technologies for the automated collection, manipulation, and processing of information for control and management of agricultural production and marketing". Such animal and plant applications of information technology as the following are likely to have significant impacts: (1) electronic animal identification; (2) electronic devices for estrus detection; (3) improved herd record keeping systems (eventually linked with the electronic animal identification systems); (4) microcomputers used in conjunction with centralized databases for pest management decision making; (5) microcomputer-based irrigation monitoring and control systems; and (6) use of radar, sensors, and computers in application of fertilizer, pesticides, and plant growth regulators.

Implications for the Structure of Agriculture

American agriculture has increasingly been taking on a dualistic structure. There are a large number of small and part-time farms, with annual sales of less than $100,000, clustered at one end of the spectrum. These farms are very much dependent on off-farm income. At the other end of the spectrum are the large and very large farms, with annual sales of $200,000 or more. These farms account for more than half of U.S. agricultural production, even though they constitute only a small proportion of the total farm numbers. Moderate size farms, with annual sales ranging from $100,000 to $199,000, now represent only a small share (19%) of the total U.S. market. This segment, however, is traditionally thought of as the backbone of American agriculture.

The emerging biotechnologies could accelerate the current trend toward more vertical integration and toward large and very large farms. More control will be possible over end-product characteristics, such as the amount of fat per unit of lean in meat. This will facilitate additional contracting, particularly in livestock production. Increased vertical coordination of production, marketing, and processing tends to lead to fewer and larger farms.

Substantially increased production capacity, such as in milk production, could aggravate surplus problems. This would squeeze profit margins of farms in all size categories, but may put special pressure on small and moderate size farms that have not been able to incorporate the latest production technologies.

Some of the new information technologies, on the other hand, have the <u>potential</u> for helping moderate size farmers keep abreast of market and other information that is essential for them to remain competitive. However, for that potential to be exploited, management capacity must continue to be enhanced. This places demands on both the individual producer and the public sector institutions serving the producer.

Public Sector Roles

In fact, the OTA report stresses certain roles that the public sector will need to play in the "biotechnology and information technology" era if moderate size farms are to have an opportunity to compete. Among those roles are: (1) increased assistance in risk management, particularly educational programs on alternative marketing methods; (2) evaluation of new biotechnology and information technology products available to farmers, since moderate size farmers can not possibly do very much of the necessary screening and experimenting themselves; and (3) targeting of technology development and transfer services at moderate size farms, to ensure farms in that size category similar opportunities for early adoption to those of large and very large farms. Much of the new biotechnology and information technology is being developed by private sector firms. Producers and consumers, however, depend a great deal on Land Grant Universities and other public institutions to evaluate and adapt these technologies and to educate the public about their uses, strengths, and shortcomings.

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