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Reordering the mission of agricultural research at land-grant universities

by Carl R. Zulauf and Luther G. Tweeten

The overarching mission of the land-grant system is to combine teaching, research, and extension to create and disseminate knowledge that benefits society. One focus of this mission has been to improve the production capability and economic efficiency of farming. This agricultural mission has been achieved with mostly positive payoffs for the environment, consumers, producers, and the nation. However, the real dollar value of federal support for agricultural research has stagnated. If federal support is to expand in the future, a new mission is needed.

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In 1990, U.S. farmers used 17 percent less aggregate conventional inputs than in 1950 (figure 1). Conventional inputs are land, labor, chemicals, machinery, feed, and other production inputs. Despite the aggregate decline in these inputs, farm output doubled between 1950 and 1990. The explanation for these divergent trends lies in increased productivity. Productivity gains since 1950 alone accounted for 57 percent of farm output in 1990, while conventional inputs accounted for only 43 percent.

A legacy of accomplishment

The agricultural component of the land-grant system contributed to this productivity revolution in farming by providing the nonconventional inputs of research, education, and extension. The agricultural component used science to improve crop seeds and livestock. It also trained scientists and engineers for private industry, which in turn developed improved farming inputs. And it trained farm and agribusiness managers and technicians who utilized the improved inputs.

Productivity payoff to the environment and natural resources

The 1990 crop output would have required 734 million acres if it had been produced with 1950 technology. That's 424 million acres more than the 310 million acres harvested in 1990. Part of the increased acreage undoubtedly would include highly erodible soils.

As well as making it possible to avoid such fragile areas, current farming practices and technologies also markedly reduced soil erosion on existing crop land. Based on data reported in the 1938 *Yearbook of Agriculture* and the 1987 Conservation Needs Inventory, sheet and rill erosion fell from over 3.5 billion tons in 1938 to 1.6 billion tons

in 1987. Intensive crop and livestock farming may cause water pollution and these problems warrant attention. But they should not detract from the progress which reduced soil erosion, historically the most serious farm environmental problem.

Productivity payoff to consumers

Since 1950, the share of personal consumption expenditures spent on U.S. farm commodities by U.S. consumers has declined from 12 percent to 3 percent (Dunham). This declining share of expenditures devoted to farm commodities freed income for improved transportation, better houses, more entertainment, cultural enrichment, and so forth.

Productivity payoff to producers

The number of U.S. farms declined from 5.6 million in 1950 to 2.1 million in 1990. Some farmers and rural towns were negatively impacted; however, the economic well-being of those left in farming improved dramatically. In 1950, per capita disposable income of the farm population was 53 percent of the per capita income of the nonfarm population. In 1990, income of farm families averaged at least that of other American families (see Graphically Speaking, *CHOICES*, First Quarter 1993).

Productivity payoff to the nation

Estimated returns to agricultural research differ among studies, geographic areas, years, enterprises, and functions, but a typical estimate is a 40-60 percent internal rate of return for all U.S. crop and livestock public research and extension (e.g., Huffman and Evenson and Braha and Tweeten). Few public or private investments pay better.

Recent trends in public funding for agricultural research

Consistent data on the allocation of public research dollars between state and federal sources are available from 1969. Since then, real public expenditures on agricultural research have steadily increased, but state funds account for almost all the increase (figure 2). Real federal funds have remained stable at approximately $1 billion since the late 1970s. State funds now exceed federal funds.

The proportion of all federal research funds devoted to agricultural research has declined since 1969 (figure 3). Furthermore, since 1977 the share of federal research dollars devoted to agricultural research and the share of Gross Domestic Product (GDP) attributed to farming have declined in a lock-step fashion. These trends suggest that the public agricultural research establishment, including the land-grant system, should find another mission.

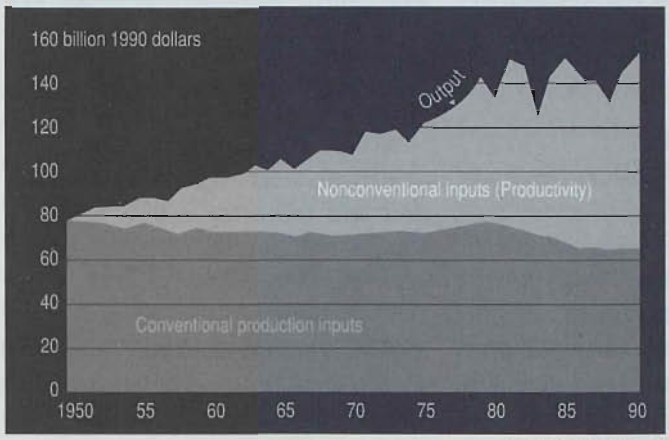
New uses—a new focus

As with its historical focus, any new focus for the agricultural component of the land-grant system should have the potential to significantly add to the well-being of all Americans. One potential new focus that meets this criteria is the development of new nonfood and nonfeed uses for farm commodities.

Interest in new nonfood and nonfeed uses for farm commodities first emerged during the 1920s and 1930s when farm commodity prices were so depressed. However, World War II and increasing farm price supports not only raised prices, but raised them relative to other raw commodities. The momentum toward new uses ceased, and was rekindled only when farm prices collapsed in the early 1980s.

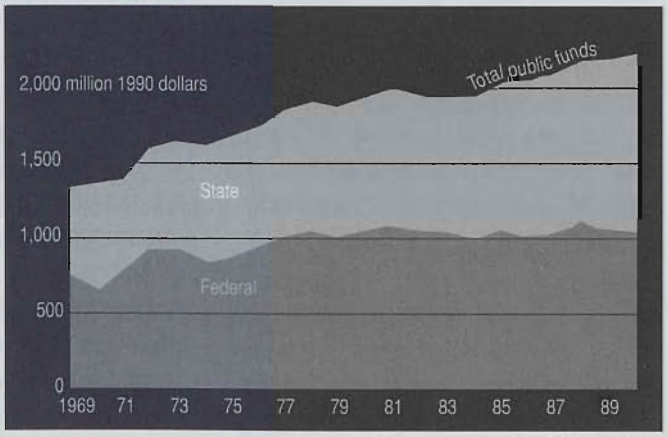
For three reasons, new uses offer a greater opportunity for success now than during the 1930s. First, measured at the stage of crude material for further processing, the price ratios of foodstuffs and feedstuffs to (1) fuel and (2) nonfarm raw commodities except fuel decreased 75 percent and 30 percent, respectively, between 1950 and 1990 (figure 4). Although the price data used to construct figure 4 only go back to 1947,

Figure 1. Farm output and sources of farm output growth, 1950-1990.



Source: Basic data from USDA

Figure 2. Public funds for agricultural research, U.S., 1969-1990.



Source: Huffman and Evenson

data using more aggregate measures of raw commodity prices suggest that price ratios are lower now than during the 1920s and 1930s. This evidence does not imply that farm commodities are currently economical replacements for other raw materials in industrial uses, but it does suggest the competitiveness of farm commodities has increased.

Second, recent advances in science, notably biotechnology, increase the chance of success for new uses of farm commodities. For example, researchers have genetically engineered rapeseed to produce polymers that are useable as degradable plastics.

Third, new demands for environmental quality can in part be met by new uses for farm commodities. For example, oil from approximately 300,000 acres of soybeans is used to supply newspapers with printing ink, especially color ink. Soybean oil-based ink was developed under an initiative by the American Newspaper Publishers Association after the price of petroleum-based inks rose sharply during the 1970s. A side benefit of soybean-based ink is lower emission of volatile organic compounds (see Hudson and Harsch for a detailed discussion of soybean oil-based ink and other new uses). On the other hand, environmental regulations may not always favor farm commodities. For example, new air quality regulations could further limit the use of hexane, the principal solvent used to extract soybean oil.

Concluding observations

The agricultural component of the land-grant university increased farm productivity by combining research, teaching, and extension and significantly benefitted not only farmers but society in general. Key goals of the land-grant system were met and its success garnered public support over a long period of time.

Founders of the agricultural component of the land-grant system did not know precisely how three blades of grass could be grown where one grew before, but a vision existed. Another vision, this time to develop nonfood and nonfeed uses for farm commodities, emerges as advances in science merge with declining real prices of farm commodities and increasing environmental awareness.

Despite widespread interest and some small steps, such as the establishment of an Alternative Agriculture Research and Commercialization Board to enhance technology transfers from research to commercial application, little public funding exists for research on new uses. Expanding publicly-funded research on new uses offers the potential to enhance farm income, help fight the environmental battle, and replace finite, mineral-based raw commodities with cheaper renewable raw commodities. The success of new uses research hinges in part on the price of raw farm products to industry. Continued public funding for traditional agricultural research is needed to keep these prices relatively low. A synergistic partnership exists between the old and proposed new visions for publicly funded agricultural research. ◘

■ For more information

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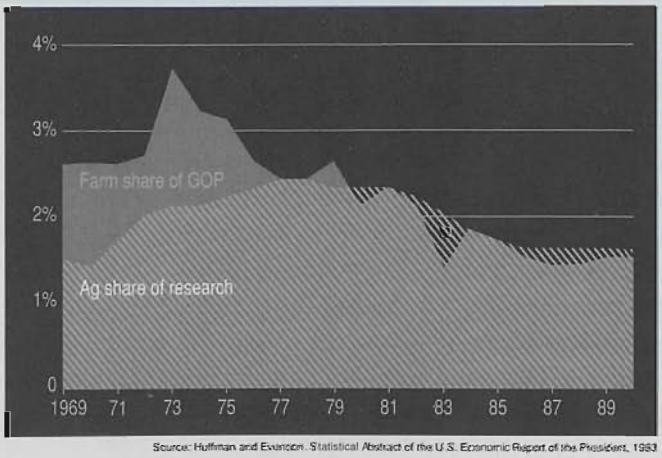
Hudson, Bill, and Jonathan Harsch. 1992. *New Industrial Uses, New Markets for U.S. Crops: Status of Technology and Commercial Adoption.* Prepared for U.S. Department of Agriculture for Biobased Products Expo 92, St. Louis, Missouri, October 6-9, 1992.

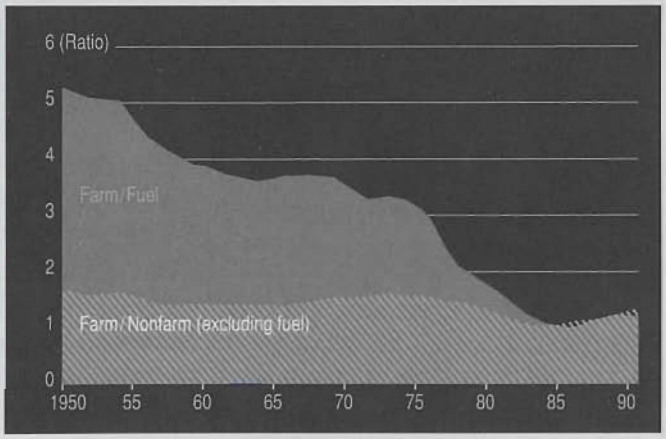
Huffman, Wallace, and Robert Evenson. 1993. *Science for Agriculture.* Ames: Iowa State University Press.

Figure 3. Farm share of GDP and ag share of total federal research, 1969-1990



Source: Huffman and Evenson. Statistical Abstract of the U.S. Economic Report of the President, 1993

Figure 4. Price ratios of foodstuffs and feedstuffs to fuel and nonfarm raw commodities excluding fuel, U.S., 1950-1991.



Source: Department of Commerce, Producer Price Index. Four-year moving averages