# Contents

# Summary

Research is a cornerstone of economic growth and development. The Federal Government has played a major role in supporting agricultural research for over a century, transforming U.S. agriculture from a resource-based industry to a science-based industry. At the same time, the demands placed on the U.S. agricultural research system are changing. Consumers and taxpayers expect a wider set of issues to be addressed, including consumer health and food safety, environmental protection, and rural quality of life. Another major change in agricultural research within the United States over the past three decades has been the growing importance of the private sector in both funding and conducting agricultural research. This report re-examines the role of the public sector and the Federal Government in agricultural research. Based on this re-examination, three broad conclusions emerge:

- ***Agricultural research continues to be a solid public investment.*** Publicly funded agricultural research aimed at improving productivity has earned an annual rate of return of at least 35 percent. Consumers, farmers, and investors in agricultural industries broadly share these returns. Even with increasing expenditures for research by the private sector, there is no evidence that the return to public research has fallen off. A 35-percent rate of return is higher than returns on conventional investments in the private sector. This high rate of return suggests that further allocation of funds to agricultural research would be generally beneficial to the U.S. economy, even if it meant reducing other investments.

- ***Agricultural research continues to require involvement by the Federal Government.*** Providing effective patent protection for biological innovations is difficult; as a consequence, the private sector generally underinvests in research. Private sector developers have captured as little as 10 to 12 percent (or less) of the economic benefits from improved nonhybrid crop varieties. Where more effective protection exists for intellectual property rights, the public sector has reallocated public funds away from variety development toward fundamental, or pre-technology, research. This reallocation is in the direction economic analysis would recommend because it focuses scarce public sector funding on research that is unlikely to be done by the private sector. State governments have also been important funders of agricultural research. However, States lack the incentive to fund many types of research because the benefits frequently accrue to farmers and consumers outside the State that paid for the research.

- ***The most compelling case for Federal funding is for more basic research, for the development of nonhybrid crop varieties and other technologies where private incentives are weak, and for research that informs public and private decisionmaking.*** The private sector has little incentive to conduct research in certain areas. These areas include basic, or pre-technology, research (such as plant and animal genetics, pathology, and physiology; conservation and development of unimproved germplasm; and soil physics and chemistry) and research that improves public and consumer decisionmaking (such as basic and applied research on agriculture's relationship to water quality; global climate change; soil quality and land degradation; ecosystem loss; human nutrition and diet; and food safety and quality). Increasingly scarce resources for public agricultural research place a greater burden on research administrators to allocate resources to high-priority areas. They must carefully assess public versus private, and Federal versus State, responsibilities in science and technology development. Economic cost-benefit analysis can be a useful tool for identifying high-payoff areas, although assessing prospective benefits of research and nonmarket benefits remains difficult.

A variety of institutions and market incentives support and encourage agricultural research in the United States These range from direct public funding by Federal and State governments to strengthening private ownership rights to new technology to encourage private individuals and firms to invest in research. With the 1980 Stevenson-Wydler Technology Innovation Act and its 1986 amendment, the Technology Transfer Act, new private-public cooperative research efforts were made possible.

Besides the general conclusions above, several specific conclusions relate to public sector research:

- ***Lack of growth in Federal agricultural research expenditures and the requirements of maintenance research constrain the ability of the public agricultural research system to respond to new demands.*** Federal expenditures for agricultural research account for about 60 percent of the total financial support for public agricultural research in the United States. However, these expenditures have not grown in real terms since the mid-1970's. As much as 30 percent of current expenditures are used to maintain current productivity levels.

- ***Institutional changes in the Federal-State partnership in agricultural research are affecting how research priorities are determined, the mission of the land-grant universities, and the distribution of Federal funds among States.*** Federal support for agricultural research at land-grant universities and State agricultural experiment stations increasingly comes as project funding instead of the traditional block grant, or formula-funding, system. In 1994, formula funds accounted for only 30 percent of Federal support for State institutions, down from 61 percent in 1970. Federal agencies other than the USDA administer an increasing share of Federal funds for agricultural research.

- ***Increased reliance on private sources of funding has raised concerns that private industry could exert a disproportionate influence on the public agricultural research agenda.*** Universities and State agricultural experiment stations rely on the private sector for an increasing share of agricultural research funds. In 1994, nearly 20 percent of agricultural research at State institutions was funded by private industry, product sales, or other private donations, up from 14 percent in 1978.

With the growing importance of the private sector, agricultural research is now a shared responsibility of both the public and the private sectors. Judgments about how and where to spend public funds must consider the level and direction of private agricultural research funding. We have found that:

- ***Private R&D tends to be more commercially oriented than public research.*** Private industry spent at least $3.4 billion for food and agricultural research in 1992, compared with $2.9 billion in the public sector. More than 40 percent of private agricultural R&D is for product development research, compared with less than 7 percent of public agricultural research.

- ***Federal R&D policies and regulations affect private research.*** Government policies affect private agricultural research in several ways. Investments in public agricultural research can lead to increased private research, because of new market opportunities created by scientific and technological advances. There is little evidence that public agricultural research crowds out private research. Intellectual property rights encourage private research by allowing an innovative company to capture a greater share of the benefits from research. Regulations can increase the cost of product development and, thus, discourage private investment in research. At the same time, regulations can encourage research on technologies that are more compatible with environmental, food safety, and nutrition goals.

- ***Strengthened ownership rights for intellectual property for biological inventions have increased private incentives for biological research, but these rights have also raised concerns for future scientific progress.*** In 1992, private industry spent $400 million on plant breeding, and nearly $600 million on all agricultural biotechnology research. However, private incentives to conduct pre-technology research, such as the development of elite germplasm, remain weak, and private investment in applied plant breeding remains uneven across commodities. Patenting of biotechnology inventions has raised concerns that monopolies on new technology may slow longrun progress in biological sciences.

- ***New institutional arrangements are being developed to increase public-private collaboration in agricultural research.*** Cooperative Research and Development Agreements (CRADA's) are formal arrangements between Federal laboratories and private companies to jointly develop and commercialize new technologies. The USDA is also working to establish research consortia between public research institutions and private industry.

Existing evidence suggests that the benefits of research spill over beyond the borders of individual countries. U.S. support of international agricultural research helps diffuse technology abroad and makes an important contribution to reducing hunger and malnutrition around the world. It also brings back technologies that directly benefit U.S. agriculture. However, the "free-rider" problem may also limit the incentives for individual countries to support global agricultural research. The broader issues of the ability of the world to feed a growing population and the relationship between U.S. and international agricultural research are important topics for future research.

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# Abbreviations

**APHIS**—Animal and Plant Health Inspection Service

**ARS**—Agricultural Research Service

**CRADA**—Cooperative Research and Development Agreement

**CRIS**—Current Research Information System

**CSREES**—Cooperative State Research, Education, and Extension Service

**EPA**—Environmental Protection Agency

**ERS**—Economic Research Service

**ESCOP**—Experiment Station Committee on Policy

**FDA**—Food and Drug Administration

**FDCA**—Food, Drug, and Cosmetic Act

**FIFRA**—Federal Insecticide, Fungicide, and Rodenticide Act

**FTE**—Full-time equivalents

**IPR**—Intellectual property right

**GDP**—Gross domestic product

**GEM**—Genetic Enhancement for Maize

**JCFAS**—Joint Council for Food and Agricultural Sciences

**NCI**—National Cancer Institute

**NIH**—National Institutes of Health

**NLEA**—National Labeling and Education Act

**NRC**—National Research Council

**NRI**—National Research Initiative

**NSF**—National Science Foundation

**OTA**—Office of Technology Assessment

**PVPA**—Plant Variety Protection Act

**PVPC**—Plant Variety Protection Certificate

**R&D**—Research and development

**SAES**—State agricultural experiment station

**UPOV**—Union for the Protection of New Varieties of Plants

**USDA**—United States Department of Agriculture