Recent Institutional Changes and Trends in Funding

The public-policy debate concerning the levels, emphases, and mechanisms of public agricultural research funding provides a context for the data summarized in this report. This debate has long been a feature of the funding process. Many of the arguments influencing the debate over the period covered in this report stem from reports from the National Academy of Sciences (1972) and the Rockefeller Foundation (1982). These reports advocated a shift away from geographically specific applied research toward more basic biological research and an increase in peer-reviewed and competitively funded agricultural research. National Research Council publications in 1994 and 2003 continued to back increases in basic research and in competitive funding.

Pros and cons of various agricultural research funding mechanisms, including competitive grants and formula funds, have been discussed by Alston and Pardey (1996) and Day Rubenstein et al. (2003). Huffman and Evenson (2006b) also discussed the relative merits of these two mechanisms, but, in contrast to the National Academy or the Rockefeller Foundation, they argued that transaction costs severely limit the effectiveness of competitive funding instruments.

Policy proposals have continued to stress competitive funding, fundamental agricultural research, and research aimed at broad national goals. One approach for increasing competitive allocations has been to propose greater emphasis on competitive grants within existing authorizations. However, an important recent change to research policy has been the proposed combination of changed funding mechanisms with institutional reorganization through the creation of a National Institute to fund extramural agricultural research, primarily through competitive grants.

For example, in 2004, the Research, Education, and Economics Task Force at USDA, composed of experts from academia and from USDA, developed a proposal for such an institute. As envisioned, the mission of this institute would be to support fundamental agricultural research with a goal of increasing the international competitiveness of American agriculture. The primary funding mechanism of the proposed institute was to award new competitive peer-reviewed grants that would be *in addition to* existing competitive public research funding.

The Food, Conservation, and Energy Act of 2008 (the 2008 Farm Act) states that the Secretary of Agriculture shall establish a National Institute for Food and Agriculture. As stated by the Act, NIFA will administer research funds and programs formerly administered by CSREES. NIFA will replace CSREES as of October 1, 2009. The Act also authorizes $700 million in competitive grants under the Agriculture and Food Research Initiative, to be administered by NIFA. This, however, is authorized funding; past competitive funding instruments such as the NRI, discussed below, have been authorized at higher levels than have been appropriated for actual spending.

Formula Funds

In addition to competitively awarded funds, a major source of funding for public research provided by USDA's Cooperative State Research, Education, and Extension Service comes from formula funds. These Federal funds provide support for research and extension activities at land-grant institutions and are appropriated to the States on the basis of statutory formulas that have changed only infrequently, as the result of legislation. Eligibility is limited to cooperating institutions, which are mainly 1862, 1890, and 1994 land-grant institutions.

Hatch Act formula funds support the State Agricultural Experiment Stations. SAES are required to provide matching funds at least equal to the federally appropriated Hatch funds for that State. A certain portion of these funds are allocated to a multistate research fund that provides money for cooperative research employing multidisciplinary approaches conducted by the SAES, working with other SAES, the Agricultural Research Service, or a college or university, to solve problems that concern more than one State.

Evans-Allen Program formula funds support 1890 land-grant institutions. Recipients of these funds must also provide a 50-percent match from non-Federal sources. McIntire-Stennis formula funds support State-designated institutions' cooperative forestry research programs.

Animal Health formula funds support research into the prevention and control of animal diseases that affect agricultural productivity. The Smith-Lever Act provides Federal formula funds through the Cooperative Extension Service for cooperative extension activities. The law requires that States provide a 100-percent match from non-Federal sources. Formula funds also support extension activities through Extension Programs for 1890 Institutions, the Renewable Resources Extension Act. Formula funds are also provided for education activities through the Tribal College Endowment Interest Program.

Competitive Grants and Competitive Funding in the CRIS System

Public policy discussion in agricultural research funding has frequently considered what percentage of public-research funding should be committed to basic research, and what percentage should be competitively awarded. One policy response to these ongoing discussions has been to increase competitive grants funding through CSREES. Analysis of competitive grants funding (Day Rubenstein et al., 2003; Huffman and Evenson, 2006b) has focused on CSREES-administered competitive grants. These grants were initiated in 1978, grew somewhat in funding in the mid-1980s, and received an additional boost after 1991 through National Research Initiative (NRI) funding.

It is difficult to identify competitive research funding for agriculture outside of named programs such as the NRI. Both sources and performers of public agricultural research in the United States are numerous. Some aspects of competitive grants (e.g., peer review) are applied in other areas of public research funding. And it is certainly conceivable that more full-fledged competitive processes could be applied at times to funding sources outside

the NRI. In the time frame we are considering, expenditures from the CSREES-administered NRI program can be tracked most consistently over a relatively lengthy time period.

However, in addition to the NRI program, CSREES competitively funds research for 20 other initiatives, including aquaculture centers; the International Science and Education Grants Program, which includes the Food and Agriculture Defense Initiative; disadvantaged farmers; 1890s institutions (historically black universities); and small business research under the SBIR program. By far the most likely additional source to be primarily competitive in nature would be funds received by the SAES from non-USDA Federal sources. In many cases, SAES have also received funding from Federal agencies such as the National Institutes of Health, the Department of Energy, the National Science Foundation, and so on, likely obtained through a competitive process. Such funds are not explicitly listed as "competitive" in the CRIS system.

Basic and Applied Research in the CRIS System

Students of science and science policy have often attempted to distinguish between fundamental ("basic") research and applied research. The first definitions below are grounded in the linear model, in which research is conceptualized as flowing from basic or fundamental research to applied research (Bush, 1945). Almost from the time Vannevar Bush formalized this model, the model has been under criticism and revision as an inadequate representation of how scientific progress and practical applications are made. Nonetheless, the distinction between basic and applied research continues to be part of ongoing debates over science policy.

Basic research is sometimes considered to have the primary objective of advancing knowledge and understanding the relationships among variables. It may be thought to be driven by the researcher's curiosity, and conducted without a practical end in mind. It may have unexpected results pointing to practical applications, although they are not the focus of the research. In any case, basic research provides the underpinning for further research, both basic and applied.[7]

Applied research is performed to solve specific, practical questions. Its principal purpose is not to gain knowledge for its own sake. It is often considered to be founded primarily on basic research.[8]

"Development" or "developmental" research refers to activities that are even closer to the production of a marketable product or process. It can be defined as systematic application of knowledge directed toward the production of useful materials, devices, and systems or methods. This can include the design, development, and improvement of prototypes.

The linear model has been subject to a number of criticisms. In fact, most representations of the linear model do not envision a stark distinction between basic and applied research, but rather indicate a continuum flowing from the most basic to the most applied research. Some observers have also noted that there are often feedbacks from applied to basic research. In

[7]The Food, Conservation, and Energy Act of 2008 defines "fundamental" research as research that "(i) increases knowledge or understanding of the fundamental aspects of phenomena and has the potential for broad application; and (ii) has an effect on agriculture, food, nutrition, or the environment." Note that the first part of the definition is similar to our discussion here; the second part actually specifies the sectors of application.

[8]The 2008 Act defines applied research as "research that includes expansion of the findings of fundamental research to uncover practical ways in which new knowledge can be advanced to benefit individuals and society."

attempting to solve certain practical problems, scientists at times have to revisit fundamental scientific questions.

Yet other students of science have argued that there is no strict association between a motivation of fundamental understanding and a motivation based only on curiosity, devoid of considerations of use. Stokes (1997) proposed a quadrant model:

Research is inspired by:

Quest for fundamental understanding?	Considerations of use? No	Considerations of use? Yes
Yes	Pure basic research (Bohr)	Use-inspired basic research (Pasteur)
No	*	Pure applied research (Edison)

* Research that "systematically explores particular phenomena without having in view either general explanatory objectives or any applied use to which the results will be put."

Source: Based on Stokes, 1997.

At times, a distinction between basic and applied research has been made based on the amount of time between research and reasonably likely practical applications. But once again, the study of any particular research development usually shows that the "paths between scientific discovery and new technology" are "multiple, unevenly paced, and nonlinear" (Stokes, 1997).

Whatever model of basic and applied research is chosen, agricultural research would not be categorized as the most pure basic research. As with many other research areas, for example, biomedical research, almost by definition agricultural research is conducted with considerations of use. Although fundamental biological, chemical, or physical insights are required, application to a particular economic activity, agriculture, is intended. However, as noted in this report, a number of observers have believed for some time that future progress in agricultural science is dependent on a greater emphasis on basic biological understanding.

When measuring basic and applied research, the CRIS database relies on a simple scheme. For each public agricultural research project, respondents to the CRIS questionnaire are asked to indicate the percentage of each project devoted to basic research, the percentage devoted to applied research, and the percentage committed to development effort. (As noted, "development effort" would refer to research that is not only designed to answer a practical question, but is also intended to yield a feasible product or process.) This method is not without problems. For example, different researchers might divide the same research project into basic and applied components in different ways. Researchers might also tend to rank their projects differently depending on whether they thought basic or applied research was more likely to receive funding. We have assumed in this report that researchers have tended to classify their projects consistently over time.

Alternative means of determining which research projects (or components of research projects) are basic, applied, or developmental would add significantly to the cost of data development, however. For example it might be possible to design an index of "basicness" calculated on predetermined criteria, or to make the determination by a single, centralized committee rather than relying on project-by-project respondents.

It is possible to regard the attribution of public agricultural research expenditures in the CRIS system to basic, applied, or developmental research, based on self-reporting, as a proxy variable for the "true" division among these three categories. Trends in the reported amounts of basic, applied, and developmental research are likely correlated with the trends that would be recorded with some more elaborate means of measurement. This is the assumption made in this report.