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## Investing in agricultural research and development

For much of this century, public and private investments in R&D have kept U.S. agricultural science and agricultural productivity on the leading edge internationally. Many of the mechanical, biological, and chemical innovations that have enhanced agricultural productivity worldwide have their origins in American agricultural research institutions. These investments have yielded high rates of social returns — as high as 45 percent a year. Today, however, American agriculture's competitiveness is eroding, partly because of underinvestment in R&D.

Currently, U.S. agricultural R&D expenditures total about \$4.6 billion annually — the equivalent of about 3 percent of the gross value of our agricultural production. Of this, private R&D constitutes about 57 percent, primarily in plant protection and nutrition and in postharvest processing and marketing research. Public investment, by comparison, concentrates more heavily in crop breeding and management as well as in livestock-related research.

The United States has the greatest investment in agricultural R&D of any single country. However, world agriculture and agricultural sciences are changing rapidly. Investment growth rates in agricultural R&D in several other countries, particularly the industrialized countries, have exceeded those in the United States in recent years. Relative to the economic value of their agriculture, investments in those countries now exceeds the U.S. investment by a substantial margin. The preeminent position occupied by U.S. agricultural science in the past 50 years can no longer be taken for granted.

Trends in U.S. public sector investments in agricultural R&D also give rise to concerns about the capacity of the system to sustain agricultural productivity and competitiveness into the 21st century. Beginning with the enactment of the Hatch Act, which created and provided the federal financial support for the Agricultural Experiment Stations at the land grant universities, public investment in agricultural R&D has been shared by the federal and state governments. Generally, researchers have looked to public investment, and in particular federal investment, for support of longer-range, or basic, knowledge-creating research, and to private research more for the "D" part of the R&D nexus. Recently, however, adjustment for inflation shows that federal support of state agricultural research through the USDA has been stagnant. Federal support through "formula" funds actually declined by nearly 20 percent in real terms in the 1980s. Although a modest USDA competitive grants program (currently about \$42 million annually) has helped to sustain more basic research in the states, it too has been stagnant. The growth in funding of special research grants through the USDA, often earmarked with respect to site and purpose, has done little to arrest declining federal support of knowledge-building, basic agriculturally related research. Fortunately, other federal agencies such as the NIH and the NSF have increased their support for research in the Agricultural Experiment Stations, preventing a precipitous decline in overall federal support of basic research.

State support of agricultural research varies widely. The State of California is by far the largest single source of support (65 percent) for UC's Division of Agriculture and Natural Resources. Although that support totals about \$92 million annually, by far the most of any state, it represents less than 1 percent of California's annual gross farm income. Here, too, the modest increases in state appropriations in the past five years have been earmarked for applied rather than basic, mission-oriented research.

These changes and trends in public investments in agricultural R&D, if continued into the 1990s, will pose ominous overtones for U.S. and California agriculture's productivity growth and competitiveness in global agricultural markets. The one major means available to California agriculture for maintaining productivity growth, and thereby basic economic competitiveness, is a continued flow of improved and new technology. In the coming decades, maintaining the growth of California's agricultural productivity will be made more complex and difficult than in the past by the necessity of minimizing the environmental effects of agriculture and food production. New or modified production systems must be developed at the farm level as well as in the food processing and input-supply sectors to cope with issues such as soil salinity, deteriorating water and air quality, pesticide use, and food safety, as well as the likelihood of higher costs for the water and land used in agriculture.

Clearly, there is now substantial public underinvestment in agricultural R&D, particularly in the more basic, knowledge-creating research needed to generate improved and new technologies for the late 90s and the early 21st century. Two recent reports suggest the magnitude of that underinvestment. The Board of Agriculture of the National Research Council, in its 1989 report "Investing in Research," called for a tenfold increase in USDA-administered competitive agricultural research grants to \$500 million annually. In 1988 the National Science Foundation estimated that \$743 million was needed to repair or renovate U.S. agricultural and biological research facilities; another \$1.9 billion was needed to construct new facilities for the same scientific areas.

The American economy, including agriculture, created a boon of employment and personal income, and a cornucopia of consumer goods and services in the post-World War II era unrivaled by any country in history. In major measure, that attainment was made possible by farsighted public and private investments in scientific R&D. However, in the past two decades U.S. competitiveness has eroded substantially in several economic sectors such as steel, automobiles, and electronics, in part because of underinvestment in R&D. In recent years, agriculture's competitiveness has been under increasing pressure, and that will probably continue to increase in the years ahead. The most important means to maintain agriculture as a vibrant sector of the California and American economies is to reverse recent public investment trends in agricultural research. Increased investment is needed now and throughout the 1990s if we are to assure our competitiveness into the 21st century.