An Assessment of the United States Food and Agricultural Research System

December 1981

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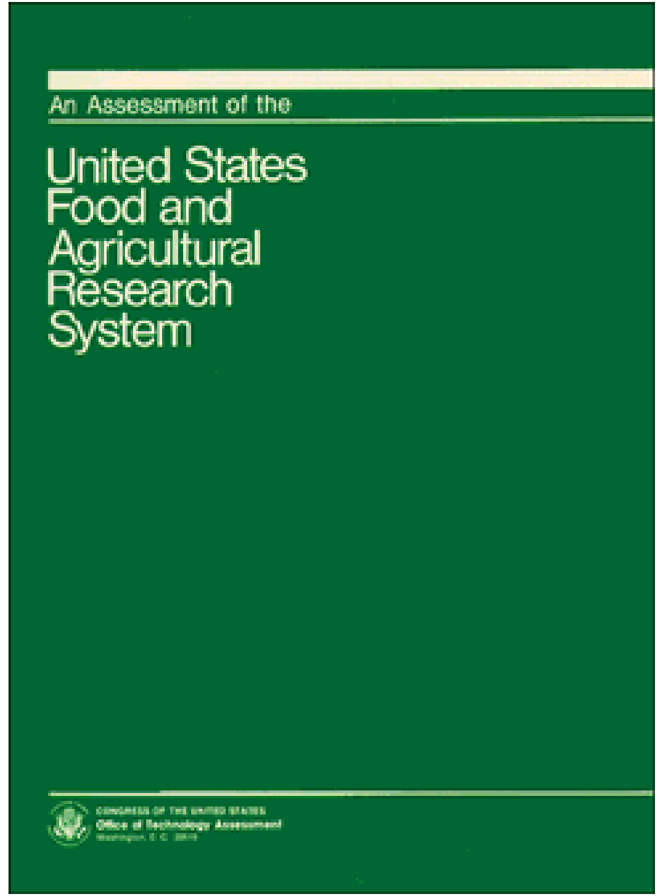

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Foreword

This report examines the U.S. food and agricultural research system. The U.S. food and agricultural enterprise has been extremely successful, in part because of sustained public support of agricultural research and demonstration. As we face a future of increased demands on our agricultural resources, it is essential to ensure that the research system function as effectively as possible. Congressional concern centers around the roles of the research participants, long-range research priority planning, funding for research, and the organizational structure of the food and agricultural research organizations. The Senate Committees on Appropriations and Agriculture, Nutrition, and Forestry, requested OTA to address these issues. The House Agriculture Committee endorsed the request. OTA was specifically asked to focus its assessment on the structure of the research system and thus complement previous studies which identified research priorities.

In early 1981 the draft report of this project was made available to the staffs of the requesting committees, USDA, and AID for review and comment. It is gratifying to note that USDA and AID have already begun to make changes within their organizations to deal with some of the problems identified in the report. Also, material in the report has been used in drafting current legislation that amends title XIV of the Food and Agriculture Act of 1977.

OTA was assisted by three work groups and an advisory panel of research administrators, scientists, farmers, processors, retailers, consumers, and those concerned with the relationship between food and agricultural sciences and society. The advisory panel was instrumental in helping us identify the issues for analysis and in reviewing the commissioned papers and drafts of the report. The work groups provided guidance in identifying the topic, component parts, and authors for each of the commissioned papers, and in reviewing the papers and drafts of the report, Sixty reviewers from universities, government, and industry provided helpful comments on report drafts. OTA expresses sincere appreciation to all these individuals.

JOHN H. GIBBONS
Director

U.S. Food and Agricultural Research Advisory Panel

Aileen Adams
Consumer Consultant

Roger Blobaum
president
Roger Blobaum and Associates

Carl W. Carlson
Retired
U.S. Department of Agriculture

Demonic L. Carney
Director
Division of Agriculture
Department of Natural Resources
State of Alaska

Tony J. Cunha
Dean
School of Agriculture
California State Polytechnic University

Susan De Marco
Consultant

Robert Di Marco
Director of Central Research
General Foods Corp.

Harold Dodd
president
Illinois Farmers Union

Lewis C. Dowdy
Chancellor
North Carolina Agricultural and Technical State University

Thomas F. Jones*
Vice President for Research
Massachusetts Institute of Technology

Jarvis E. Miller
Texas A&M University

Albert H. Moseman
The Rockefeller Foundation

Lewis F. Norwood
Director of Affiliate Relations
National Association of Retail Grocers of the United States

William A. Reiners
Professor
Department of Biological Sciences
Dartmouth College

James E. Tillotson
Vice president
Technical Research and Development
ocean Spray Cranberries, Inc.

Harold L. Wilcke
Retired
Ralston Purina Co.

*Deceased.

OTA Food and Agricultural Research Assessment Staff

Joyce C. Lashof, Assistant Director, OTA
Health and Life Sciences Division

Walter E. Parham, Program Manager
Food and Renewable Resources Program

Michael J. Phillips, Project Director

Omer J. Kelley, * Principal Investigator

Dana G. Dalrymple, " * Senior Analyst

Elizabeth A. J. Williams, Senior Analyst

Ward W. Konkle, * Writer and Editor

Administrative Staff

Phyllis Balan, Administrative Assistant

Gillian Raney   Marilyn Cassady   Elizabeth Galloway

OTA Publishing Staff

John C. Holmes, Publishing Officer

John Bergling   Kathie S. Boss   Debra M. Datcher   Joe Henson

*OTA contract personnel.
* *On detail from USDA and AID.

Work Group I: Management of Food and Agricultural Research

James Albrecht
Vice President for Business Development
The Nestle Co.

William P. Flatt
Dean
College of Agriculture
University of Georgia

Hugo O. Graumann
Retired
U.S. Department of Agriculture

Robert Judd
Managing Director
National Soybean Crop Improvement Council

Roy L. Lovvorn
Retired
North Carolina State University and U.S. Department of Agriculture

Thomas S. Ronningen
Director-at-Large
Northeast Regional Association of State Agricultural Experiment Station Directors
University of Maryland

John Stovall
Deputy Director
Joint Planning and Evaluation
Science and Education Administration
U.S. Department of Agriculture

Work Group II: Structure, Evaluation, and Funding of Food and Agricultural Research

C. L. Duncan
Vice President
Campbell Soup Co.

B. R. Eddleman
Director
National and Regional Research Planning and Analysis, SAES
Mississippi State University

Earl Glover
Retired
U.S. Department of Agriculture

R. J. Hildreth
Managing Director
Farm Foundation

James Kendrick
Vice President
Agriculture and University Services
University of California, Berkeley

E. F. Knipling
Retired
U.S. Department of Agriculture

Vernon Ruttan
Professor
Department of Agricultural and Applied Economics
University of Minnesota

Work Group III: Determination of Food and Agricultural Research Priorities

Thomas Army
Deputy Administrator
Agricultural Research
U.S. Department of Agriculture

Charles E. French
Coordinator of International and Interagency Programs
Development Support Bureau
Agency for International Development

Keith Huston
Director-at-Large
North Central Regional Agricultural Experiment Station Directors

Ronald D. Knutson
Professor
Department of Agricultural Economics
Texas A&M University

Donald Kuesel
Vice President and Director of Quality Assurance and Research
Larsen Co.

John P. Mahlstede
Associate Dean
College of Agriculture
Iowa State University

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Chapter I

Summary

NOTE: This report was largely completed in early 1981 and refers to the food and agricultural research system as of that date. Draft copies of the report were made available at that time for congressional committee staff and executive agencies. Some of the report's potential solutions to food and agricultural research problems have already been enacted. The text has not been revised to reflect all those changes, but the more important ones have been mentioned in footnotes. /

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Chapter I

Summary

The food and agricultural industry in the United States is by far the largest of all our industries. In 1980, farm assets totaled over $900 billion. And one of every five civilian jobs was in the food and agricultural industry. Agricultural products rank first among all U.S. exports. Moreover, food costs to U.S. consumers, while rising, are among the lowest of any country in the world.

Food and agricultural research has contributed markedly in making the United States a giant of industrial enterprise. Research has given us new and better ways to improve production, processing, and marketing. In addition, agricultural research is solving problems in environmental quality and human nutrition. The aim of such research is to assure an ample, safe, and nutritious food supply at reasonable cost, while maintaining a sustainable production system. The United States is generally recognized throughout the world as a leader in agricultural research.

Despite its notable achievements, the U.S. food and agricultural research establishment today is facing new problems. These problems are exerting severe strains on our ability to meet current and projected challenges. Scientists are concerned that new technology may not be keeping pace with domestic and world needs.

The tight world supply-demand balance is also a growing problem. Unless major breakthroughs occur in either expanded resources or new technology, the world food problem is likely to worsen. Changes are also occurring in the structure of agriculture. For example, large farms and businesses have more influence than small farms on the direction public research programs take. New technology tends to be adopted more readily by larger and more mechanized firms than by smaller and less organized agricultural interests.

Recognizing this trend toward industrialization of agriculture, the Office of Management and Budget (OMB) has taken the stand that funds for some forms of public agricultural research are no longer needed. The implication is that the private sector has enough resources to conduct its own research. This argument has been used most specifically for post-harvest technology research. In the future, the argument might be expanded to other forms of technology-related food and agricultural research.

The 1970's brought a host of new public issues and concerns that will likely continue in the 1980's. These include food safety, environmental protection, nutrition, and increasing competition for water resources.

Today, there are additional pressing issues: sustainability of the present agricultural system, water shortages in the West, widespread droughts, excessive soil erosion, increased energy costs, and continued environmental concerns.

Because Federal research funding has not substantially increased in recent years, new research problems must be funded at the expense of traditional research. Moreover, the cost of conducting research has increased. Research today requires more sophisticated and costly equipment and support staff than 10 years ago. Thus, many research areas are receiving relatively much lower real funding today than earlier.

The U.S. Department of Agriculture (USDA) and the State agricultural experiment stations (SAES) have always had a close working relationship in food and agricultural research. As a general rule, USDA has been concerned more with national and regional problems, and the SAES with local and State problems. But over the years, the SAES research programs have grown to include problems of regional and national significance.

With the present structure of USDA, there is some question as to whether USDA has a national research program or merely a series of local and regional activities. Consequently, USDA and SAES appear to be working on seemingly indistinguishable problems. Many people, including Congress, have voiced concern that little, if any, overall planning and coordination of research exist, especially at top levels of administration. They question whether national issues are receiving adequate attention. Further, there seems to be much duplication and vying for funds.

Now, the question arises: How should these new issues and concerns be handled? Over the years, there have been many studies dealing with food and agricultural research. Most studies, such as the World Food and Nutrition Study, have concentrated on agricultural research priorities. These studies have identified the research that requires highest priority and the level of funds needed for the research. Few of these studies have looked into the structure of the research system. There has been little, if any, attempt to identify roles of research agencies or to seek solutions to the problems they face. In addition, there has been little, if any, attempt to classify research from a management perspective.

Congress and others have raised questions about the allocation of research resources and the mechanisms used to develop research priorities. Other issues of concern include the adequacy of research funding, the distribution of research benefits, and the quality of expertise and interest being brought to bear on identifying and conducting research.

These concerns led directly to a request from Congress for the Office of Technology Assessment (OTA) to undertake an assessment of the U.S. food and agricultural research system. Congress stressed that the assessment focus on the structure of the research system and that it complement previous studies which identified agricultural research priorities. The requests for an assessment came from the Senate Committee on Appropriations as well as the Senate Committee on Agriculture, Nutrition, and Forestry, The House Agriculture Subcommittee on Department Operations, Research, and Foreign Agriculture also endorsed the requests,

The objectives of this assessment are to:

1. evaluate the funding, benefits, and burdens of food and agricultural research;
2. determine the basis, scientific or otherwise, for the classification of research from a management perspective;
3. identify the roles of Federal, State, and private institutions in developing technologies for solutions to international, national, regional, and State or local problems;
4. examine the management, structure, and policies of USDA in the conduct of food and agricultural research;
5. evaluate methods by which the expertise and interests of Federal, State, and private research organizations can be brought to bear cooperatively in identifying priority research areas; and

60 provide public policy options for Congress that will maximize our research potential.

The working groups and advisory committee that prepared and reviewed the resource material for this assessment recognized the urgency for resolving the issues that characterize the present situation in the agricultural research sector. They were motivated by a deep concern for maintaining a strong and growing food and agriculture industry. It is hoped that the analysis of these issues and public policy options offered herein will provide a good starting point for increased effective use of the Nation's scientific capabilities and other research resources.

STRUCTURE OF THE RESEARCH SYSTEM

When it is working properly, the U.S. agricultural research system is tremendously effective. The participants* —USDA, SAES, and private industry—concentrate on mission-oriented research; that is, research directed toward solving identifiable problems, although the programs include some basic research activities. Most land-grant universities and many nonland-grant universities have strong discipline-oriented research programs in the basic sciences, such as physics, chemistry, and botany, that form the foundation of biological and physical sciences on which agricultural research is based.

Federal Research

USDA is the major Federal agency conducting agricultural research. It is also the lead agency for the coordination of all federally funded agricultural research. Through early 1981, the Science and Education Administration (SEA) of USDA was responsible for: 1) broad agricultural research policies and coordination and 2) an operating organization which had day-to-day management supervision over a number of offices including Agricultural Research (AR), Cooperative Research (CR), and Human Nutrition (HN). **

AR is responsible for most of USDA's inhouse agricultural research. AR is accountable and responsive to Congress and the executive branch for broad regional, national, and international concerns. It is headed by an administrator located in Washington, D. C., and four regional deputy administrators, one located in each of the four SAES regions. Each region is subdivided into areas under a research area director (fig. 1). A national program staff (NPS) prepares an integrated budget and assists in technical planning and coordination. NPS has no direct line responsibility for program development, staff selection, or resource allocation.

CR is responsible for administering Federal funds that go to States for agricultural research. This includes formula funds, special grants, and competitive grants. Formula funds help to provide a stable and dependable base, ensuring a strong experiment station in each State. Grants provide an opportunity for researchers in nonland-grant universities, SAES, and other institutions to work on problems important to the agricultural industry.

Human nutrition research in USDA is carried out by six research centers. Research at all centers is directed to national concerns.

Through early 1981 the economics research program was conducted by the Economics and Statistics Service (ESS). In addition to research, its primary objective is the collection and analysis of economics data. *

State Agricultural Experiment Station Research

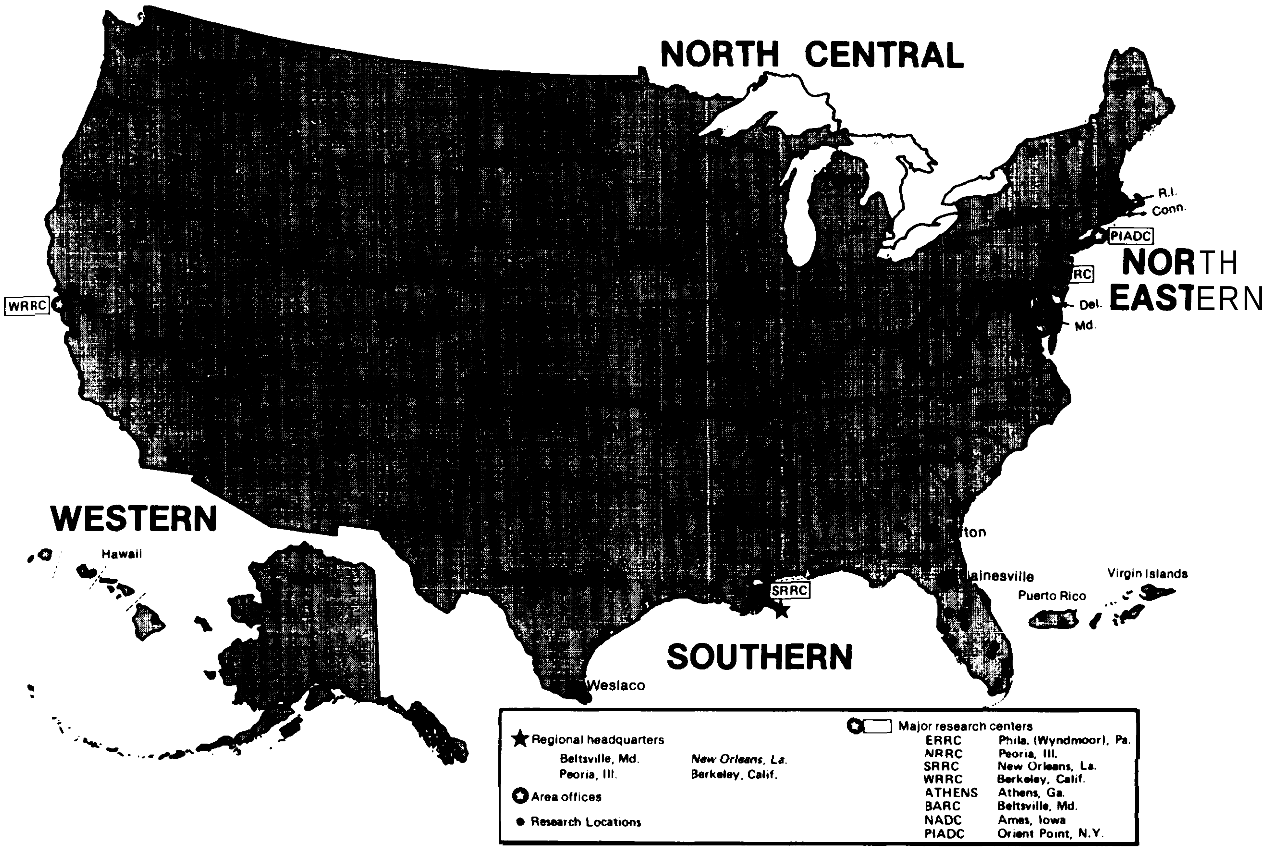
Over the years, the structure of SAES has changed little. Stations typically include a central station and headquarters, which is generally located on the campus of the State's land-grant university, and a number Of branch stations located throughout the State (fig. 2). Stations are organized by departments according to the various scientific disciplines represented on their staffs, such as departments of animal science, entomology, plant pathology, etc. These departments usually are the same as those of the academic unit and, in

*A large number of Federal agencies and public and private institutions are also involved in U.S. agricultural research. This assessment, however, is concerned primarily with the traditional agricultural research system, which includes the USDA research agencies, SAES, and private industry. The 1890 schools, nonland-grant universities, etc., are discussed where most relevant, but no in-depth study was made of them. Forestry research is not included in this assessment,

**In June 1981, USDA announced a reorganization that eliminated the Science and Education Administration and established AR, CR, and Extension Service as separate operating agencies. Most of HN was merged into AR. USDA established an Office of Science and Education, which is to establish broad agricultural research policies, planning, and coordination.

*In June 1981, USDA announced a reorganization that eliminated the Economics and Statistics Service and established two separate agencies, Economic Research Service and Statistical Reporting Service.

Figure 1.—USDA Agricultural Research System



SOURCE: U.S. Department of Agriculture.

most cases, also include extension. In many cases, USDA personnel are located in departments and participate fully in departmental activities. The chief administrative officer of each department typically reports three ways —to the dean, to the director of SAES, and to the director of cooperative extension service.

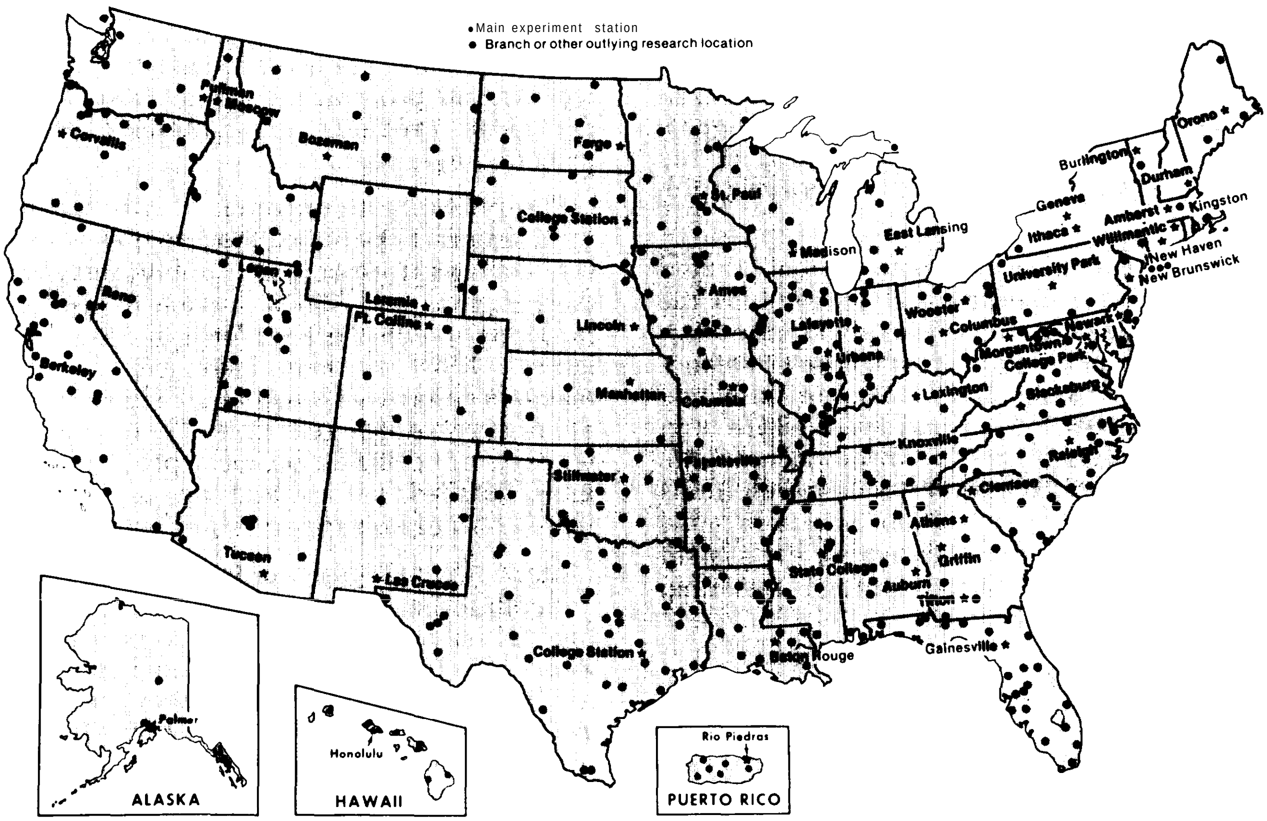
In the early 1900's, the station director reported directly to the president of the university. Today, most station directors report directly to the dean of the college of agriculture. This relationship of the SAES working with the land-grant universities and USDA provides a unique opportunity for graduate training of future scientists for research, teaching, and other State, Federal, and industry needs. In fact, it is by far the principal source of trained scientists.

Beginning in the 1960's, increasing amounts of non-State funding became available from agencies other than USDA. USDA funding remained stable or declined, and grants to some SAES scientists tended to draw them away from the State program toward the interests of individual scientists or the granting institution.

SAES-USDA Interaction

In many areas of agriculture research, there have long been closely knit cooperative relationships between SAES and USDA agricultural research. This relationship has been one of the strong points of the U.S. agricultural research system. Generally, it has resulted in scientists from each group developing respect for those from other groups. The major diffi-

Figure 2.—State Agriculture Experiment Station System



SOURCE: U.S. Department of Agriculture.

culties that have arisen are at the administrative level. The root cause of nearly all of these difficulties appears to be centered around competition for limited funds, which tends to create problems in the roles of the two groups. At times, this problem seems to permeate the entire system.

Private Sector Research

Participants in the private sector include foundations, industry, and industrial associations. Private industry research is conducted in those areas that are of major concern to the firm, primarily from a profit standpoint. While reliable data are difficult to obtain, private industry's investment in agricultural research appears to be about three-fourths of that of the public funds spent by USDA and SAES combined. Industry research tends to favor the developmental aspects and continues to draw heavily on basic research conducted in the public sector.

There are some 400 American philanthropic foundations that award grants of $5,000 or more to performers of agricultural research. The nature and purpose of the grants vary with the interest and purpose of the granting foundations. Compared with the amount of funds available to the performers of agricultural research from public sources, the amounts provided by foundations are indeed modest. The decision to make each grant is based on policies established by the individual foundation's governing board.

Other Research Institutions

At least 10 Federal agencies other than USDA conduct or fund some kind of food and agricultural research. In most cases, such research is complementary to that of USDA. It is conceived and operated to support the basic mission of the respective agency. In order to increase the effectiveness and productivity of Federal R&D agencies, Congress in 1977 mandated the establishment of the Committee on Food and Renewable Resources.

In 1890 Congress passed an act that granted certain Negro colleges and universities the same privileges as those provided by the Morrill Act of 1862. They are called the 1890 land-grant institutions and Tuskegee Institute. Under the 1977 Food and Agriculture Act, these institutions receive substantial amounts of formula-funded agriculture research funds from Federal sources. Their role is to meet the needs of those people whom the system was designed to serve through teaching, research, and extension.

The nonland-grant universities include private institutions and public State universities. The major expertise of the private nonland-grant universities lies in research in the basic sciences. They generally receive no direct continuing State or Federal assistance and support their research through government grants, endowments, and corporate grants and contracts. Competitive grant funding opens up an opportunity for the universities to be more involved in agricultural research. Large public State universities without agricultural programs have, in many cases, the same problems and interests as the private universities.

The public State universities with agricultural programs perceive their role as providing teaching, research, and public service to their regions and States in accordance with missions and charters set forth by State legislatures. Most of them have evolved from teachers colleges and have a strong emphasis on undergraduate teaching. Their research tends to concentrate on local problems of a more applied nature and on projects for which corporate support is more available.

Most nonland-grant universities have no Federal or State charter for research. Financing, heavily dependent on contracts and grants, has lacked continuity and dependability. Because of the concentration on undergraduate teaching, funding generally has not provided sophisticated facilities and equipment for graduate teaching and research, except for a few outstanding private research institutions.

PROBLEMS AND POTENTIAL SOLUTIONS

Food and Agricultural Goals

The lack of well-defined and agreed-upon national goals for U.S. food and agriculture is a major deterrent in formulating broad food and agricultural policy at the national level.

A goal is the end toward which effort and resources are directed. The end must be definable and achievable at least in theory. Other than general goals of self-sufficiency, the United States has not had well-articulated national food and agricultural goals.

There are implicit goals, but they provide little help in formulating policies and giving direction to the research community. One implied goal is to provide an ample supply of nutritious food for the consumer at reasonable cost with a fair return to farmers within an agricultural system that is sustainable in perpetuity. However, this “goal” is open-ended and, therefore, not achievable. For example, what is meant by “ample supply?” What is nutritious food? What is a reasonable cost to consumers? What is a fair return to farmers? When is this return to be expected? How much soil erosion or dependence on fossil fuel can a sustainable system tolerate?

These and other questions must be answered for a goal to be useful in formulating policy and for the research community in planning a research agenda. With such questions unanswered, setting research priorities is a difficult task at best.

Policy options

Congress and/or the executive branch could set national goals for U.S. food and agriculture. This could give a clear direction to the research community for developing a research agenda. Public funds would be allocated to research needed to meet goals established by society through its elected officials. Because society provides the funds for research, it can set broad long-term goals and expect the research community to respond accordingly through planning, conducting, and evaluating achievements.

Not setting explicit goals could save time and money at least in the short term. Goal setting is a complex, time-consuming endeavor, and because of the diversity of conditions under which food and fiber are produced, it could be a complicated procedure. However, in the absence of goals established by society, the research community has to set goals. Problems arise when there is lack of agreement on those goals and when there is no practical process for determining the views and priorities of those who are affected.

Research Priority Determination

There is no satisfactory long-term process for evaluating research activities, research opportunities, and development of research priorities. Decisions are made on an ad hoc basis with very little coordination among USDA, SAES, and other agencies conducting food and agricultural research. Long-term research planning, updated every 4 years or more, could be accomplished by an intensive study involving research administrators, scientists, users, and consumers.

Congress established the Joint Council on Food and Agricultural Science (JC) and the National Agricultural Research and Extension Users Advisory Board (UAB), which is made up of citizens, to aid in coordination and priority setting. These groups have struggled with their assignments. Concern exists as to whether the functions assigned to the JC are attainable. The council has had a limited impact because of: an inability to define its role, a perceived dominance by USDA, and overorganization. UAB's functions are more attainable than the JC's; however, the board's impact on research priorities is unclear. Neither of the units has the capacity to conduct a long-range systematic study of research priorities that involves scientists, research administrators, users, and others; neither was set up to do that.

Involvement of scientists and research administrators is needed for the obvious reason that they have the expertise and are the performers of the research. Research users are needed because they have specific problems that need to be addressed by research. Likewise, consumers have legitimate concerns that the research community needs to address.

Policy Options

Option **A.** Prepare a national research agenda, updated at specific intervals, using scientists, administrators, users, and consumers under the auspices of USDA. * Such a study could use methods like those pioneered by the National Academy of Sciences *World Food and Nutrition* Study and the OTA studies Nutrition Research Alternatives and Emerging Food Marketing Technologies for priority determination.

A planning system of this type would include a cross section of scientists, research administrators, users, and consumers. A small staff would manage the study. The bulk of the work would be conducted through a variety of work groups. This ad hoc feature is viewed as being critical to success in long-range infusion of new ideas.

Short-range planning would be done regularly by each research entity in conjunction with budget preparation. This system would not set priorities for SAES, since they are primarily responsible for State and local issues.

*The presently drafted Agriculture and Food Act of 1981 mandates USDA to conduct a long-range research planning study.

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The JC and UAB would modify their responsibilities to place emphasis on: 1) supervising the planning process, 2) providing a forum for communication, and 3) providing interim evaluation of planning goals. This modification would permit a more simplified structure than is currently anticipated, especially for the JC. Also, the number of meetings would be reduced.

Coordinating the study under USDA would be in keeping with its responsibilities for food and agricultural research established by Congress.

Option B. Prepare a national research agenda, updated at specific intervals, using scientists, administrators, users, and consumers under the auspices of the National Academy of Sciences (NAS). This would be the same concept as discussed in the previous option except that it would be coordinated under the auspices of NAS rather than USDA.

Some participants in the research system would consider NAS a more objective party than USDA. However, in the past NAS has resisted the use of lesser known scientists, nonscientists, users of research, and the public in conducting such studies. The success of this effort depends to a large extent on the participation of these groups. In addition, NAS expertise is concentrated more in basic rather than mission-oriented research. This would also weaken USDA's leadership role in research, which is contrary to recent legislation.

Funding

USDA research expenditures are proportionately the smallest of any major Federal research agency. In 1978, USDA's share of Federal expenditures for research and development was 1.5 percent of total expenditures compared with the Department of Defense—45 percent, Department of Energy—16 percent, and Department of Health and Human Services—12 percent.

The purchasing power of total SAES and USDA agricultural research expenditures increased 23 percent in constant dollars from 1966 to 1979. The constant-dollar agricultural research expenditures of USDA increased 1 percent, while those of SAES increased 40 percent from 1966 to 1979.

Total expenditures by private enterprise for food and agricultural research are about three-quarters of the expenditures of Federal and State governments combined.

Justification of public funding of food and agricultural research is based on benefits well in excess of costs.[1] Issues of equity, because of the interstate flow of food and related commodities and the spillover effect of research from one geographic region to another, are also cited. Producers benefit from expanding demand and reduced costs. The distribution of consuming population among States, however, is related to the distribution of agricultural production only to a very limited degree. Paradoxically, Federal research funding, relative to State funding, has decreased as the interstate flow of commodities has increased. Therefore, taxpayers in food-surplus States are subsidizing consumers in food-deficit States and the degree of subsidization is increasing steadily.

Policy Options

Option A. Maintain present Federal real funding levels. From a management standpoint, limited funding, up to a point, tends to increase efficiency in the use of funds. It focuses the use of funds on high-priority areas at the expense of less urgent areas. However, a certain level of funds is needed just to maintain the research system. This does not allow research institutions to keep pace with increasing costs, nor does it allow research in new problem areas without abandoning important traditional areas. From an equity

[1] Fred White, B. R. Eddleman, and Joseph Purcell, Nature and Flow of Benefits From Agriculture-Food Research, OTA background report, 1980.

standpoint, the ratio of Federal research funding relative to State funding would not improve, causing taxpayers in food-surplus States to continue subsidizing consumers in food-deficit States.

Option B. Significantly increase real Federal funding levels for food and agricultural research. Increased Federal funding would: a) allow research institutions to keep pace with the high cost of conducting research, b) allow the research system to open new areas of research while maintaining important traditional research effort, and c) increase Federal research funding relative to State funding, thereby decreasing taxpayer subsidization in food-surplus States to consumers in food-deficit States. From a management standpoint, however, an increase in funding may tend to decrease efficiency in the use of funds. Funds may not be focused on the highest priority problem areas.

Roles of Research Participants

There is a role for a strong national USDA research program. This role has been carried out in the past by AR, HN, ESS, and Federal funding to SAES. The USDA role has been associated with broad regional, national, and international activities. The role of SAES, insofar as Federal funds are concerned, has been primarily for local, State, and regional problems. There has been considerable overlap; some portions of the Federal and State roles are becoming indistinguishable.

USDA's role is to conduct research on: a) agricultural problems important to the Nation, problems that no one State or private group has the resources, facilities, need or incentive to solve, and b) those programs required to fulfill stated objectives of Congress, the President, and the Secretary of Agriculture. USDA could carry out its role by: a) working as a partner with SAES to achieve complementarily and b) cooperating with private universities and industry to coordinate its own contribution to achieve national goals with minimum effort.

Most of the 1890 land-grant institutions and Tuskegee Institute research funds come from Federal resources and if they are to meet their obligations, pressing needs must be addressed. One important need is improved facilities. But an even more important concern is the future role of these institutions and their ability to compete for and maintain faculty and staff. While there is some cooperation with USDA and SAES, coordination with the system is less than adequate.

In 1977, Congress established the Committee on Food and Renewable Resources (CFRR) to improve coordination of the research activity of USDA and the 10 other Federal agencies involved in food and agricultural research. CFRR has not yet satisfactorily fulfilled its role. As of early 1981, CFRR did not have a classification of the food and agricultural research conducted or funded by these agencies nor the amount of funds allocated for such research. Identifying definite objectives for CFRR would be helpful. Further, CFRR lacks authority to carry out the functions assigned by Congress. USDA has an opportunity to take an aggressive leadership role in this area, but to be effective it will require high-level attention and support.

Grant funds provide resources to further the program of USDA. SAES, nonland-grant universities, and other institutions compete for these funds on the basis of their interest and ability to do Federal research. This broadens the base of resources for agricultural research.

The private sector tends to view its role primarily from a profit potential. It conducts research in areas of interest to the companies and in areas that may give them proprietary advantages. There are significant research areas of interest to the public that are not receiving nor are likely to receive adequate research attention if left to the private sector.

Policy Options

Option A. Maintain present roles with clarification. This option would imply continuation of most existing procedures.

USDA would continue in its role as lead agency in the Federal Government in coordinating all agricultural research, extension, and teaching activities conducted or financed by Federal funds.

This provides Congress and the executive branch with one Federal agency, USDA, to hold responsible and accountable for the coordination of all Federal agricultural research funds, and broad regional, national and international research programs. It provides a mechanism whereby Federal funds can go directly (through formula funding) to SAES to have available resources of the institutions for problems of national concern. It also recognizes the public interest in support of a decentralized system of food and agricultural research and provides a mechanism for handling problems of local and State concerns.

This option continues to perpetuate the concern of SAES of too much direction and coordination of research conducted with Federal funds. It also perpetuates the problem of lack of strict accountability to Congress or USDA regarding what research problems formula funds are to be used.

Option B. Eliminate the in-house USDA research role. Provide increased funding to SAES to conduct most publicly supported research. Funds to SAES would be increased on the basis that regional and national agricultural research problems would be solved by the cumulation of local and State solutions. Important national research issues, however, are not solved by a large number of researchers working "on" a problem, but by a few concentrating and coordinating their efforts on the more important aspects of the problem. There would be no research agency having direct responsibility and accountability for regional and national problems to the executive or legislative branches of Government. The research needs of action agencies of USDA would have to be solved by the SAES, or by adding a research function to the action agencies.

Option C. Eliminate the in-house USDA research role. Use present in-house funds, special grants, and competitive grant funds for contract research to carry out important USDA research programs. This would eliminate many Federal positions in USDA and would ease the personnel ceiling problem considerably. Coordination might be improved where the SAES or State universities receive contracts to carry out USDA programs. It might make the closing of some low-priority Federal facilities easier.

However, it would eliminate the largest agricultural research organization in the United States under one management system—AR. Since conduct of research on broad regional and national problems in agriculture is the principal purpose of the Federal programs, this function would be mostly lost. This plan could be an expensive alternative. Overall, it would be very disruptive to present research programs.

Option D. Reduce the role of the SAES in regional, national, and international research by eliminating all formula funds, leaving grants as their source of Federal funds. This would help to answer the criticism that formula funds are given to SAES without sufficient accountability and Federal management. It might help remove some of the competition between SAES and USDA over budgets. It would increase the probability that Federal funds going to SAES and other institutions would go to those judged to be most capable of performing good research, if done on a truly competitive basis. It would make it more certain that the funds were spent on high national priority problems.

However, unlike research in other fields, much of agricultural research is site-specific, simply because it is so closely related to problems of a specific area. And biological research must be long-term and continuous to be effective. Hence there must be facilities and professional staff available for such research, none of which can be created or dissipated on short notice. SAES are best equipped to manage this research, and formula funding provides continuous and secure source of funds for this activity.

Option E. Increase the role of the private sector through incentives to conduct more research of concern to the public. Private industry has the capacity to conduct more research and probably would if it were profitable. The private sector could probably be induced to increase its efforts in agricultural research through direct grants, reduced taxes, or other incentives. Since the nature of the private sector requires that it be concerned with self interest, no amount of incentives would assure adequate research on all issues of public concern. But the private sector could become more active through this process.

Management of U.S. Agricultural Research

The level of agricultural research funding has been constantly decreasing as a percentage of total Federal research and development. Within USDA, the number of positions assigned to agricultural research has been decreasing, and the relationship of the size of the agricultural research budget to other functions of USDA has likewise been decreasing. This indicates a lack of appreciation at the USDA policy level of the importance of agricultural research. Yet, a prime function of the director of SEA and the SAES directors is to assure that the importance of agricultural research is maintained in policy decisions.

Much of SEA's efforts are dissipated in operational activities at the expense of policy-level activities. This has resulted in inadequate funding requests by the executive branch, less-than-adequate funding by Congress, continuing vying for funds between USDA and SAES, and inefficient management at the agency administrators' level.

As of early 1981, SEA was headed by a director who had responsibility for: 1) broad agricultural research policies, planning, and coordination and 2) an operating organization which had day-to-day management supervision over AR, CR, HN, and its other offices.

The operating aspects of this dual responsibility: 1) reduce the time and attention that can be given to determining policy, planning, and coordination; 2) reduce the authority of the administrators of AR, CR, HN, and other offices; 3) reduce their operational efficiency; and 4) increase bureaucratic delays in decisionmaking.

AR is not organized to manage, conduct, and be responsive to broad regional, national, and international agricultural research needs and interests of the United States. When the 1972 reorganization of USDA's Agricultural Research Service transferred line responsibility to four regional administrators, the NPS was left without direct line responsibility for program development, staff selection, resource allocation, etc. This caused AR to lose much, if not all, of its ability to plan, manage, and conduct research on broad regional and national problems. AR's research has become more oriented to local and State issues. Not only does this provide opportunities for duplication, but it increases the likelihood that: 1) broad regional and national interest will not receive adequate attention and 2) Federal funds appropriated for these purposes will be diverted or used inefficiently.

CR is responsible for administering formula funds, special grants, and competitive grants. It conducts project reviews of activities that are supported by formula funds (Hatch Act), but these reviews are more a formality than an in-depth examination. As a part of the process, onsite reviews are held every 3 to 5 years at the request of the client institution. Their value rests mainly on actions taken by the institution being reviewed, since CR has no followup responsibilities. Further, CR has little authority in dealing with SAES. CR has at times tended to operate as though it were under the supervision of SAES, rather than the director of SEA.

It is questionable whether CR is the appropriate office to administer the competitive research grants. All U.S. research institutions and research scientists that have expertise and capabilities are supposed to be considered equally as potential grantees. Having one agency whose main function is so closely tied to one segment of the research community (and which receives a large share of the grants) administer the grants gives reason for concern.

SEA has not accomplished the intent of the Food and Agriculture Act of 1977 with respect to human nutrition research. SEA established human nutrition research as a mission, but it did not establish human nutrition as a separate budget item. HN consists of six research centers at which human nutrition research is conducted. Functioning of the centers, however, has been hampered by insufficient funding. The three newest centers are particularly hard hit because they had to be developed anew, and as of early 1981, the total professional staff at the three centers numbered only six.

As of early 1981, economics research remained combined with statistical reporting activities. Concern exists that this combination has caused confusion for the public. A small part of the economics research budget is allocated to research, and there is little cooperative effort with AR.

Policy Options

SCIENCE AND EDUCATION ADMINISTRATION

Option A. Operate SEA as a policy and coordination office. * SEA would no longer have an operating function and could spend full time on policy and coordination which does not now receive adequate attention. The administrators of the respective agencies would be responsible for the operating functions of their agencies. For example, budgets and other management functions would be prepared within each of the agencies and coordinated at the SEA level. This would improve management efficiency and reduce bureaucratic delays.

* USDA has begun putting this option into effect (see footnote ** on p. 5).

Option B. Establish an assistant secretary for research, extension, and higher education with a deputy assistant secretary who would coordinate agencies comprising SEA. * The position of director of SEA would not be retained. This would give research increased visibility in USDA and in the eyes of OMB and Congress. The office would have a larger role in forming overall USDA research policy. Administrators of the agencies within SEA would be responsible for the operating functions of their agencies. This has the potential for improving the efficiency and management of these agencies and reducing bureaucratic delays.

*The presently drafted Agriculture and Food Act of 1981 authorizes a USDA Assistant Secretary for Research, Extension, and Higher Education.

AGRICULTURE RESEARCH

Option A. Within AR, transfer line authority, including the responsibility and accountability for planning and coordination of research, and resource allocation for regional and national research, from regional administrators to NPS. This would restore to AR the capability to plan, execute, and be responsible for research programs with regional, national, and international concerns. It would reduce manpower requirements and strengthen the scientific aspects of AR's program. It would give greater assurance to Congress that funds appropriated for regional and national concerns were being spent on those issues. Less attention would be given to local and State issues. This change can best be handled by the executive branch.

Option B. Same as above, but consider a change in the number and location of regions to provide more efficient management and eliminate the offices of area directors. The geographical area covered by each regional deputy administrator was chosen to coincide with the SAES regional areas and has no significant correlation with regional research problems. Such problems do not follow State lines, nor does any group of regional problems fall within the same cluster of States. Consideration should be given to whether there is a need for four such regional administrators and, if so, determining their best geographic locations, including the possibility of locating them in the D.C. area.

Both options would eliminate the need for area director positions. All technical planning would be conducted by NPS and technical staff. With the reduced workload, it appears that regional administrators could carry out the administrative functions without area directors. Locating regional administrators in the D.C. area would facilitate focusing on broad regional and national issues. However, two advantages of locating them in the field and having their duties correspond to SAES regions are: a) to facilitate communication between regional administrators and SAES directors of the region and b) probably to aid in coordination at the management level. This change can best be handled by the executive branch.

COOPERATIVE RESEARCH

Option A. Strengthen CR's authority in managing Federal funds allocated to the States. CR would exercise more authority in approval and disapproval of proposed projects under formula funding and for review of such projects for continued, reduced, or discontinued funding. CR could represent the SAES in a more meaningful way on such items as budgets, research priorities, formula or grant funds, etc. Since the original Hatch Act makes the directors of the SAES responsible and accountable for the Hatch funds they receive, legislation would probably be required if a major change were to be made.

Option B. Establish formula funds as block grants and eliminate the CR office; establish a secretariat for handling block grants. Since SAES already have responsibility and accountability for Hatch funds, this would save time, funds, and personnel positions in administering these funds. It should have little or no adverse effect on the research programs. This option, however, would increase the criticism that formula funds receive little or no meaningful review by USDA (CR). Other services provided to SAES by CR would either be lost or picked up by another office.

Option C. For Options A and B above, eliminate administration of all competitive grants from CR or secretariat staff and establish an office for this function that would report directly to the director or assistant secretary. This would provide for administration of these grants by an office that had no vested interest in who receives the grants. This would improve the climate for more objective administration of the competitive grants program.

HUMAN NUTRITION

Option A. Maintain present management structure within USDA with clarification in budget and staffing. This would clarify HN's status within USDA. At present, administrative and budgetary authority are split. It would obviate possible conflicts of interest between AR research interests and HN interests. It can be argued that HN is not large enough to warrant a separate system, but it would carry out the mandate of Congress. This change can best be handled by the executive branch.

Option B. Remove HN from SEA and place it under the Assistant Secretary for Food and Consumer Services. This option would place all nutrition activity of USDA within the purview of a single assistant secretary concerned with human nutrition and would give the administrator of HN direct access to the assistant secretary. However, it would separate human nutrition from all other research in USDA. Placement of HN within an action arm of USDA would cause research results to be less respected than if they were produced by an independent research arm. It would tend to cause research to be directed toward the needs of that arm and thus hamper long-term research projects. It could politicize nutrition research so that research directions would change with each new administration. This change can best be handled by the executive branch.

Option C. Dispense with HN as an administrative and planning entity and disperse HN research within AR. Place each of the centers under the authority of the director for the region in which it is situated. Any positive aspects of such a move would be political rather than managerial. It would reassert that USDA places producers' interests at a higher priority than consumers' interests. Segmentation of HN research would make it extremely difficult for USDA to develop a coordinated research effort in human nutrition. It would also place the centers in a position of competing for funds with other research in a particular region, and research at the centers would lose its national character and could become focused on agricultural products of a region rather than on basic human conditions and their nutritional needs.

Option D. Dispense with HN as an administrative and planning entity, disperse the clinical and laboratory components within AR under the authority of the regional directors, and place the survey and statistical research and information services under the Assistant Secretary for Food and Consumer Services. * Food and Nutrition Service, the major agency under the Assistant Secretary would have closer coordination with the developers of nutrition-informative and educational material and with the researchers who survey and analyze food-consumption patterns in the United States. All the disadvantages of options B and C apply, as well as a problem of separating the development of educational and informational materials from the research on which they are based. Not only would the possibility of misinterpretation arise, but it would be necessary to hire additional staff to do the interpretive work, since the scientists who developed it would be in a different division of USDA.

*USDA has put this option into effect.

Option E. For all options above, determine if all regional human nutrition research centers are needed, and if not, which ones best serve the public interest. Available funds for human nutrition would be allocated to the needed centers. This would assure that funds allocated to human nutrition are used for high-priority needs and would assist in funding centers at a level commensurate with national interest. However, even though the centers are not adequately funded, there is continuing interest in these centers and a felt need for this research.

ECONOMICS RESEARCH

Option A. Reinstate the Economics Research Service (ERS) and the Statistical Reporting Service (SRS) to separate agency status reporting to the Assistant Secretary for Economics. * This option would aid in eliminating the confusion between the statistical unit's information and the projections and forecasts of the economics research unit. It would, however, create two entities where only one existed previously. This change can best be handled by the executive branch.

Option B. Reinstate ERS and SRS to separate agency status with SRS reporting to the Assistant Secretary for Economics and ERS reporting to the Director of SEA. This would mean that ERS would join the other research agencies in SEA. For the economic policy analysis that needs to be conducted, an analytic and policy staff would be assigned directly to the Assistant Secretary for Economics.

With all the major research agencies reporting to SEA, it would mean that coordination among research agencies is much easier. It would facilitate the integration of economics research with biological and physical science research, and by working more closely with these disciplines, it may be easier for economics research to obtain increased funding.

* USDA has put this option into effect.

It would, however, have some drawbacks. Only certain economics-research activities in ERS lend themselves to integration with biological and physical science research, and the economics unit might tend to be regarded as a service unit to biological and physical research. This change can best be handled by the executive branch.

International Agricultural Research

It is in the U.S. interest to help developing countries solve their technical problems related to food production and availability. Strengthening agriculture in developing nations: 1) enables them to increase their own supplies and reduces the need for expensive food aid from the United States, 2) stimulates their general economic growth so that they become better customers for trade with the United States, and 3) helps them attain the stability needed to provide a wide range of commodities that are important to the United States. Finally, it is the humanitarian thing to do, even where the United States receives no immediate benefit.

The U.S. Agency for International Development (AID) and USDA are involved in international agricultural research and technical assistance, but from the developing-country standpoint, AID is the prime Federal agency.

For AID to provide effective research and technical assistance to developing countries, it must have an in-house capability in the technical disciplines. Moreover, organizational structure, responsibilities, accountabilities, and procedures must reflect this fact. These conditions have not existed in AID. Technical staff is now scattered throughout the agency and no regional bureau has enough scientists to cover the required disciplines for developing-country programs. Advanced training of technical staff is usually lacking. With 50 percent of the total budget in food and agricultural activities, technical personnel trained in these areas account for 5 percent of the total personnel. Few, if any, are in decisionmaking positions.

The United States has much to gain, as well as give, in the international research network. There are 10 international agricultural research centers and 3 related programs sponsored by the Consultative Group on International Agricultural Research (CGIAR). Most of these centers have modern facilities, excellent staffs, and are highly productive. In recent years, many developing countries and most developed countries have been expanding their agricultural research base much faster than the United States (where Federal funds for agricultural research have remained fairly constant).

The United States has an opportunity to benefit from these new and expanding research efforts. At present, no Federal agency has the specific responsibility for taking the lead in coordination and cooperation on methods, procedures, and actions necessary to facilitate acquisition of technology which might benefit the United States.

Policy Options

Option A. Centralize technical staff in one bureau in AID. * USDA would maintain its present level of activity. The technical staff from the regional bureaus and missions would be combined with the central staff of the Development Support Bureau to form an overall operating technical bureau. The technical bureau would have responsibility for country and central programs of technical assistance, research, training, and institution building, and would be headed by outstanding professionals in their relevant fields. The functions of the regional bureaus would be reduced to those necessary for liaison with State and collation of normal desk functions. Presidential appointees would not be required for these positions. This would permit, but not assure, improved use of U.S. technical expertise in assisting developing countries in research and technical efforts. This change can best be handled by the executive branch.

*AID has moved in the direction of this option, but still retains the regional bureau structure.

Option B. Establish technical bureaus around the major thrusts of AID programs as defined by legislation—i.e., food and nutrition, population and health, and natural resources and energy. USDA would **maintain its present level of activity.**

Technical bureaus would have responsibility for country and central programs of technical assistance, research, training, and institution building, and would be headed by outstanding professionals in their relevant fields. Regional bureaus would be eliminated and regional office positions set up either in the Program, Planning, and Coordination Office or under an assistant administrator with limited role and powers necessary for liaison with the Department of State and operation of normal desk functions. This would improve organizational changes and enlarge the role of technical to nontechnical personnel. It would permit a much greater use and concentration of U.S. technical expertise in identifying and solving problems of interest to both the developing country and the United States. AID's difficult problem of recruiting and maintaining technical personnel would be greatly relieved. This option would require some major changes in AID, and additional study on details would be desirable. This change can best be handled by the executive branch.

Option C. Increase USDA involvement in the international agricultural research network with major emphasis on maximizing U.S. benefits. This applies to both options A and B above. One Federal agency, USDA, would take the lead in programs to facilitate acquisition and use of agricultural research conducted in other countries and the international centers. Our ability would be increased to quickly obtain knowledge of research breakthroughs in the international area. There could be criticism from other countries that the United States has mixed aims in assisting developing countries, but this is true of the overall assistance programs. This change can best be handled by the executive branch.

Chapter II

Introduction

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Introduction

The food and agricultural industry in the United States is by far the largest of all U.S. industries, In 1980, the value of farm assets was $900 billion, and one of every five civilian jobs was in the food and agricultural industry, which includes chemical companies, equipment manufacturers, transportation, etc. Agricultural products make up the largest single category of total U.S. exports. In times of crop failure elsewhere in the world, this ability of American farmers to produce such an abundance of food has meant the difference between survival and starvation for millions of people throughout the world.

Our agricultural success is based largely on adoption of technology developed through research. Indeed, the application of science to agriculture has significantly helped make the United States a giant of industrial enterprise.

Paradoxically, the United States has never had a well-articulated set of agricultural goals mandated by law. Yet throughout U.S. history, there have always been presumed goals that government has a responsibility for developing an ever-increasing array of new technologies that efficiently provide adequate food supplies. Because of this national philosophy, set in perpetuity, the United States has never been a hungry Nation—nor is it likely to be in the future.

To carry out the tasks of conducting food and agricultural research, the United States relies on Federal agencies, State agricultural experiment stations (SAES), universities, and private industry. Their research and development efforts and the resultant high production of American farms have assured consumers an ample supply of quality food at reasonable cost. The agricultural sector has been able to do this mainly because technological advances have produced the methods and tools to meet rising consumer demands.

EMERGING PROBLEMS

Despite its continued notable achievements, the food and agricultural research establishment is facing new problems that are exerting severe strains on goal fulfillment. Of prime concern among scientists are indications that new technological developments may not be keeping pace with our needs.

Two events in the early 1970's raised doubts as to the ability to feed an ever-expanding world population. First, the Southern corn leaf blight in 1970 reduced corn production in the United States by about 16 percent. Second, the combination of unfavorable weather and purchasing strategies of centrally planned economies (such as Russia) led to an uncomfortably low grain stock and high prices from 1973 through 1975.

This combination of events resulted in several assessments of the world food situation and its ability to feed an ever-expanding population (NAS, 1975 and 1977; USDA, 1974 and 1979; U.N. World Food Conference, 1974). The consensus of these studies was: 1) world supply-demand balance was tighter in the 1970's than in the 1960's, 2) periodic spot shortages of food could be expected in years ahead and the potential for shortages could become increasingly severe, 3) more trade in agricultural products would be required to satisfy increasing demand for food, 4) government policies should be oriented toward obtaining increased production of food, and 5) need exists to give increased attention to the quantity and quality Of resources available for food production, ineluding the need for larger public and private expenditures for agricultural research.

There is a problem of an increasingly tight world supply-demand balance. Without major breakthroughs based on either an expanded resource base or technological developments, the world food problem is likely to become increasingly severe. Since development of a substantially expanded agricultural resource base is uncertain, technological change through research bears much of the burden for expanded food production.

Public support for food and agricultural research has been based on the public interest in an adequate and stable supply of food at reasonable prices. The concept embodies the maintenance of a sustainable resource base to assure a continuing supply for future generations. Realization has traditionally existed that farmers, as individuals or groups, have neither sufficient economic incentive nor scale of operation to conduct their own research programs. In addition, it was believed that the existence of a competitive agricultural structure would result in rapid adoption of new technology by farmers.

This justification for public support for agricultural research is still prominently used. While it still has merit, many changes have occurred in the structure of agriculture that can change significantly the distribution of benefits among input suppliers, farmers, marketing firms, retailers, and consumers. Reality suggests that: 1) large farms have more influence than small farms on public research programs, and 2) some food and agricultural research is not neutral with respect to structure—e.g., technology has been adopted more readily by larger and more mechanized farms than by small and less organized farming interests. The magnitude and effects of these changes have not been adequately evaluated.

Realizing this trend toward industrialization of agriculture, some members of the executive branch, including the U.S. Department of Agriculture (USDA) and the Office of Management and Budget (OMB), have in the past taken the position that it is no longer necessary to increase investment in certain forms of research. The implication is that proprietary firms have sufficient resources to conduct their own research. This argument has been used with respect to post-harvest technology research, In the future, the argument might be used for nearly all technology-related agricultural research.

In addition to food shortages and the continuing process of industrialization, the 1970's brought a host of new issues and concerns that will continue in the 1980's. Demand developed for more generous food programs, organization rights for farm labor, lower food prices, increased food safety, increased environmental protection, sharing water rights, and improved nutrition.

Today, there are pressing issues that should receive increased research attention. The sustainability of our agricultural system is being severely questioned. The United States is running out of water in parts of the West, droughts persist in much of the country, excessive rates of erosion on some of the most productive lands may prohibit maintenance of a sustainable system, increased costs of energy (fuel and fertilizer) threaten to price our products out of reach, and environmental concerns continue.

Concern exists within the food and agricultural research establishment that because there have been no substantial increases in research funding, this new agenda of issues has transferred and is transferring resources from traditional research interests associated with increasing production and efficiency. This is a legitimate concern, considering that Federal funds have remained relatively constant in terms of real dollar expenditures while the research base has broadened, In addition, the costs of conducting research have increased in real terms. Research today requires more sophisticated and expensive equipment and support staff than 10 years ago. Thus, with the expanded research base, accompanied by higher costs and constant funding levels, many research areas are receiving less funding today than earlier.

Historically, USDA and the SAES have had a close working relationship in U.S. agricultural research. USDA as a general rule has been more concerned with problems of national and regional importance, and the SAES with problems of a local and State nature. The land-grant colleges have grown into universities and generally have become large research institutions. Their research activities naturally have grown not only to include State and local problems but also to have significance on both a regional and national basis. Congress has provided SAES funds for regional research. However, as a result of the 1972 reorganization of the Agricultural Research Service in USDA, there is a question of whether USDA has a national research program or merely a series of local and regional activities. Consequently, USDA and the SAES appear to be working on seemingly indistinguishable problems.

This in itself is not necessarily bad if planning and coordination are appropriately used. But many people, including Congress, have come to believe that little, if any, overall planning and coordination of research exist, especially at top levels of administration, and question whether national issues are receiving adequate attention. There seems to be much duplication and vying for funds.

By 1977, it became apparent to congressional leaders that new steps were needed to upgrade agricultural research and coordination. As a result, the Food and Agriculture Act of 1977 directed the Secretary of Agriculture to establish: a) a committee known as the Joint Council on Food and Agricultural Sciences (JC) and b) a National Agricultural Research and Extension Users Advisory Board (UAB). Primary responsibility of the JC is to foster coordination of agricultural research, extension, and teaching activities of the Federal Government, the States, colleges and universities, and other public and private institutions involved in the food and agricultural sciences. UAB is responsible for preparing independent advisory opinions on the food and agricultural sciences.

NEED FOR AN **ASSESSMENT**

There have been many studies that have dealt with food and agricultural research. They include reports by the President's Science Advisory Committee (1962), the Committee on Research Advisory to the USDA (1972), the Agricultural Production Efficiency Study (1975), the World Food and Nutrition Study (1977), and USDA's Study of Agricultural and Food Research Issues and Priorities (1978). This latter study reviewed 50 reports and studies dealing with priorities for food and agricultural research. Thirty-two of the reports addressed the inadequacy of funding of agricultural research and called for its strengthening. Few of these studies have addressed the structure of the research system. No attempt has been made to define local, regional, and national problems on a scientific basis in order to assign research responsibilities. Nor has there been any attempt to identify roles of those agencies and institutions participating in domestic and international research or to seek solutions to the problems they face. The question still arises as to the adequacy of the funding level for research, the distribution of the benefits of research, and the quality of research. In addition, there is the question as to whether present methods are satisfactory by which expertise and interest of Federal, State, and private organizations are brought to bear on identifying and conducting research.

Hence many, including Congress, have become concerned over the allocation of resources to various domestic and international research activities and the mechanisms used for development of research priorities. Within the U.S. food and agricultural research system, there appears to be a dichotomy of professed procedures for priority setting and actual practices. Need for a sound, workable process seems apparent in order to maintain continuity in planning and to keep the research system viable. These concerns led directly to a request from Congress for OTA to make an in-depth assessment of the U.S. food and agricultural research system. Congress stressed that the assessment focus on the structure of the system and that it complement previous studies which identified agricultural research priorities.

In conducting this study, OTA recognized certain emerging factors that are markedly affecting the conduct and decisionmaking within research agencies and their funding sources. One of the more important of these factors is the high cost of performing research today—not only from the standpoint of spiraling costs for personal services but also because of the need for more sophisticated, expensive research equipment. In addition, the research base has broadened to include new issues such as environmental protection, improved nutrition, and social concerns. Restricted budgets and limited personnel ceilings have also left their mark on the planning of research programs,

Specifically, the request for an assessment came from the Senate Committee on Appropriations and the Senate Committee on Agriculture, Nutrition, and Forestry, In addition, the House Agriculture Subcommittee on Department Investigations, Oversight, and Research has endorsed this request.

OBJECTIVES OF THE ASSESSMENT

The objectives of this assessment are to:

- evaluate the funding, benefits, and burdens of food and agricultural research;
- determine the basis, scientific or otherwise, for the classification of research from a management perspective;
- identify the roles of Federal, State, and private institutions in developing technologies for solutions to international, national, regional, and State or local problems;
- examine the management, structure, and policies of USDA in the conduct of food and agricultural research;
- evaluate methods by which the expertise and interests of Federal, State, and private research organizations can be brought to bear cooperatively in identifying priority research areas; and
- provide public policy options for Congress that will maximize our research potential,

The working groups and advisory committee that prepared and reviewed the resource material for this assessment recognized the urgency for resolving the issues that characterize the situation in the agricultural research sector. They were motivated by a deep concern for maintaining a strong and growing food and agricultural industry, It is hoped that the analysis of these issues and public policy options offered herein will provide a good starting point for increased effective use of the Nation's scientific capabilities and other research resources,

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Chapter III

The Role and Development of Public Agricultural Research

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Chapter III

The Role and Development of Public Agricultural Research

For centuries, farmers have tried to find ways of increasing production on their own land—to make two blades of grass grow where one grew before. But as long as land was plentiful, output could be rather easily increased just by enlarging the area grown. As land became more scarce, however, there was an increasing need to expand the productivity of existing land. This often was a more difficult process and required new techniques of production beyond those which could be generated at the farm level.

The result was a gradual realization of the need to find a way to expand the broad-scale development of agricultural knowledge and technology. This inevitably led to calls on the government for assistance,

THE ROLE OF AGRICULTURAL RESEARCH

Agricultural research is the systematic search for new ways of improving agricultural production and marketing. In most cases, production research is oriented to maintaining or increasing the productivity of our agricultural resources. Marketing research is largely devoted to maintaining quantity and quality of products as they move to and through the market. The result of both types of research is an expanded supply of agricultural products at a lower cost per unit of product than otherwise would have been the case. This outcome usually benefits many producers and all consumers of that product, Some research is increasingly devoted to related questions concerning, for example, environmental quality and human nutrition where the measure may be somewhat different. But generally the final measure is a more ample food supply at reasonable cost, while maintaining a sustainable production system and reducing the uncertainty of production.

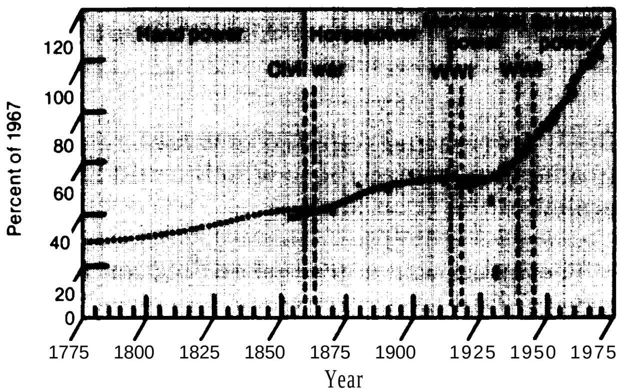
The United States is generally recognized as having developed a productive and efficient food system. Many factors contribute to such a situation, but research is of vital and central importance. Research relates to all three major factors of production: land, labor, and capital, Land became less abundant with the closing of the frontier in 1890. On the other hand, production inputs that could be purchased with capital—particularly machinery and chemicals—have grown in supply.

Viewing the development of productivity—measured by output per unit of inputs —in American agriculture from 1775 to 1975, one might separate the 200 years into four periods. The first, from 1775 through the Civil War, largely relied on hand power, supplemented near the end of the period by the introduction of labor-saving equipment. From the Civil War to World War I, horse-drawn equipment was increasingly substituted for human labor. From World War I to World War II, mechanical power increasingly substituted for animal power. The fourth period, which started in the 1930's and extends from World War II to the present, might be considered the era of "science power" (Lu et al., pp. 8-10). *

Overall productivity changes were quite modest through the mid-1930's (fig. 3), Much

*It should be recognized that these are relative terms and that there is considerable overlap between periods. Some science was involved throughout, but its role grew materiality over time.

Figure 3.–U.S. Agricultural Productivity Growth During the Past 200 Years



SOURCE: Lu, Cline, and Quance, p. 10

of the effect of new technology was to increase labor productivity; considerably less was accomplished in increasing land productivity. But starting in the late 1930's there was a sharp growth in the rate of productivity, particularly in yields per unit of land (Cochrane, pp. 127-128, 202, 245). This was caused by the introduction of science power, which in turn was largely the result of research.

The research undergirding science power was carried out in the private and public sectors. Actually the private sector had long taken the lead in developing new forms of horse-drawn equipment and mechanical power for agriculture; the public sector contributed relatively little in this area. The private sector also played an important role in the development of chemical fertilizer, a vital component of increases in agricultural productivity. All of these products are proprietary goods where the manufacturer can retain at least some of the profit of innovation, in part through patents.

The public sector–composed of U.S. Department of Agriculture (USDA) research agencies and State agricultural experiment stations—arrived on the scene in a meaningful way only in the late 1800's and did not become a significant source of new technologies until the early 1900's. The public sector devoted most of its resources to biologically oriented research. This kind of research is considerably less likely to produce a proprietary or patentable product. The public sector did not move far into the area handled by private industry, but rather moved on from it. Its work in breeding new higher yielding varieties of crops, for instance, greatly enhanced the potential value of chemical fertilizers. The result was a highly productive symbiosis of public and private research and development activities.

Research and its associated science power have been the major factors in bringing about the sharp increase in total agricultural productivity. But recent dropoffs in the rate of productivity growth have increased concern about the condition and productivity of agricultural research in the United States.

EARLY INSTITUTIONAL DEVELOPMENTS, 1862 TO 1887

The early agricultural societies stirred up considerable interest in agricultural experimentation in the first half of the 1800's. Quite independently, and nearer the middle of the century, a number of American scientists received graduate training in Europe and brought back the idea of agricultural experiment stations.[1] This concept was in turn fed to the agricultural societies and other such groups. But little resulted in formal terms except for some institutionalization of fertilizer analyses.

Two major steps toward the creation of agricultural research systems were taken in 1862 with: 1) Presidential signature on a bill on May 15 establishing USDA, and 2) the pas-

[1] Agricultural experiment stations were established in Europe at an earlier date than in the United States and had considerable influence on American thinking. For details, see: Atwater; Knoblauch, et al., pp.5-18; Rossiter, 1975; True and Crosby; Congressional Globe; and Agricultural Experiment Stations.

sage of the Merrill Act on July 2, which provided the basis for the land-grant colleges of agriculture. Neither bill said very much about research, which was to be a source of some difficulty, but they did create the basic institutions that could in turn foster research.

As Knoblauch, et al., stated: "Born in the same year, the Federal Department of Agriculture and the land-grant colleges grew up together. Confronted by a mutuality of problems, the colleges and the Department matured into a nationwide system of agricultural research and education" (p. 111). The interaction of USDA and the colleges provides a main theme in the subsequent development of agricultural research in the United States.

The U.S. Department of Agriculture

Although the act that established USDA said little about research, the House Committee on Agriculture clearly had research in mind. In its report on the bill, the committee noted the establishment of agricultural experiment stations in England and France, citing in particular the role of the French Government in promoting agricultural science. The committee stated that accurate knowledge of the processes of nature "can be obtained only by experiment, and by such and so long continued experiments as to place it beyond the power of individuals or ordinary voluntary associations to make them" (Congressional] Globe, p. 856).

In any case, USDA was hardly in a position to do much research when it was established in 1862. Such resources as it had initially were inherited from the Patent Office: a few employees, a few rooms in the basement of the Patent Office, and a small 6-acre propagating garden and house on the Mall in front of what is now the site of the National Gallery of Art.

In April 1863, USDA was given authority to use roughly 40 acres of land at the west end of the Mall (the square between 12th and 14th Streets and Independence and Constitution Avenues) for use as an experimental farm. The site was then occupied as a holding yard for livestock for the Union Army and did not become available to USDA until the spring of 1865. During the next two seasons, a wide variety of imported seeds and plants were planted and evaluated; the results were reported in considerable detail in the annual reports of the Commissioner of Agriculture. The limitations of the site, however, were becoming apparent. Also, space was needed for a new USDA building.

In May 1868, the Commissioner of Agriculture, Horace Capron, reported that he had abolished the experimental farm and recommended that ". . . not less than 200 acres of land should be obtained in a conspicuous locality, upon one of the great thoroughfares, within easy access from the city; a portion to be appropriated to the propagating garden, and the remainder to constitute the farm proper." (Report, 1867, p. 19). The new administration building, with some laboratory space, was erected on the southern side of the experimental farm site, and much of the remaining land was gradually converted into a public arboretum. Still, some land remained for outdoor plots, and a few greenhouses were erected.

Despite Capron's request for more land, none was forthcoming through 1887 and, in fact, not in any significant quantity until the early 1900's. In 1879, Commissioner Le Duc cited as one of the USDA's "immediate necessities" the acquisition of an experimental farm of 1,000 acres in the Washington area (Wiser and Rasmussen, p. 288). In 1880, he suggested making use of land that was part of Arlington National Cemetery (Report, p. 18). Nothing immediately came of either idea. Some land, however, was rented for research on animal diseases in 1883. The very limited facilities on the Mall continued to be critical restraints on any extensive experimentation.

Moreover, the early commissioners of agriculture were not particularly committed to the experimental work. As Knoblauch, et al., stated, they were:

> . . . unfamiliar with the intricacies of scientific research. There was a tendency in those

> early years to become preoccupied with other responsibilities outlined in the Act, Many problems combined in delaying until the late 1880s crystallization of any clear departmental research policy based on "long continued experiments" (p. 27).

Thus lack of direction by the commissioners and a lack of facilities meant that for its first 25 years USDA did relatively little in agricultural research. Nor did it provide any particular leadership to others except in relation to the Hatch Act.

The States[2]

It has been suggested by Knoblauch, et al., that the slow progress in developing the USDA as a national agricultural experiment station served ". . , as an incentive in the States to go ahead with State stations" (p. 27). This was not much of an incentive, however, and early State progress was hardly striking. Part of the problem was that Senator Merrill "had not clearly indicated his ambitions concerning the nature and extent of research activity in the land grant colleges" (p. 32). The bill itself made only two references to the research function: it provided that: 1) up to 10 percent of the initial endowment could be used to purchase lands for experimental farms, and 2) that the annual report should record any experiments made with their cost and results.

As a consequence Knoblauch, et al., state that:

> Collegiate experimentation in agriculture appeared very early in the agricultural colleges founded in the mid-19th century. The first States to institute the new schools explicitly directed, either by charter provision or by separate enactment, that the collegiate governing bodies initiate and maintain a program of experiments. These directives did not authorize, however, or imply the establishment of experiment stations (p. 29), The indistinct nature of the research authority . . . prompted the first generation of college administrators to doubt that the Act of 1862 required the colleges to experiment, except as an aid in the instruction of students (p. 32).

The first significant State development occurred in Connecticut as the result of work by several members of the Sheffield Scientific School at Yale University. During the mid-1800's, Sheffield (and its Analytical Laboratory) was widely known for its teaching of agricultural science. One staff member, Samuel W. Johnson, had studied in Europe where he had become acquainted with the experiment-station concept. In 1863, Connecticut's Merrill Act funds were given to Sheffield, which in turn employed William H. Brewer as professor of agriculture, Among those studying under Johnson and Brewer was W.O. Atwater, who also later studied in Europe and became familiar with the agricultural experiment station concept.

Johnson encouraged the formation of a State Board of Agriculture in 1866 and secured an appointment as its official chemist. He, Brewer, and Atwater then pressed for the idea of an agricultural experiment station. In 1875, some State and private funds were provided for a 2-year experiment-station program at Wesleyan University; Atwater was named director. The initial work, principally fertilizer analysis, was considered promising, and in January 1877, the State Board proposed renewal of the station.

On March 21, 1877, the proposal establishing the Connecticut State Agricultural Experiment Station became law. A $5,000 appropriation was provided. The charter severed organic connection with a university: the Wesleyan operation was closed and the station leased space at Sheffield. Johnson was named director, while maintaining his position at Yale. The station continued at Sheffield until 1882, when the State legislature provided funds to purchase the former Eli Whitney estate in suburban New Haven. Although the Connecticut station was thus the first public station in the U.S. in a formal sense, much of the early work related to fertilizer analysis and ". . . Johnson found it practically impossible to incorporate re-

[2]This section is based, except where otherwise noted, on True, pp. 82-118, and True and Clark, pp. 29-34, 146-147, 163-164. On California, also see Rosenberg, 1971, pp. 11-12,

search into the station program before 1890" (Rossiter, 1975, p. 170).

A quite different pattern was followed in California. In early 1875, E. W. Hilgard joined the College of Agriculture at the University of California in Berkeley. The university regents gave him a laboratory and $250 a year for 2 years for experimental work. In that year, he began a field experiment on deep and shallow plowing for wheat grown for hay; he soon added an experiment on the fertilization of wheat. In 1877, the first legislative appropriation was made specifically for experiment station work: $5,000 a year for 2 years. The amount was raised to $10,000 a year in 1879. Hilgard does not seem to have been tied down with fertilizer analysis, as was the Connecticut station, and hence was able to more fully engage in the type of work now done by experiment stations.

During the next decade, the Connecticut and California models of organization were followed, although slowly, in several other States. Independent stations were established in North Carolina [1877), New Jersey (1880), New York (1880-81), Ohio and Massachusetts (1882), and Louisiana (1884, 1886). In several cases, however, the stations were located near the land-grant college. Experiment stations connected with land-grant colleges were established in New York (at Cornell, 1879-81), Tennessee (1882), Alabama and Wisconsin (1883), Kentucky and Maine (1885), and Vermont (1886). Establishment of several of the stations in the mid-1880's was no doubt encouraged by ongoing congressional discussions of predecessors of the Hatch Act of 1887. In addition, more or less systematic agricultural work was being done at land-grant colleges in 13 other States.

Thus the first 25 years after the passage of the Merrill Act scarcely brought about a great increase in experiment stations at colleges of agriculture. There were about as many stations established independently of colleges as were established in association with them. Knoblauch, et al., note that the governing boards of the land-grant colleges were hesitant to organize experiment stations and that "customarily until the mid-eighties they accepted as satisfactory the State legislative actions which founded and subsidized stations operating independently of college control" (p, 29), "Thus in the early eighties the outlook for establishing permanent stations under college direction appeared, if not bleak, distant and uncertain" (p. 38).

THE TURNING POINT: THE HATCH ACT OF 1887

The Hatch Act of 1887 was undoubtedly the most important legislative step taken in the development of agricultural research in the United States. In one stroke it brought about the establishment of the modern network of State agricultural experiment stations, and it bound the USDA and the States together in the process.

The Hatch Act was not developed overnight; it had a long and complex history. The precursors might be said to go back to 1871, when representatives from 12 land-grant colleges met to discuss how to accelerate agricultural research, and to 1872, when Commissioner of Agriculture Watts called a national agricultural convention (involving colleges of agriculture) at which a committee on experiment stations was appointed. The campaign for Federal support, however, did not pick up much speed until the early 1880's. In 1880, a group of research-oriented professors from Midwestern colleges met at the University of Illinois and formed a group known as the Teachers of Agriculture to promote college-affiliated stations. They met again in 1881 and developed a more detailed proposal. It called for State support—justified in part by the fact that ". . . improved agricultural production benefits the entire population, not solely the producers on the farms" (Knoblauch, et al., p. 39). The role of experiment stations was also discussed at two meetings of land-grant colleges called by Commissioner Loring in Washington in January 1882.

The first proposal for Federal funding seems to have been advanced in an article by E. W. Hilgard of California in The Atlantic Monthly in May 1882. He noted the meager funds available at the State level and criticized the commissioners of USDA for their neglect of Federal research. He encouraged the use of Federal funds in cooperation with the land-grant colleges for the operation of a station in each State.

A bill toward this end was introduced in Congress in May 1882 by Representative Carpenter of Iowa. The bill was based on a proposal by Seaman Knapp of Iowa State. It called for "national experiment stations" at each college. Carpenter contended that the American farmer, confronted with the need for developing intensive cultivation, needed as never before the aid of scientific research. The bill called for an annual Federal allocation of $15,000 for each station. Management of the station was basically to be under State control. As finally reported out from the House committee in July 1884, the bill was somewhat different and became known as the Cullen bill.

In July 1885, the new Commissioner of Agriculture, Norman Colman, called a special convention of college delegates in Washington. The experiment-station proposal was on the agenda and was favored by Colman. It was decided to push the proposal on the basis of two points: the duty of the Federal Government to aid agriculture, and the duty of the land-grant colleges to aid the farmer. Having subsidized the colleges for teaching students, Congress should now subsidize the stations for assisting farmers,

The report on the bill prepared by the House Agriculture Committee (chaired by Congressman Hatch), dated March 3, 1886, contained the following statements:

> The object should be to increase production at a decreased cost and at the same time to preserve the fertility of our soils (p. 2).

> Combining as they do the precision of scientific methods with an intelligent regard to the requirements of practical operations, it is not surprising that they (the experiment stations) have come to be looked upon, wherever established, as the most important aids to successful farming as well as the foremost agency for the advancement of agricultural science (p. 3).

The bill was the subject of a fiery debate in the Senate in January 1887. There was widespread sympathy for the new idea of Federal subsidies for conducting research on State stations. But there was also, even then, concern that Federal dictation would automatically follow the flow of Federal funds. Revisions made on the floor allowed funds to go to independent (noncollege) stations (a grandfather clause) and removed all statements that the Commissioner of Agriculture had powers beyond aiding and assisting the stations. The bill was passed by the Senate on January 22 (without a record vote) and by the House on February 25 (152 to 12). It was signed into law by President Cleveland on March 2, 1887. It was reportedly the first direct cash grant-in-aid to individual States (Rosenberg, 1964, p. 3).

The Hatch Act provided, as did the previously proposed Carpenter bill, $15,000 for agricultural experiment stations in each State. The first appropriation for the stations was provided in a special act of February 1, 1888. On July 18, the Hatch Act funds were carried in the annual appropriation act for USDA. The appropriation provided $10,000 for administration of the act; the Office of Experiment Stations was established for this purpose on October 1, 1888.

In commenting on the Hatch Act, True said that it "established a new policy of relationship between the Federal Government and the States by granting money to the States for agricultural experiment stations, which were thus to be distinctly State institutions" (p. 130). As such, they were to focus on State and local problems.

GROWTH AND INTERACTION, 1888 TO 1953

The Hatch Act set the stage for the Federal-State agricultural system as we know it today. It led to the establishment of an experiment station in each State and provided the basis for continuing Federal support. The Hatch Act, however, had a less immediate impact on the role of research within USDA itself.

Federal Research

The course of Federal research changed relatively little from 1887 through 1897. Thereafter the situation changed sharply.

1888 to 1897

In February 1889, USDA was given Cabinet status, but only modest increases were made in Federal agricultural research under the first two Secretaries of Agriculture (excluding N. J. Colman who served only 3 weeks). Under Secretary J. M. Rusk (1889 to 1893), "the aggregate funds used for experimental work did not materially increase, " though "more scientific work was performed in a few lines, especially vegetable pathology and biology" (True, p. 178). Under Secretary J.S. Morton (1893 to 1897), there was no increase in overall appropriations for USDA, but the proportion of funding for scientific work increased somewhat.[3] This was particularly true with soils, grass and forage plants, and forestry (True, p. 183).

USDA research facilities remained very limited during this period. In 1887, then-Commissioner N. J. Colman suggested the establishment of a central experiment station (Report, p. 12). The following year, he elaborated on the concept which was:

> To relieve the State stations of much costly and laborious scientific work and enable them to devote their energy the more completely to the things that are of practical interest to the farmer, and to enable the Department to give the advice and assistance which Congress calls for and the stations need . . . This would in no way take the place or do the work of the stations throughout the country but would, on the other hand, be a most helpful, economical, and I am inclined to add, essential part of the whole organization (Report, 1888, pp. 12-13].

[3]According to one calculation, the following proportions were spent on "scientific work:" Fiscal Year 1892, 46.2 percent; 1893, 45.6 percent; and 1894, 51.8 percent (Dabney, p. 66). The definition of scientific work may have been much broader than the definition of research used in later years (see Moore, p. 3).

Not everyone felt this way. Edwin Willets, the first Assistant Secretary of Agriculture (and former president of Michigan Agricultural College), who was placed in charge of scientific work, said in an 1889 speech that while the previous Commissioners of the Department "without exception . . . wanted an experiment farm" for their own research, he hoped to "head off any such proposition. . . ." Yet late in that same year Secretary Rusk formally requested transfer of the Arlington land to USDA [Wiser and Rasmussen, pp. 288, 289).

Meanwhile, the facilities on the Mall proved increasingly inadequate. In 1894, Secretary J. S. Morton commented that: "There is hardly a university or agricultural college in the United States which has not better constructed, better lighted, or better ventilated laboratories than those used by the Department of Agriculture" (Yearbook of Agriculture, 1894, p. 64).

Thus, from 1888 through 1897 agricultural research in USDA continued at a relatively modest level and was severely handicapped by limited facilities.

The Wilson Era, 1897 to 1913

The research situation, however, began to change sharply with the arrival of James Wilson as Secretary of Agriculture in March 1897. The following September, he took charge of scientific and regulatory work (previously under an Assistant Secretary). He continued in this position for an unparalleled term of 16 years.

Wilson did not necessarily arrive with the upgrading of Federal research prominently in mind. He described his metamorphosis to the State experiment station directors in these words in November 1905:

> when I came down here—with a good deal of reluctance–to do something in the Department of Agriculture, my prevailing thought was that I would try to make that institution subservient to the stations of the country, and to help build them up. I found that it was necessary to first build the Department up; that it was not as strong in educated scientists as it should be . . . and so I was compelled to turn my attention to that one thing and push it in all possible directions, to select strong men, and interview Congress occasionally for increased appropriations. We have been doing what we can (Wilson, p. 15).[4]

In congressional hearings earlier that year, he acknowledged that his already-achieved goal had been to build a corps of full-time specialists, "the greatest scientists in their respective lines today that the world knows of" (Knoblauch, et al., p. 105).

During Wilson's regime, seven new scientific bureaus were established (only one, the Bureau of Animal Industry, existed before his arrival). Four were established in 1901 alone: Plant Industry, Forestry (which became the Forest Service in 1905), Soils, and Chemistry. Three were established in subsequent years: Statistics (1903), Entomology (1904), and Biological Survey (1905).[5] The bureaus were built on previous organizations but represented an elevation in status and eventually an enlargement in size. The latter point is illustrated in data on the growth in number of employees between 1897 and 1912:

Bureau	Number of employees 1897	1912
Animal Industry	777	3,311
Plant Industry	127	2,128
Soils	33	159
Chemistry	29	546
Entomology	27	339
Biological Survey	23	97
Total	1,016	6,580

SOURCE: True, p 190

Staff increased more than sixfold. Not all of the work of the bureaus, however, was devoted to scientific work; regulatory work played a large role in some cases.

The growth in research may also be reflected in other terms. It has been estimated that expenditures on USDA research increased from $800,000 in 1900 to $4 million in 1910 (Hayami and Ruttan, p. 144), Between 1887 and 1904, the Federal Government quadrupled the portion of the Department budget (excluding the Hatch appropriation) spent for research. The Bureau of Plant Industry (BPI), for example, in 1904 reportedly operated on a budget larger than the total Hatch appropriation to all of the States. Similarly, the departmental scientific staff had grown steadily until in 1904 it substantially outnumbered the nationwide total of station workers (Knoblauch, et al., p. 103).

In terms of management philosophy, the emphasis:

> . . . was on lines of work directed by prominent individuals rather than on administrative units. In general, subordinate units were organized on an informal basis , , , Informality was fostered by Secretary Wilson, who made a point of knowing who the scientists were and what they were doing. He frequently visited the laboratories in the buildings that were clustered in the vicinity of the main building of the Department (Baker, et al., p. 42).

During Wilson's early years, USDA had been stuck with the same limited facilities in Washington that had existed previously. But in 1900, he was able to secure the use of 400 acres of the Arlington National Cemetery, although it took about 3 years to get the site

[4]Rosenberg notes that "though the stations had hoped that 'Tama Jim' Wilson, originally an experiment station man, might be a bulwark of State interests in Washington, he had been a disappointment" (Rosenberg, 1964, p. 5), Wilson had also served previously for three terms in the House of Representatives.

[5]For further details on the bureaus, see: Baker, et al., pp. 42-56; Dupree, pp. 158-169, 176-181; and Rossiter, 1979, pp. 220-239,

ready for use. In 1907, two laboratory buildings were completed on the Mall site (the current east and west wings of the present administration building). In 1910, a 475-acre farm was purchased near Beltsville for work in dairying and animal husbandry.

Expansion was not confined to the Washington area. After its establishment, a large and increasing amount of the work of BPI was conducted at USDA field stations. By 1913, BPI operated 18 field stations in 9 States, 8 in cooperation with State experiment stations. In the same year, the Bureau of Entomology had 35 field laboratories in different parts of the United States (True, pp. 197-198, 203),

The Office of Experiment Stations, established to administer the Hatch funds, also became involved in the conduct of research in cooperation with State stations. Nutrition investigations began in 1894, irrigation investigations in 1898, and drainage investigations in 1902. In 1898, the Alaska Experiment Station was put under this office; the Hawaii and Puerto Rico stations were added in 1901 (True, p. 133).

USDA's growth in research staff and geographic scope was not looked upon entirely favorably by the States. Some of this was probably jealousy, for the State stations were not having an easy time with their own legislatures. Some was a result of dislike of certain Bureau chiefs. And some was a result of concern that USDA activity in the States might lessen financial support for State agricultural experiment stations.

W. H. Jordan, director of the New York SAES at Geneva, expressed the concerns of many of his State colleagues, when he stated in January 1905:

> As a natural and inevitable result the Department with its overwhelming equipment of men and means, is not now, as formerly, confining its research work largely to that which can be done in the laboratories at Washington, but is, of very necessity, as a means of securing opportunities, reaching out into the several States and . , , is now traversing, to a large extent, the field that had been and still is also traversed by the experiment stations (Knoblauch, et al., p. 103).

USDA administrators undoubtedly would have put the matter differently.

The Adams Act of 1906 doubled Federal funding to the States, which thus became less vocal, although still irritated, on the matter of Federal research. By any measures, however, Wilson put USDA solidly on its feet in agricultural research.

Early Coordinated Research Programs

Research conducted by USDA and the State experiment stations before 1900 was largely by individual investigators, with cooperation based primarily on personal contacts. One of the first efforts to conduct coordinated research programs involving Federal and State scientists and cooperating farmers was the work on dryland agriculture in the Great Plains area (Quisenberry, pp. 218-228; Moseman, et al., 1981).

When the Hatch Act was passed by Congress in 1887, only a few States had agricultural experiment stations and none were in the Great Plains. However, systematic experiments were in progress in Colorado, Kansas, and Nebraska. Dryland research was started by E. C. Chilcott at Brookings, S. Dak., in 1897. The need for such work was subsequently recognized by M. A. Carleton of USDA. In 1905, Carleton hired Chilcott to take charge of dryland research. In 1906, the Office of Dry Land Agriculture (DLA) was established with Chilcott in charge.

One of Chilcott's first moves was to call a meeting in Washington, D. C., to plan cooperative research, with representatives from various units of BPI and from the agricultural experiment stations of North and South Dakota, Kansas, Nebraska, and Oklahoma. The stated purpose of the meeting was "to encourage and facilitate the coordination, systemization, and unification of all the cooperative experimental work to be engaged in by BPI and the experiment stations and sub-stations of the several states included in whole or in part in the Great Plains area. "

Later it was agreed that Texas and Colorado should be included in the cooperative program,

The first meeting of the new Great Plains Cooperative Association was held in Lincoln, Nebr., in June 1906, and such meetings were continued until World War I. This was the start of State-Federal cooperation in agricultural research and set the pattern for similar cooperation on other regional and national problems confronting agriculture in later years,

The association conducted research at the stations then in existence and also established new stations—by the States, the Federal Government, or cooperatively—with the experimental work done jointly by the State and Federal workers. Stations were established at Hays, Kans., in 1901; Nephi, Utah, in 1903; Amarillo, Tex., in 1904; and North Platte, Nebr,, in 1906. By 1910, there were 20 stations in operation and by 1916 there were 29. Eventually 30 stations were involved. The Pendleton, Oreg., station was started in 1928 and was the only DLA station outside of the Great Plains.

1913 to 1953

The patterns of operation established during the Wilson period generally continued until 1953. Although an increased amount of research was done in the Washington, D. C., area, a substantial amount was carried out in various field locations. A. C. True reports that in the case of BPI from 1922 to 1925, "fully 60 percent of the research was carried on at field stations, and much of it was done in cooperation with the State experiment stations" (p. 255). By 1931, USDA reportedly maintained 51 field stations in 24 States (Waggoner, p. 242). The field operations in some cases continued to be a source of friction with State experiment station officials.

Meanwhile, the Arlington farm was enlarged slightly in 1915, and gradual but substantial additions were made to the land area at Beltsville. The Beltsville Research Center was formally established in 1934. In 1940-41, the Arlington farm and the greenhouses on the Mall were closed down and activities shifted to Beltsville.

Regional research activities were given a substantial boost by two congressional acts during the mid to late 1930's. In 1935, the Bankhead-Jones Act authorized the establishment of laboratories in different regions of the country to work on priority problems of the region. Nine were established by 1939: Plant, Soil, and Nutrition (Ithaca, N.Y.); Pasture Research (State College, Pa.); Vegetable Breeding (Charleston, S.C.); Poultry Research (East Lansing, Mich.); Soybean Research (Urbana, Ill.); Sheep Research (Boise, Idaho); Salinity (Riverside, Calif.); Plant-Growth-Regulating Substances, and Photo-Period and Plant Development (Beltsville). These facilities tended to be regarded as Federal field laboratories (Moseman, et al., 1981; Purcell, pp. 235-236).

The Agricultural Adjustment Act of 1938 authorized USDA to establish four regional utilization-research laboratories that were to concentrate on developing new uses and outlets for surplus commodities. The laboratories were located at Philadelphia, Pa.; Peoria, Ill.; New Orleans, La,; and Albany, Calif. The laboratories were constructed around 1940 and cost $1 million each; the annual budgets were approximately the same (Moseman, et al., 1981; Purcell, pp. 238-239).

As with the field stations, these regional laboratories were a source of concern to some State agricultural experiment stations because they found it difficult to cooperate with them. They were also considered interlopers by some of the old-time USDA bureaus. Partly to help correct these problems, an Agricultural Research Administration was created in the early 1940's as an administrative layer between the bureaus and the Secretary (Irving, et al., 1981; Purcell, pp. 237-240),

Of greater importance was the passage of the Research and Marketing Act of 1946. It was initially designed to increase marketing research in USDA, but by the time it was passed involved substantial sums for research on utilization, quality improvement, and other areas of agricultural research (Moseman, et al., 1981).

As a result of these changes, agricultural research in USDA appears to have been in relatively good condition in the early 1950's.

State Research

The State agricultural experiment stations (SAES) underwent a remarkable period of growth following passage of the Hatch Act. ” This growth was then stimulated in surges by the passage of additional legislation, the first of which was the Adams Act in 1906.

1888 to 1906[6]

Passage of the Hatch Act in 1887 provided a great and immediate impetus to the establishment of State agricultural experiment stations. As noted previously, an Office of Experiment Stations was established in 1888, with W. O. Atwater as its first director, to administer the Hatch funds.

Just before the passage of the act, there were only 15 State stations, By the end of 1888, there were 46 such stations. The number grew to 55 in 1893, 56 in 1894, and 60 in 1906—quadrupling in number in less than 20 years.

Within the overall numbers, a few stations continued to be wholly State-sponsored (two by 1906), and three of the territorial stations (Alaska, Hawaii, and Puerto Rico) were sponsored by USDA. Virtually all of the remaining 55 stations were tied to land-grant colleges.

All of this was accomplished with a rather modest expenditure of Federal funds. The total annual Hatch funding was: 1888 to 1893, from $585,000 to $708,000; 1894 to 1906, $720,000. There was no allowance for growth or inflation. On the other hand, the $15,000 provided to each station was large compared to funding available in Europe.

Yet modest as they were, the Federal funds were of vital importance because of the limited or nonexistent State funding available. True notes that in fiscal year 1902, of the 52 stations receiving Hatch funds, 27 (52 percent) did not receive any State aid, while only 25 (48 percent) were also supported by State funds. In the latter case, only eight States equaled or exceeded the Hatch appropriation ($15,000); six did not exceed $1,000; and several provided support only for substations (for which Hatch funds could not be used).[7]

The role of Federal funds, while massive at first, gradually declined as the Federal contribution held steady and as State contributions gradually increased. In 1888, the Hatch funds accounted for 82.4 percent of the funds available to the State stations; by 1906, this proportion had been reduced to 47.6 percent.

One of the problems in administering the Hatch Act was to limit its use to scientific research, particularly original research. Then, as now, there were many competing demands for overhead, applied research, and extension. The result was a "snail's pace toward significant research" (Knoblauch, et al., p. 87).

The question of applied v. original research became a major topic at the annual meetings of the American Association of Agricultural Colleges and Experiment Stations around 1900.[8] Few States were inclined to make substantial grants for original research, and even then they were commonly earmarked for specific topics.

Adams Act of 1906

The answer to these problems appeared to be to obtain additional Federal funds. Cong. H. C. Adams of Wisconsin was contacted in late 1903, and he in turn requested A. C. True of USDA to draw up a proposed bill. True's

*The SAES as discussed in this section do not include the 1890 colleges of agriculture for which no Federal research funds were regularly provided from 1888 to 1953. Details on subsequent Federal support are provided on p. 46.

[6]The statistics reported in this section were derived from True, pp. 130-131, 138, 166, 212, 237-238, 274.

[7]At first, some Hatch funds were used for substations, and by 1894 there were 40 such stations. However, in 1896 the Office of Experiment Stations ruled against their use for this purpose, and by 1897 their number was reduced to 11. 'I'he use of State funds raised their number to 16 in 1899 and 28 in 1904 (True, p. 131).

[8]This matter is discussed in more general terms in Rosenberg, 1977, pp. 403-412.

proposal followed the Hatch Act in its funding level ($15,000 per year per State), but limited expenditures solely to original research.

In mobilizing support for the bill, much comment was made about the sharp expansion in Federal research and the comparative poverty of the States. The State group sought "some measure of equity in the appropriations made for this purpose from the National Treasury" (Knoblauch, et al., p. 100).

The bill was passed by the House and Senate early in 1906 and was signed by President Roosevelt on March 16. According to Knoblauch, et al., the act "firmly established the principle in American governmental policy that Federal aid shall join with State aid for the purpose of subsidizing scientific research in the State stations" (p, 107). Rosenberg viewed the matter less grandly: ". , . as a strategic victory for the stations in a continuing conflict with the Department of Agriculture" (1964, p. 5),

It is not commonly noted that the act states that its funds are to be used for ". . . paying the necessary expenses of conducting original researches or experiments bearing directly on the agricultural industry of the United States, having due regard to the varying conditions and needs of the respective States or Territories" (Knoblauch, et al., p. 221).

1907 to 1953[9]

The Adams Act doubled the Federal contribution to each State—although the increased funding was phased in over a 5-year period. Thus the Federal contribution of $720,000 in 1906 was raised to $1,44 million by 1911. It remained at that level through 1925,

During this period the level of non-Federal funds available to the stations increased so that the proportion of Federal funds provided through USDA continued to decline—from 47.6 percent in 1906 to an all-time low of 14.9 percent in 1925. Still, a substantial number of stations received only limited State funds. In fiscal year 1921, for example, 22 stations received less than $50,000 of State funds, including 6 which received none (True, p. 238).

Several other developments were also of significance. The number of substations continued to grow, from about 70 in 1913-14 to 130 in 1920 (True, pp. 210,238). Passage of the Smith-Lever Act in 1914 formalized and funded the extension function, sharply reducing pressures on the experiment stations,

The Federal research funding provided through USDA was subsequently raised with the passage of the Purnell Act in 1925, which also enlarged the scope of research at the stations by stressing studies of economic and social problems of agriculture, including marketing and prices. In addition to the $30,000 of Hatch and Adams funds, the States were to initially receive an additional $20,000 a year; the amount was to be ultimately increased to an additional $60,000 a year by fiscal year 1930. Thus total Federal funding increased from $1,44 million in 1925 to $4.335 million in 1930, a figure which then held through 1935. The proportion of station funds provided by the Federal Government increased from 14.9 percent in 1925 to 32.5 percent in 1935 as State appropriations withered during the depression (Porter, p. 99),

In 1935, the Bankhead-Jones Act provided additional funds to the States and for regional Federal research. Funds were allocated on a formula basis rather than as an equal sum to each State, as had previously been the case, States were also required to match the Federal funds dollar for dollar, Federal funds to the States gradually increased through the end of World War II–from $5 million in 1936 to $7 million in 1946. The Federal portion of funding dropped gradually—from 33.9 percent in 1936 to 25.7 percent in 1946.

In 1946, substantial changes were introduced by the Research and Marketing Act. It increased Federal funds for the States on a formula basis and made provision for support of regional research by the State stations, Federal funds increased from $7.197 million in 1947 to $12.265 million in 1953; still, the Fed-

[9]The statistics reported in this section were derived from Agricultural *Appropriations for 1957*. They may differ slightly from those reported in app. B. The percentages are presented in fig. 7 on p. 43.

eral proportion of station funding dropped from 20.6 percent to 16.5 percent in the same years.

Federal-State Financial Interaction

As a result of these congressional actions, Federal and State Governments were uniquely bound together in the sponsorship of agricultural research during the period of growth and interaction from 1888 to 1953. This partnership extended from straight funding to coordinated national and regional research programs,

Policy Aspects

The Federal-State funding arrangement that developed after 1888, while highly productive, had the seeds of conflict built into it. USDA not only sponsors its own research program but also passes Federal funds on to the States; this was bound to lead to some contention about the relative proportion of funds used for each purpose.

The countervailing forces and their attitudes were summarized in an exchange between a congressman and Whitman Jordan, representing the State stations, at a hearing on the Adams bill in January 1905:

> Congressman: Don't you think a fair inference from these figures is that we should give you all the money we have got?
>
> Jordan: No; you have a great big Department in Washington that needs all the money you can give it. But on reflection, I would say that we will take all the money we can get, and we can use it well. (Knoblauch, et al., p, 104)

Passage of the Adams Act was a major boost for the States ". . . but it made long and rigorous competition with the Department ineditable. " Other crises in the relationship arose in 1930-32 and in 1953-58 (Knoblauch, et al., p. 121).

In analyzing Federal/State relations since the passage of the Hatch Act, Knoblauch, et al., made the following observation in 1963:

> A theme of continuity runs through 20th century developments . . . . The thread is one of undulating competition between the experiment stations and Federal research activities within the States. Which of the two types of agencies should have priority? (p. 120)

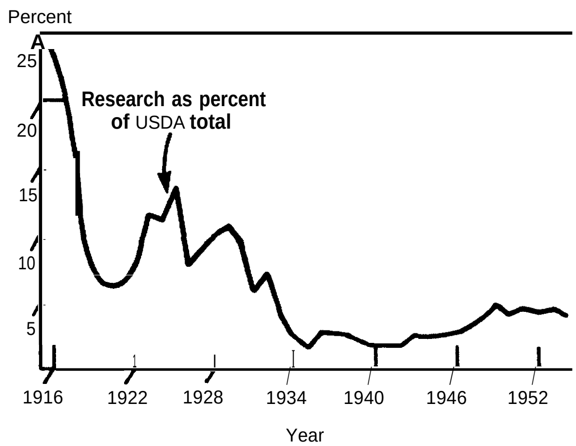
While the Federal/State relationship is commonly referred to as one of cooperation, in reality it is the product of "collision and compromise . . . the never-ending search for adjustments between the stations and the Department as to the division of responsibility for research in the States" (Knoblauch, et al., p. 121).[10]

Funding Aspects

Shortly after the conclusion of Secretary Wilson's term in 1915, research made up about 25 percent of the total USDA budget. The research proportion then dropped sharply until 1920, when it accounted for only 6 percent (fig. 4). The proportion rose through

[10]The job of the Office of Experiment Stations in such a situation must have been a most uncomfortable one at times. A. C. True, one of the early and long-time directors of this office, was, however, remarkably successful. Rosenberg attributes this in part to ". . . his ability to assuage the suspicions of station leaders and to convince them that his ultimate loyalties lay not with the Department of Agriculture, but with the State stations" (Rosenberg, 1964, p. 4, fn. 3)

Figure 4.— Role of Research in USDA Budget Allocations, 1915-55

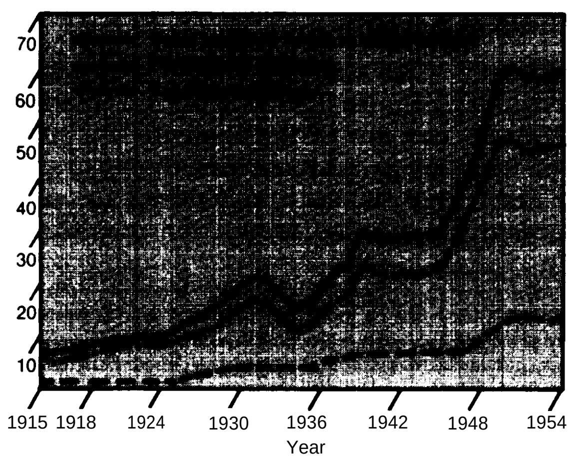


SOURCE App. B, table B-1 (col 3)

the mid-1920's, and dropped through the mid-1930's. It remained at roughly the 2.5 percent level until the 1950's, when it rose to 4 percent.

The declining relative importance of research was a result more of an expansion in the USDA budget for other activities than of any particular drop in the research budget. In fact, USDA's research budget rose through 1931, dropped during the depression of the 1930's, rose through 1940, remained constant through 1945, rose sharply through 1950, and then leveled off through 1954 (fig. 5). Allowance for inflation would have reduced the rate of increase.

Figure 5.–Appropriations for Research in USDA Budget, 1915-54 (in millions of dollars)



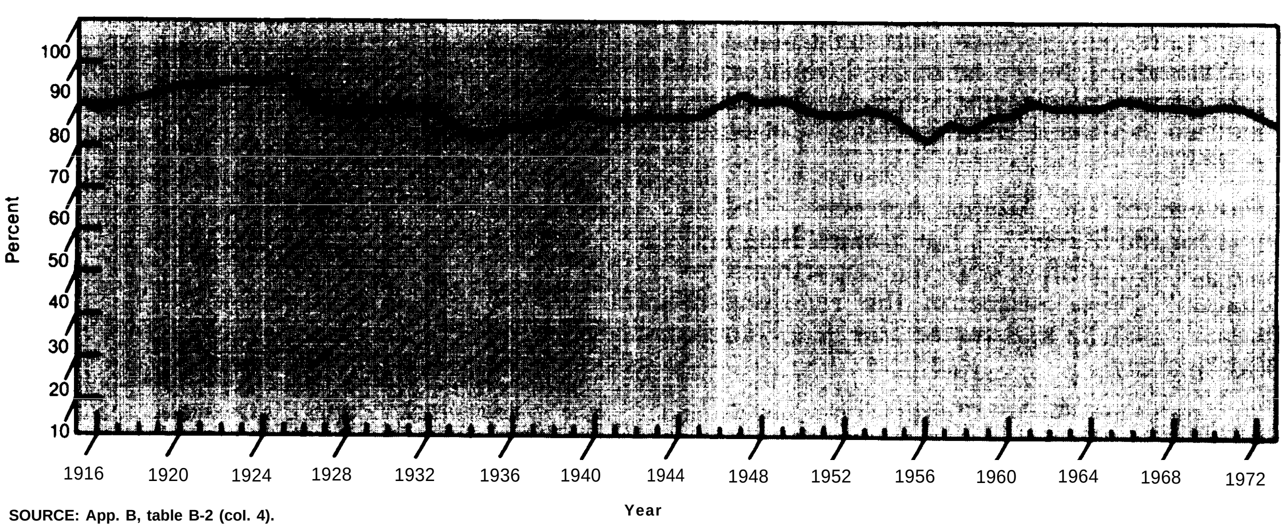
SOURCE: App. B, table B-2 (cols. 1-3)

Within the USDA budget, the actual dollar amount devoted to Federal research mirrored the above trends, while the amount passed on to the States was more stable—rising in response to each of the special funding acts and then leveling off (fig. 5).

Despite these variations, the actual proportion of the USDA research budget going for Federal research was remarkably steady over the 56-year period (fig. 6). The same is true of the State proportion. Over the period, an average of 78.8 percent was devoted to Federal research and 21.2 percent to State research. The highest Federal proportion, 86.6 percent, was reached in 1925; the lowest portion, 71.9 percent, in 1934. Over the 5-year period from 1950 to 1954, the Federal portion was down slightly to 77.6 percent.

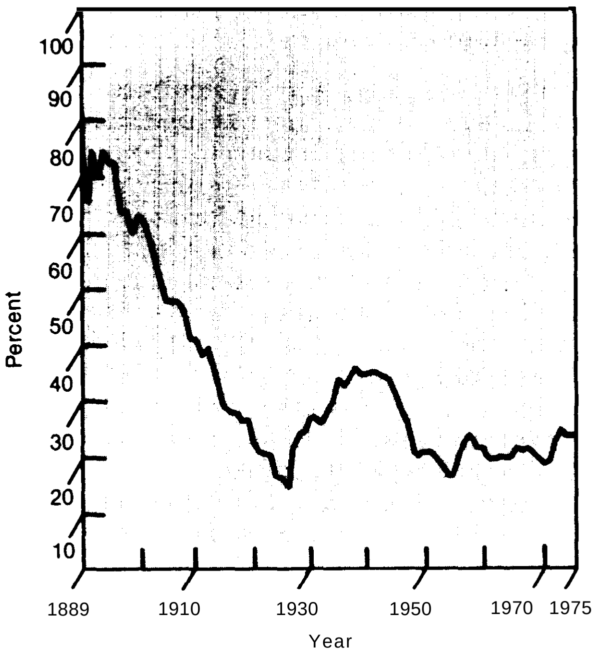
The proportion of the budgets of SAES coming from USDA funds is summarized in figure 7. Clearly, the USDA portion was very high at first and dropped rather steadily through 1925; and then, with the enactment of the Purnell and other acts, rose to another peak period in the late 1930's and early 1940's. It dropped again after 1944 to another low point in 1954. Non-Federal funds were largely composed of State appropriations, but

Figure 6.—Proportion of USDA Research Funds Used for Federal Research, 1915=73



SOURCE: App. B, table B-2 (col. 4).

Figure 7.—USDA Funds as Proportion of Expenditures by State Agricultural Experiment Stations, 1889-1975



SOURCE: Calculated from data in *Agricultural Appropriations for 1957,* Senate Hearings, 1956, insert opposite p. 136; and *Funds for Research at State Agricultural Experiment Stations,* USDA/CSRS, annual.

also included grants from foundations and industry, fees, sales, and miscellaneous.

On balance, it would appear that the Federal/State partnership through the early 1950's resulted in a remarkable degree of stability in terms of the division of USDA funds between Federal and State research. One hesitates to think, however, of how much tension and time were involved in reaching this state of relative equilibrium.

REORGANIZATION AND DECENTRALIZATION, 1953 To THE PRESENT

With the arrival of a new Secretary of Agriculture in 1953, the structure of research organization and administration of funds for State research underwent the first of a number of reorganizations that continued on through the late 1970's. These reorganizations will be only briefly introduced here; they will be discussed in greater detail in subsequent chapters. (Further organizational details and comments may be found in Moseman, et al., 1981.)

Reorganization

The reorganization of 1953 abolished both the long-standing scientific bureaus and the Office of Experiment Stations. Administrative authority for both functions was centralized with the Agricultural Research Service (ARS), which might be considered an outgrowth of the Agricultural Research Administration.

Although the reorganization may have led to some administrative improvements, it evidently had a very destabilizing effect on Federal research and cooperative programs. On the Federal end, much of the financial and decisionmaking authority was centralized and moved up a level. The division of the Office of Experiment Stations into two units and its placement under the control of the Administration of ARS was not well received by the States. (In 1962, a separate Cooperative State Research Service was established.)

Aside from the immediate problems it created, the reorganization "had the effect of subjecting the research structure of the Department—which had substantial stability and immunity from political interference for 40 years . . . —to a succession of pressures for further drastic reorganizations with the changes in political administration in future years" (Moseman, et al., 1981).

In the early 1960's the Life Sciences Panel of the president's Science Advisory Committee (PSAC) prepared a report entitled Science and Agriculture, which focused primarily on USDA. It included several recommendations relating to research organization. A Committee on Agricultural Science was appointed by Secretary Freeman in April 1962, and several changes were made in research organization in the first 6 months of 1963 (Moseman, et al., 1981). In the process, some of the PSAC recommendations were implemented. These were more in the nature of continuing adjustments, rather than major disruptions or reorganizations.

In late 1969, a National Academy of Sciences Committee on Research Advisory to USDA was established, later known as the Pound Committee. It, too, presented a number of recommendations for improving USDA's research program, many of which reflected the academic composition and thrust of the committee, Some of the committee's comments were quite critical of USDA and SAES, and these were given extensive coverage in the press, In the process, many of the committee's other comments, which would have been quite useful, were overlooked (Moseman, et al., 1981).

Shortly after the Pound report was issued, but unrelated to it, USDA initiated the reorganization of 1972. Developed by a small group of administrators, its main thrust was administrative decentralization. Line operating responsibility was delegated to four regions, each under a regional deputy administrator. Each of the regions was further subdivided into a series of research area centers. The national program staff (NPS) was retained in Washington, but otherwise all scientists and facilities, including Beltsville, were placed under regional administrators. The NPS, as its name implies, had staff and not line responsibility.

Finally, the Food and Agriculture Act of 1977 further defined the role of USDA, the States, and other institutions in planning and coordination agricultural research, extension, and teaching. It called for the establishment of a Joint Council of Food and Agricultural Sciences and a National Agricultural Research and Extension Users Advisory Board. The Science and Education Administration (SEA) was established in USDA with authority over research, extension, and teaching activities. While coordination of these activities is desirable, there is some question whether a new layer of management was necessary, desirable, or productive, The combination of the advisory groups and SEA has required a great deal of staff time—much of it contributed by the agencies involved. It is uncertain whether the cause of research has been materially advanced in the process.

Funding

Despite the many organizational changes since 1953, research funding continued to follow the same patterns that were established near the end of the previous period. *

Role of Research in USDA Budget, 1963 to 1980.—During this period, research funds continued to represent 3 to 4 percent of the total USDA budget, The average was 3.55 percent from 1963 to 1971, and 3.60 percent from 1972 to 1980 (Agriculture , . . Appropriations for "1972, and Special Budget Tables, FY 1981),

Division of USDA Funds Between Federal and State Use, 1955 to 1973 (fig. 6).—Over the period from 1955 to 1973, an average of

* Unfortunately, it was not possible to compile statistics comparable to previous data for the whole period since 1954. One key data series was discontinued in 1975; hence, only portions of the period are covered. The data are also not fully comparable with those reported in ch. IV.

77.4 percent of the USDA funds continued to go to the Federal research program, and 22.6 percent to the States.[11] The Federal figure was down slightly (from 78.8 percent) and the State figure up slightly (from 21.2 percent) compared to the previous 40-year period. The Federal proportion dropped and the State proportion increased somewhat in 1972 and 1973; data from other statistical series suggest that this trend continued through 1981.[12]

Role of USDA Funds at the State Level, 1955 to 1975 (fig. 7).*—uSDA funds continued to represent over 20 percent of the expenditures of the SAES. The average was 21 percent from 1955 to 1975, and rose to over 23 percent in the mid-1970's.

Although most of the research conducted by USDA is carried out under SEA, research is also conducted by several other USDA agencies, most notably the Forest Service (FS) and what was the Economics, Statistics, and Cooperatives Service (ESCS). Over the 1972 to 1980 period, 76.6 percent of the research was carried out under SEA, 16.1 percent under FS, 5.5 percent under ESCS, and 1.8 percent under other agencies (Special Budget Tables, FY 1981, table 10).

Facilities

As of 1980, the Federal SEA research program was quite decentralized, both in administration and deployment of facilities and staff. Research was carried out at 148 locations, ranging from the massive 450-scientist facility of the Beltsville Agricultural Research Center down to one-scientist stations (Mission of SEA/AR, p. 12). A common arrangement is to place scientists at State agricultural stations. It is estimated that more than one-third of the 2,700 SEA/AR scientists are housed in such facilities (Ronningen, 1981). About one-half of the USDA research facilities were built through the initiatives of Congress between 1958 and 1977 (Flatt, et al., 1980).[13]

The highly decentralized nature of the USDA research system, a source of friction through much of the 20th century, now seems to be accepted and even favored by the States. Some observers have suggested that this is a case of divide and conquer: a highly dispersed program is easier for the States to influence and mold to their own purposes than would be the case with a highly centralized institution. This dispersion, in fact, has led to criticism that many USDA employees essentially function as State employees and that this in turn has led to a loss of focus on national issues.

[11]Other data series produce somewhat different divisions between Federal and State funds. One table provided by SEA for the 1960-81 period ["Appropriations . . . " SEA) indicates that the Federal use portion of SEA research averaged 70.7 percent, while the State portion was 29,4 percent. (As noted later in the text, the SEA totals accounted for about 76.6 percent of total USDA expenditures for research from 1972 to 1980; inclusion of the other USDA research activities would have raised the Federal portion and reduced the State portion.)

[12]The SEA data cited above indicate that the proportion of SEA funds spent for Federal research declined from an average of 72.5 percent for 1970 and 1971 to 67 percent for 1980 and 1981 ["Appropriate ions . . .," SEA). And while there was an increase in the proportion of funds going to the States, there was also a change in the composition of funds, More specifically, there was a decline in the relative role of Hatch funds (from 27.7 percent of total SEA research funds in 1960 to 20 percent in 1981) and a relative increase in the non-Hatch portion of the State funds (from 1.1 percent of total SEA research funds in 1960 to 11.8 percent in 1980). This trend is a matter of great concern to the State directors and is a motivating force behind some recent legislative endeavors.

*The data cited in this section do not include Federal funds from agencies other than USDA and hence understate both the total Federal and other funds available to the stations.

[13]Hadwiger, in a forthcoming book, notes that 44 percent of all USDA research facility construction between 1958 and 1977 was in States represented by members of the Subcommittee on Agriculture of the Senate Appropriations Committee. He states that this practice has forced "the federal Agricultural Research Service to operate a 'traveling circus, ' opening up new locations in current Senate constituencies, while closing some locations in States whose Senators are no longer members of the subcommittee. "

THE 1890 LAND-GRANT COLLEGES[14]

The role and development of agricultural research at the 1890 land-grant colleges have followed a somewhat different pattern than was true of the 1862 institutions. In August 1890, Congress passed what has become known as the Second Merrill Act. Basically, it authorized the establishment of separate land-grant colleges for Negroes. Seventeen Southern and border States established such colleges; 16 remain today, plus Tuskegee Institute.

Like the original Merrill Act, the 1890 act was vague about the role of research. And as it turned out, by far the main emphasis of the institutions established under it was on teaching, particularly the training of teachers. None of the Hatch Act or Adams Act research funds made available to the States were in turn directed to the 1890 schools. Nor were State funds provided for research. Only occasional funding was sometimes arranged for special projects. Consequently, no significant agricultural research programs were initially established at the 1890 schools.

The one exception to this pattern was Tuskegee Institute, which was not technically an 1890 institution, * The Alabama State Legislature established the Tuskegee State Experiment Station in 1897. It was headed by George Washington Carver from its inception until his death in 1943. Subsequently, the experiment station activities were deemphasized.

Agricultural research remained in limbo at the 1890 institutions until the mid-1960's, when the situation began to change sharply. Public Law 89-106, passed in 1965, made it possible to provide Federal research funds to the 1890 schools. The first appropriation for this purpose was provided in fiscal year 1967, when $283,000 was allocated for the 16 1890 schools (Tuskegee was at first excluded). This modest level of funding was carried through to 1971. In fiscal year 1972, however, a sharp increase—to nearly $8.9 million—was provided, and provision was made for inclusion of Tuskegee.

Under the Food and Agriculture Act of 1977, these institutions acquired a more complete funding authority and responsibility than they had previously (Public Law 95-113, sec. 1445), The funding level was set at 15 percent of the funding provided the SAES (Hatch funds), Funding under this authority was first provided in fiscal year 1979. The appropriation in fiscal year 1981 was nearly $19.3 million. In addition, a bill is before Congress that would provide $50 million over a 5-year period for capital construction.

So far, essentially all (about 99 percent) of the agricultural research funds for the 1890 schools are from Federal sources. State funding is limited to small amounts at a few institutions. Whether State funding will grow significantly remains to be seen. The 1890 schools must join with the experiment stations in their State and submit joint-funding requests to USDA, but thereafter, the Federal funds are allocated directly to them. Funds are administered by the Cooperative State Research Service. They might be viewed as additional funding for the States that receive them,

Thus, after a long period of financial neglect, it seems that agricultural research at the predominantly black 1890 schools is becoming a significant factor in publicly supported agricultural research in the United States.

[14] This section is based on information provided in Mayberry, Payne, and Schor, and by Mayes.

*However, a special act of Congress in February 1899 authorized the Governor of Alabama to select 25,000 acres of land from the public domain to endow Tuskegee Institute. Alabama Agricultural and Mechanical University was designated as the 1890 institution after a spirited competition with Tuskegee.

PRINCIPAL FINDINGS

- As population expands and quantity of land decreases, there is a growing need to increase agricultural yields per unit of land, Research is a major source of yield-increasing technology, Science has played a vital role in increasing U.S. agricultural productivity. Research is also needed to improve the marketing of this expanded production and to serve other needs of society.

- Agricultural research is conducted by public and private agencies in the United States. Each tends to generate different types of technologies: the public sector largely produces biological technology, and the private sector largely produces mechanical and chemical technology. The public sector produces public knowledge; the private sector tends to use it to produce proprietary goods. Yet, both are greatly needed, complement each other, and overlap. The public is well served by the combination.

- Since the turn of the century, both State and Federal agencies have been active partners and competitors in research. At first, the State research programs were heavily dependent on Federal funds, but this dependence lessened through 1920 as State support increased, Aside from the late 1930's and early 1940's, USDA provided about 20 percent of the funding of State stations through 1975. These funds have in turn represented from 20 to 25 percent of the research funding received by USDA.

- The substantial involvement of USDA in research brought about by Secretary Wilson early in the century has continued. Over time, from 75 to 80 percent of the research funding received by USDA has been used for its own in-house research program.

- Decentralization of USDA research was at first opposed by the State scientists. State administrators now favor a decentralized pattern, in part because they seem to have adapted it to their needs. This in turn has raised questions about whether the Federal system has sufficient national focus.

- The two-valved nature of USDA research funding—divided between State and Federal research units—has long been a source of friction. State and Federal researchers each would like a larger share of the pie. The actual division of USDA funds has been remarkably stable over time (though it may have swung in favor of the States in recent years), probably as a result of this dynamic tension. But maintenance of the balance has undoubtedly consumed an enormous amount of time and effort.

- While the State research structure has been relatively stable, as was the USDA research structure for many years, the USDA research structure" has been the subject of a number of reorganizations since 1953. A common characteristic of each reorganization is the continuous addition of administrative layers and functions and a certain loss of national focus,

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Chapter IV

Measuring Costs, Benefits, Burdens, and Quality of Research

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Chapter IV

Measuring Costs, Benefits, Burdens, and Quality of Research

Achievements in agricultural research and technology have contributed markedly to the economic stature and social well-being of the United States and have enhanced our standing among world powers in many ways. Such achievements, however, have not been attained without certain costs and burdens to society. In other words, the benefits accruing from research must be weighed against the magnitude of whatever dollar and manpower investments are required, together with such factors as impact on environmental quality, labor displacement, or impairment of sensory quality caused by mass food production, Most evaluations show, however, that the benefits far outweigh the costs and burdens. Actually, on a rate-of-return basis, consumers reap benefits well in excess of costs.

Among scientists themselves, attempts have been made at various times to measure the quality of research performance but it is also important to measure research productivity and its ultimate impact on society as a whole, Although trends in funding U.S. food and agricultural research show only modest increases over time, the cumulative benefits to all segments of society would seem to more than justify whatever investments have been made.

TRENDS IN FUNDING

Food and agricultural research in the United States is conducted chiefly by the U.S. Department of Agriculture (USDA); the State agricultural experiment stations (SAES) in conjunction with land-grant universities, including the 1890 Schools and Tuskegee Institute; and private industry. USDA and SAES research constitute public research regardless of the source of supporting funds. USDA agricultural research is funded from Federal sources. SAES research is supported by Federal funds, State appropriations and sales, and grants from private sources.

The scope and magnitude of food and agricultural research performed by private industry cannot be accurately reported because of the lack of reliable data. Private firms engaged in agricultural research are not required to identify themselves, nor are they required to publicly disclose their investments in agricultural research. Thus, any analysis of agricultural research by private industry has to be based on incomplete data. Those figures that are available will be discussed later in this chapter.

Accurate figures are available for total expenditures on food and agricultural research by USDA and the SAES. In this segment of the report, patterns and trends in expenditures focus on the period 1966 to 1979. Note that figures are given for expenditures in current dollars and constant dollars—that is, dollar expenditures adjusted for inflation. The deflator factor used for this study is explained by Havlicek and Otto in their OTA resource paper.

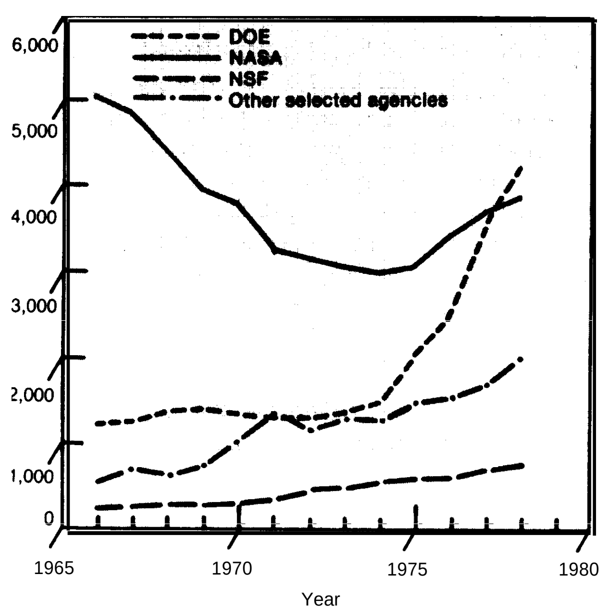
R&D Expenditures by Federal Agencies

Among the major Federal research agencies that conduct research and development (R&D), USDA expenditures are the lowest in terms of dollar expenditures. In 1978, total Federal expenditures for R&D were $26.2 billion. USDA's expenditures were $381 million or approximately 1.5 percent of the total. This compared with Department of Defense (DOD) share of 45 percent; Department of Energy (DOE) of 16 percent; and Department of Health, Education, and Welfare (HEW) of 12 percent. USDA's status among Federal agencies represents a continuing decline in share of the Federal budget for R&D from a high of 39 percent in 1940 to 1.5 percent in 1978.

Federal obligations for all R&D by the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), DOE, and a category of other selected agencies for the 1966-78 period (the most recent available data) are presented in current dollars in figure 8 and constant dollars in figure 9. The level of funding for NASA is large relative to the other agencies considered. As may be observed from figures 8 and 9, R&D funding for NASA decreased from 1966 to 1974 and thereafter increased, although in constant dollars the increase from 1974 to 1978 was quite small. R&D funding for DOE increased in current dollars from 1972 to 1978, but in constant dollars did not increase until after 1974. In current and constant dollars, R&D funding for NSF increased steadily during the 13-year period. R&D funding for "all other agencies" increased about 270 percent in current dollars during the 1966-78 period, but in constant dollars increased about 67 percent.

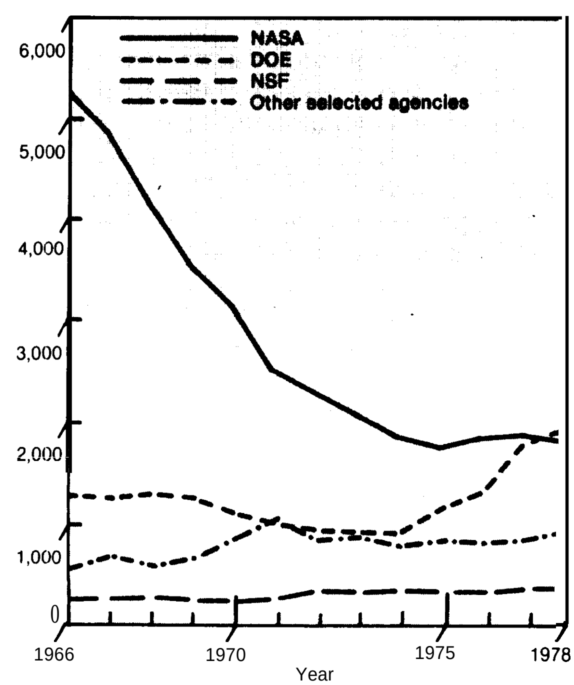
R&D expenditures for USDA, DOD, HEW, and the total for all Federal agencies for the 1966-78 period are presented in current dollars in figure 10 and in constant dollars in figure 11. In current dollars, R&D expenditures by DOD increased 68 percent from 1966 to '1978, but in constant dollars this represented a decline of 26 percent; R&D funding for HEW increased steadily by 209 percent from 1966 to 1978, and in constant dollars the expenditures increased 35 percent. In current dollars, R&D funding for USDA, which in-

Figure 8.–Federal Obligations for R&D by NASA, DOE, NSF, and Other Selected Agencies—1966.78 (in millions of current dollars)



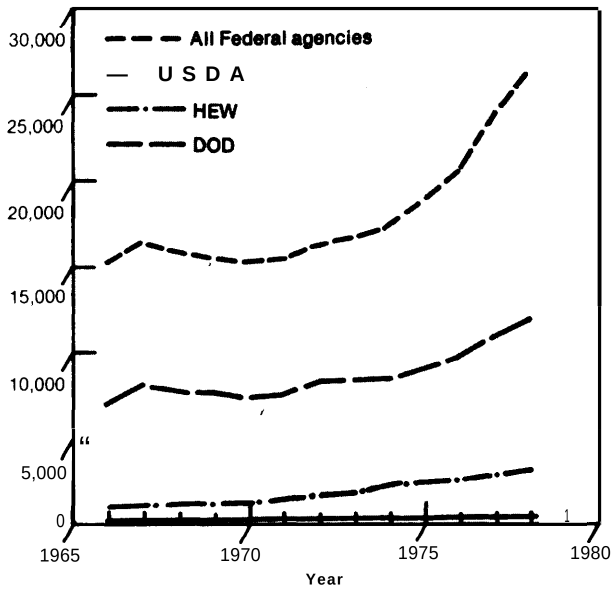
SOURCE: Joseph Havlicek, Jr , and Daniel Otto, "Historical Analysis of Investment in Food and Agricultural Research in the United States, " OTA background paper, 1981

Figure 9.–Federal Obligations for R&D by NASA, DOE, NSF, and Other Selected Agencies—1966.78 (in millions of constant dollars)



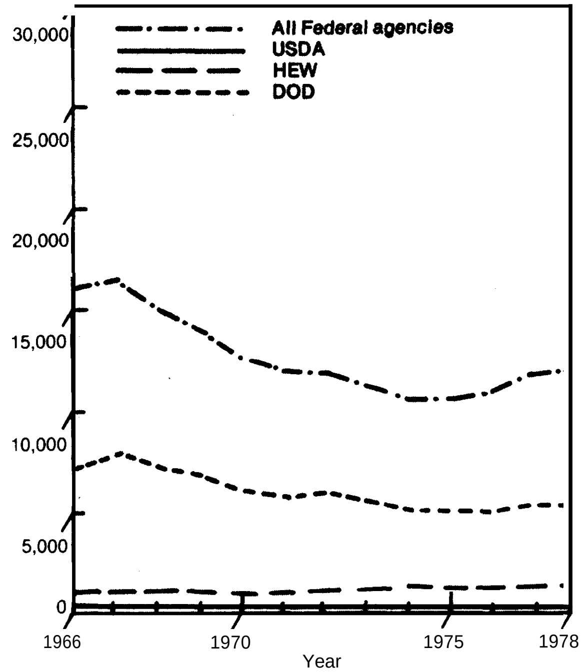
SOURCE Joseph Havlicek, Jr , and Daniel Otto, "Historical Analysis of Investment in Food and Agricultural Research in the United States, " OTA background paper, 1981

Figure 10.— Federal Obligations for R&D by USDA, DOD, HEW, and All Federal Agencies—1966-78 (in millions of current dollars)



SOURCE Joseph Havlicek, Jr , and Daniel Otto, "Historical Analysis of Investment In Food and Agricultural Research in the United States, " OTA background paper, 1981

Figure 11.— Federal Obligations for R&D by USDA, DOD, HEW, and All Federal Agencies—1966-78 (in millions of constant dollars)



SOURCE: Joseph Havlicek, Jr, and Daniel Otto, "Historical Analysis of Investment in Food and Agricultural Research in the United States, " OTA background paper, 1981

eludes pass-through funds to the States, increased steadily by 149 percent from 1966 to 1978, and in constant dollars by 10 percent. Finally, the current-dollar Federal obligations for all R&D for all Federal agencies increased 72 percent from 1966 to 1978, but in constant dollars this ended up being a 25-percent decrease. The pattern in the expenditures for all R&D for all Federal agencies and the patterns in R&D expenditures of NASA and DOD, the two largest agencies in terms of R&D funding, are quite similar,

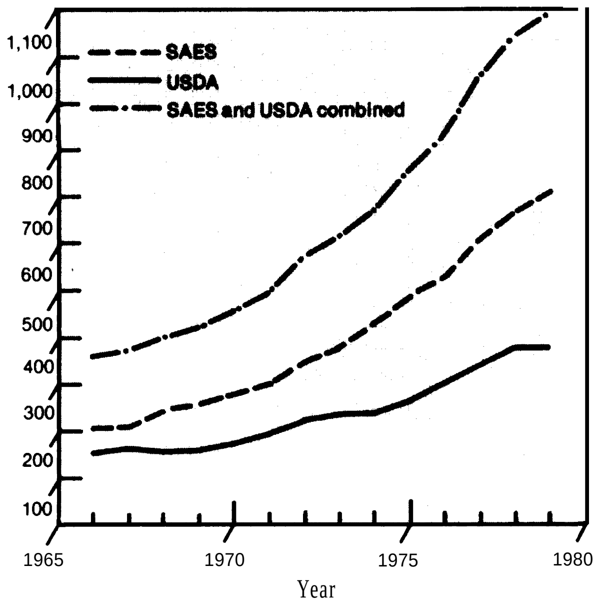
R&D Expenditures for U.S. Agricultural Research

Current dollar expenditures on total agricultural research for USDA, SAES, and USDA and SAES combined for the 1966-79 period are presented in figure 12, and the constant-dollar expenditures are shown in figure 13. The top line in each figure represents the expenditures of USDA and the SAES combined—i.e., the funding of public agricultural research in the United States. In current dollars, the total funding for public agricultural research increased 204 percent for the 14-year period. Total research expenditures in the SAES increased 245 percent during this period, while USDA expenditures increased only 149 percent.

But the funding picture shown in figure 13 is quite different, For this figure, expenditures were adjusted to 1967 constant dollars (deflated). The increase in the purchasing power of the total SAES and USDA agricultural research expenditures increased only 23 percent from 1966 to 1979. Furthermore, the constant-dollar agricultural research expenditures of USDA for in-house research increased only 1 percent during this period, while those in the SAES increased 40 percent.[1] Clearly, during this time and particularly during the latter part of the period, inflation severely eroded the purchasing

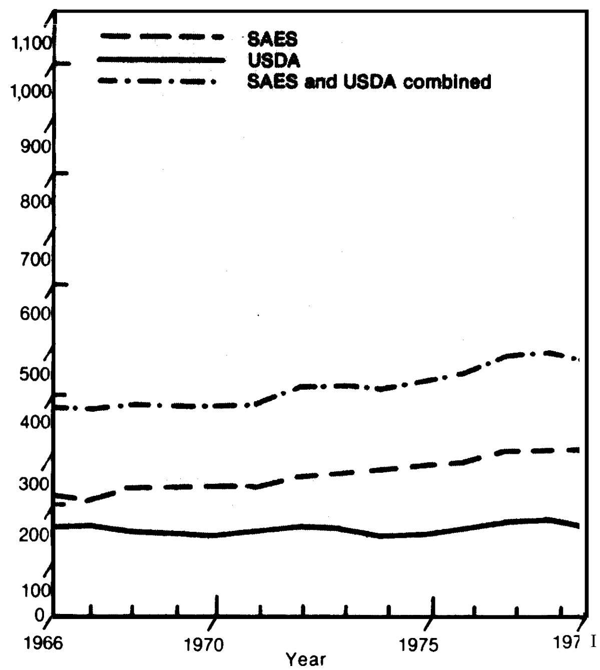
[1] The USDA figures exclude pass-through funds to the States. For further information see Havlicek and Otto, 1981.

Figure 12.–SAES, USDA, and Combined SAES and USDA Total Research Expenditures—1966-79 (in millions of current dollars)



SOURCE: Joseph Havlicek, Jr., and Daniel Otto, "Historical Analysis of Investment in Food and Agricultural Research in the United States," OTA background paper, 1981,

Figure 13.—SAES, USDA, and Combined SAES and USDA Total Research Expenditures—1966-79 (in millions of constant dollars)



SOURCE: Joseph Havlicek, Jr., and Daniel Otto, "Historical Analysis of Investment in Food and Agricultural Research in the United States," OTA background paper, 1981.

power of agricultural research funds. Moreover, the constant-dollar expenditures of USDA remained at about the same level during the period, so that the modest increase that occurred is attributable to SAES expenditures. During the 1966-79 period, SAES expenditures accounted for an increasingly greater share of public agricultural research funds.

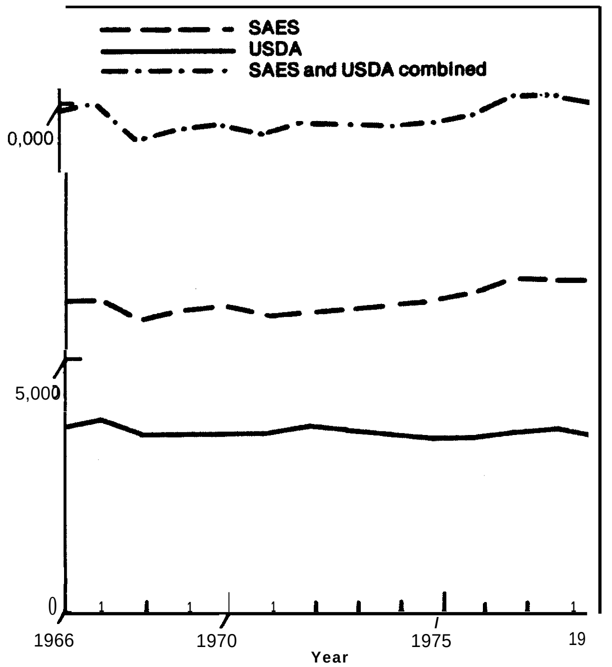
Scientific Manpower

During the same 14-year period, USDA scientist-years devoted to agricultural research remained nearly constant after a slight decrease from 1967 to 1968 (fig. 14). In the SAES there was a very gradual upward trend in the scientist-years in agricultural research, and the total increase from 1966 to 1979 was approximately 460 scientist-years. Increases in expenditures on agricultural research by USDA and SAES have basically been used to cover the salaries, supporting research equipment, and supplies for a nearly constant scientist manpower force. Yet during this same period, the demands on agricultural research have been greater than ever.

This is an acute problem in the strong research demand areas such as genetic engineering. The new demand for research manpower, especially from the private sector, creates problems for Federal agencies and especially universities in keeping staff and maintaining graduate programs in the field.

While USDA scientist numbers remain relatively constant, the average age is increasing. Between 1969 and 1976, the number of Science and Education Administration-Agricultural Research (SEA-AR) scientists 50 years of age and older increased from 28 to 39 percent of the work force; the number of those 30 years of age and under decreased from 9 to only 2 percent in the same period. By way of comparison, at the National Institutes of Health (NIH) the number of scientists 50 years of age and over (1976) was 15 percent,

Figure 14.—SAES, USDA, and Combined USDA and SAES Scientist Years–1966-79



SOURCE Joseph Havlicek, Jr , and Daniel Otto, "Historical Analysis of Investment in Food and Agricultural Research in the United States, " OTA background paper, 1981

and 30 years of age and under was 25 percent. The average age of SEA-AR scientists in 1976 was 47 and of NIH, 35 (General Accounting Office, 1976, 1977). Most research institutions desire a continuous influx of young scientists in their organization.

Both personnel ceilings and shortage of funds are valid reasons given for these trends. Since both will probably remain as constraints in varying degrees in the near future, especially personnel ceilings, some management practices need to be established that will assure attraction and hiring of capable young scientists in SEA-AR.

USDA Expenditures

The agricultural research expenditures in current dollars of the major agencies within USDA are presented in figure 15 and the corresponding constant-dollar expenditures in figure 16. For the period 1966 to 1979, the Agricultural Research Service (ARS) was by far the largest component in terms of expenditures on agricultural research. In current dollars, ARS expenditures on agricultural research increased 139 percent from 1966 to 1979, but in constant dollars decreased about 3 percent.

Except for slight decreases from 1967 to 1968 and 1969 to 1970, the current-dollar expenditures on agricultural economics research by the Economics and Statistics Service (ESS) increased rather steadily during the 14-year period, and there was a 127-percent increase from 1966 to 1979. However, this increase did not keep up with inflation, and in constant dollars there was an 8-percent decrease from 1966 to 1979.

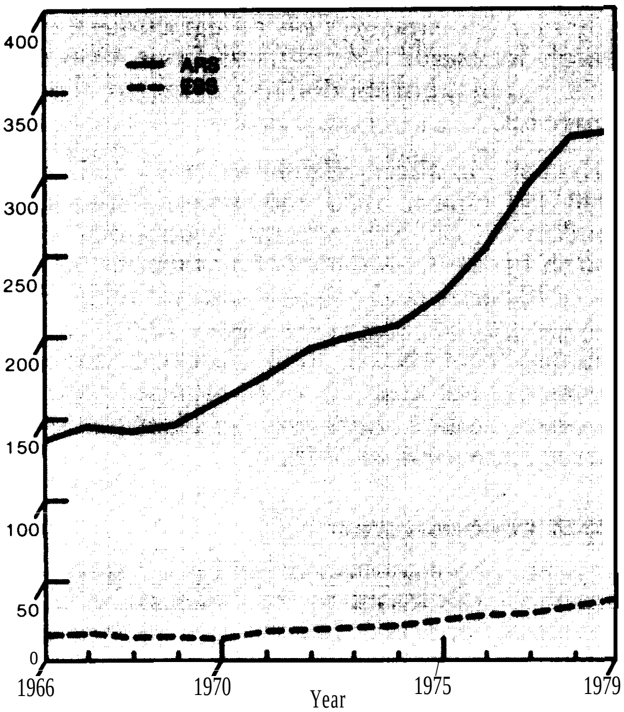
SAES Expenditures

Levels of expenditures on agricultural research by the SAES for the 1966-79 period, according to major components of Federal research funds, are presented in current dollars in figure 17 and in constant dollars in figure 18. The largest component from Federal sources was the total of the formula funds, including Hatch and other appropriations. In current dollars, these expenditures steadily increased from 1966 to 1979; the 1979 level was nearly 200 percent greater than the 1966 level. However, in constant dollars, the current-dollar increase translates to a 20-percent increase, or an average increase of about 1.5 percent a year.

Cooperative grants and cooperative agreements were the smallest component of Federal funding of agricultural research in the SAES. In current and constant dollars, these funds declined from 1968 to 1971, but since then have been increasing. Over the entire 14-year period, the current-dollar expenditures increased 197 percent, while the constant-dollar expenditures increased only 20 percent.

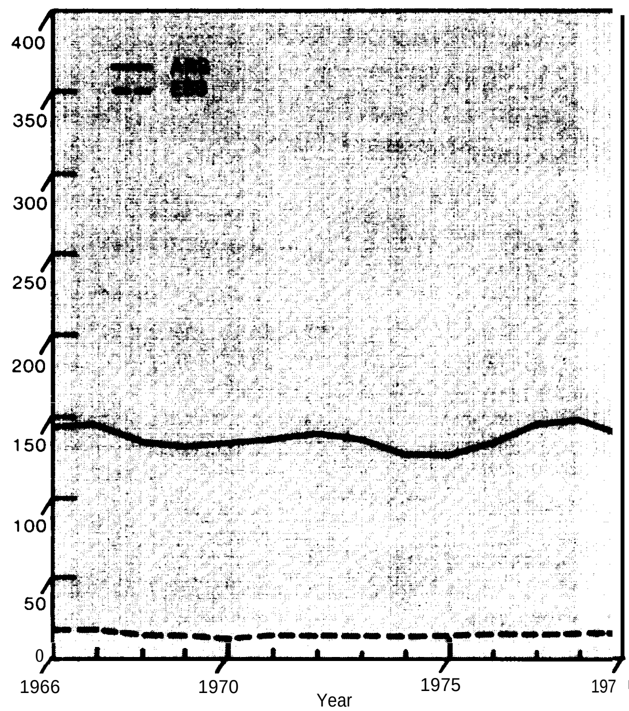
Other Federal funds for agricultural research at the SAES are one-half to one-third of the size of formula funds, but two to three times the size of expenditures from cooperative grants and cooperative agreements.

Figure 15.–USDA Research Expenditures by ARS, ESS—1966-79 (in millions of current dollars)



SOURCE: Joseph Havlicek, Jr., and Daniel Otto, "Historical Analysis of Investment in Food and Agricultural Research in the United States," OTA background paper, 1981.

Figure 16.—USDA Research Expenditures by ARS. ESS—1966-79 (in millions of constant dollars)



SOURCE: Joseph Havlicek, Jr., and Daniel Otto, "Historical Analysis of Investment in Food and Agricultural Research in the United States," OTA background paper, 1981

These other Federal funds have been an important source of funds to the SAES. With some variation, the current-dollar expenditures increased by 129 percent from 1966 to 1979, but in constant dollars this was an overall 7-percent decline.

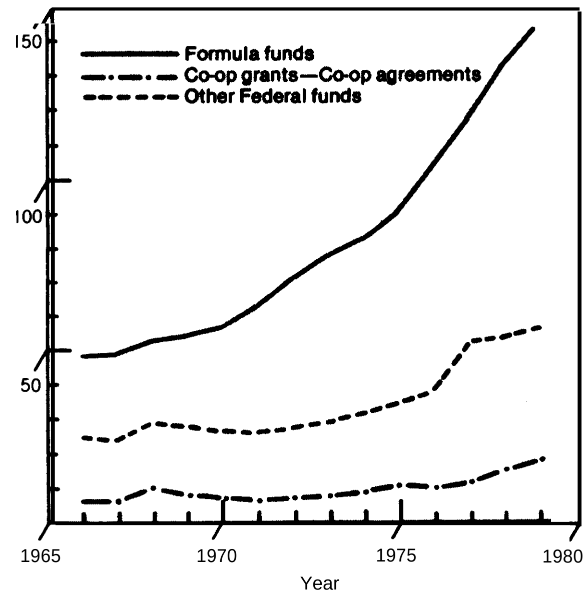
The major source of agricultural research funding at SAES is State appropriations and sales. Expenditures from these sources, private sources, and formula funds from Federal sources are presented in current dollars in figure 19 and in constant dollars in figure 20. In current dollars, all three sources increased during the 1966-79 period. State appropriations and sales increased nearly fourfold, resulting in a constant-dollar increase of 57 percent.

Private research funds for agricultural research at SAES are small relative to State appropriations and sales and the Federal formula funds. Nonetheless, they have steadily increased since 1966 and are becoming an important source of agricultural research funds. During the 1966-79 period, private sources of agricultural research funds going to SAES also increased fourfold in current dollars, which resulted in a constant-dollar increase of 63 percent.

Private Industry Expenditures

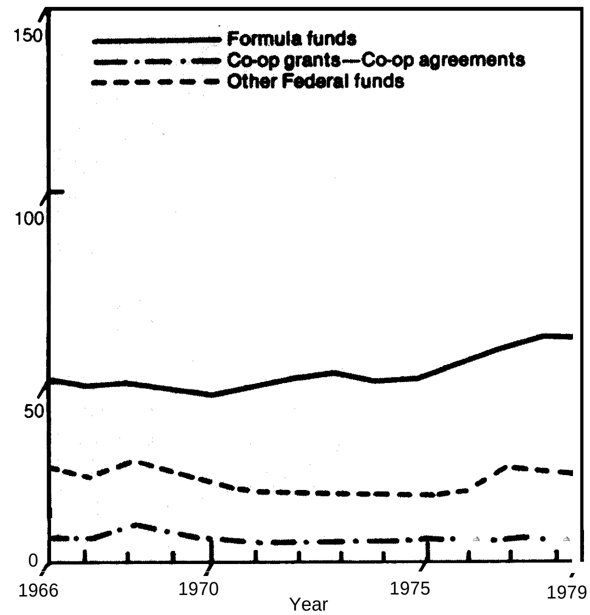
Data on the expenditures for agricultural research by private industry are considerably more limited than those on SAES and USDA. Some data concerned with applied research and development for agricultural-related products obtained from the Surveys of Science Resources Series of NSF are presented in figure 21. The time period covered is 1963 to 1975. In current dollars, the 1963 total expenditure by private industry for agricultural research was about $220 million, and increased to slightly over $600 million in

Figure 17.—Formula, Cooperative Grants and Cooperative Agreements, and Other Federally Funded Research Expenditures at SAES–1966-79
(in millions of current dollars)



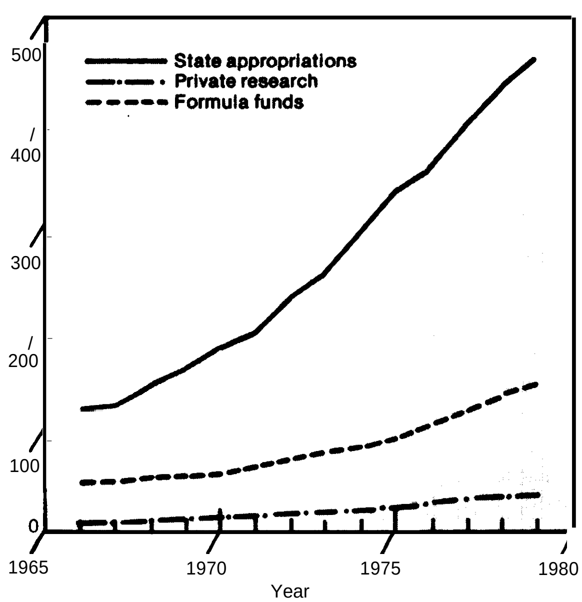
SOURCE Joseph Havlicek, Jr., and Daniel Otto, "Historical Analysis of Investment in Food and Agricultural Research in the United States," OTA background paper, 1981

Figure 18.—Formula, Cooperative Grants and Cooperative Agreements, and Other Federally Funded Research Expenditures at SAES–1966-79
(in millions of constant dollars)



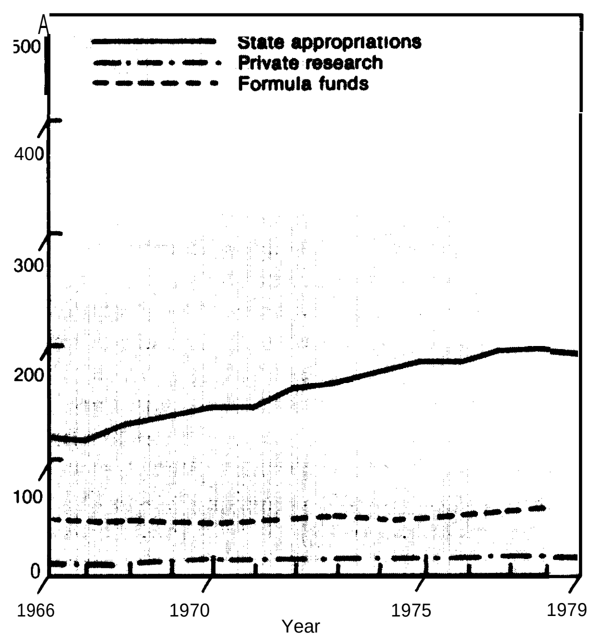
SOURCE' Joseph Havlicek, Jr, and Daniel Otto, "Historical Analysis of Invest. ment in Food and Agricultural Research in the United States," OTA background paper, 1981.

Figure 19.—State Appropriations, Private Research, and Formula Funds at SAES—1966-79
(in millions of current dollars)



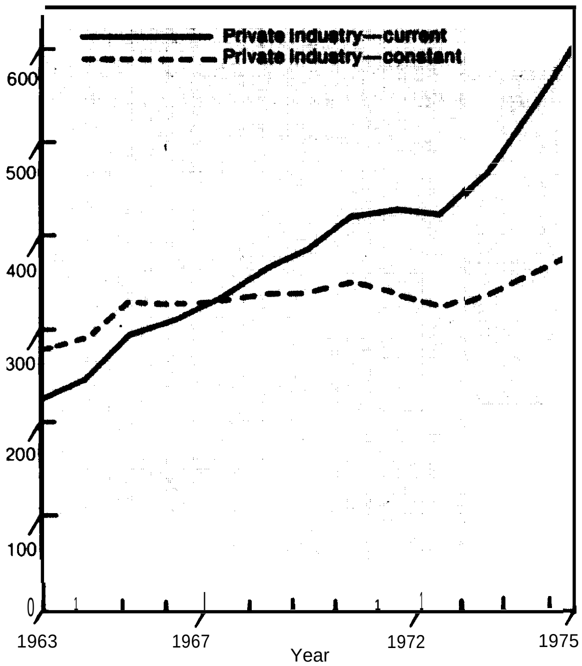
SOURCE: Joseph Havlicek, Jr., and Daniel Otto, "Historical Analysis of Investment in Food and Agricultural Research in the United States," OTA background paper, 1981.

Figure 20.—State Appropriations, Private Research, and Formula Funds at SAES—1966-79
(in millions of constant dollars)



SOURCE: Joseph Havlicek, Jr., and Daniel Otto, "Historical Analysis of Investment in Food and Agricultural Research in the United States," OTA background paper, 1981.

Figure 21 .—Total Expenditures for Applied R&D for Agricultural. Related Products by Private Industry—1963-75 (in millions of current and constant dollars)



SOURCE. Joseph Havlicek, Jr., and Daniel Otto, "Historical Analysis of Investment in Food and Agricultural Research in the United States, " OTA background paper, 1981,

1975—about a 170-percent increase. In constant 1967 dollars, this is a 39-percent overall increase or a 3-percent average annual increase.

A second, even less comprehensive source of data on private agricultural research, was obtained from a separate survey of agribusiness firms conducted by the Agricultural Research Institute (ARI) for 1975. The estimated research expenditures by agricultural firms for 1975 from this survey were $575 million, which is slightly less than the $602 million estimated from the NSF survey for 1975. The categories from the ARI survey are not strictly compatible with those of the NSF survey, so that direct comparison of the two surveys is not possible. However, similarities of the estimated overall level of private research from these two sources help substantiate the NSF figures as reasonable estimates of the level of agricultural research being conducted by private firms.

To get some perspective about relative magnitudes, in 1975 the total expenditure by private industry on applied R&D for agricultural-related products was about 72 percent of the total public expenditure (SAES and USDA combined) on agricultural research. This total expenditure by private industry in 1975 was approximately 23 percent greater than the SAES expenditure on agricultural research and about 75 percent greater than USDA's.

BENEFITS AND BURDENS

Research benefits must be evaluated in relation to whatever costs society must pay for them—whether in dollar investment, environmental impact, or whatever. In some cases these benefits have varying effects on producers and consumers. Researchers and their institutions also may reap benefits in terms of increased support. Likewise, State research may generate spillover benefits that accrue to residents of adjacent States or similar agroclimatic regions. In many cases, the degree of return from the research investment may influence decisionmakers as to the level of support that seems appropriate for future programs.

Nature of Benefits

People individually and collectively strive to improve their well-being, and research contributes to this societal goal. Benefits may be classified as primary (a direct result of research) and secondary (developed indirectly from the basic research activity). In addition, research produces certain questionable benefits or, in some cases, actual burdens to society, the degree of which may vary from slight to moderate, depending on individual evaluation.

Primary Benefits

Primary benefits include improved productivity, conservation, preservation, and reasonable costs of food and fiber.

The greatest emphasis in production research has been to improve crop varieties and breeds of livestock and poultry. In addition, research on purchased inputs has developed fertilizers with improved nutrient content, new and improved agricultural chemicals, and dramatic changes in farm machinery and equipment.

For the period 1945-79, technological innovations increased agricultural output 85 percent, but there was no change in the aggregate level of agricultural inputs (USDA, 1980). Substantial evidence shows that the rate of return on food and agricultural research investment is high relative to most other social investments (Evenson, Waggoner, and Ruttan, 1979). Therefore, the total volume of all goods and services is greater as a result of research investment than it would be if these funds had been invested in other alternatives.

Marketing research has made more food available through improved processing and fabrication, upgrading products, preventing waste, and providing for the use of products previously not considered viable.

Marketing research designed to reduce losses in quantity and quality of food obviously has an impact on the availability of food and its cost to consumers. Prevention of food waste by appropriate preservation and processing methods constitutes a large potential source of food. Research on reducing loss caused by pests results in estimated savings of $1.5 billion annually in the United States (National Academy of Sciences (NAS), 1977). Reducing the storage and transportation losses of fruits and vegetables could increase the supply of these products from 15 to 30 percent (NAS, 1977).

A reduction of the relative real costs of food and fiber results from conducting research at all stages of production, processing, storage, and distribution. In the United States, this reduction is quite substantial compared with that in other countries. For example, in 1977 only 16.5 percent of U.S. disposable income went for food, tobacco, and beverages (Mackie and Allen, 1980). In Canada, the figure was 21 percent. Elsewhere, spending on food, beverages, and tobacco ranged from 25 to 50 percent of total expenditures in high-income countries of Europe and Asia; around 45 to 50 percent in centrally planned countries; and between 40 and 65 percent in developing countries (United Nations, 1978). Note that all high-income nations spend less of their income on food than poorer nations.

Improved technology generated by research usually leads to relatively lower costs for farm products. This effect is brought about by supply and demand factors. On the supply side, the technology expands output. On the demand side, the expanded supply generally leads to relatively lower prices.

In terms of production, there is usually little point in a farmer adopting a new technology unless it reduces per-unit production cost, meets a regulation, or is for some personal reason such as reducing drudgery. The rate of adoption of new technology, in whole or part, is usually influenced by profitability.

The price factor represents the other side of the equation. As total output expands because of the adoption of the new technology, prices fall relatively. The rate and extent to which they fall depends on the price elasticity of demand. The domestic price elasticity of demand for most agricultural products is quite low, which means that a given increase in supply will bring about a substantial decrease in price. This has little effect on the early adopter of the technology, because his individual production is too small to affect the overall price level. But as the technology is widely adopted by other farmers, prices will drop relatively.

The effect of this general relative price decline on the individual farmer will depend on the degree to which he has adopted the cost-reducing technology. Those who have adopted it will be able to bear some reduction in price, although this will reduce their earlier profits. Those that have not adopted the technology will be disadvantaged because their costs have not been lowered. To the extent that the price decline is greater than the reduction in costs, all farmers will be disadvantaged. As prices go down, consumers will receive the advantage.

In a report on agricultural production efficiency, NAS concluded that: "Between 1950 and 1971, U.S. farm output increased 50 percent, while consumer prices remained relatively stable. If the same farming methods had been used in 1971 as in 1950, an equivalent abundance of food and other products coming from the farm would have cost consumers two to three times more than they did" (1975, p. 188).

Changes in the marketing and distribution of food have been significant in the last 30 years as evidenced by the expansion of supermarkets, which have reduced by 15 to 25 percent the retail cost of food to consumers (Kramer, 1973). These cost savings were made possible by labor reduction through self-service and large-volume operations in transportation, storage, and distribution.

Secondary Benefits

From the primary objectives of research flow secondary benefits, which include improved human nutrition, improved food quality and safety, an international trade balance, expansionary impacts on other sectors of the economy, release of labor to other sectors of society, and increased leisure time.

Research on food quality and safety and human nutrition results in: 1) better understanding of human nutrition needs; 2) improved diets and nutrition for individuals; 3) safer methods of food processing, preservation, and preparation; 4) reduced costs through knowledge of nutritional content of food and through food preservation; and 5) improved understanding of food additives and food contaminants.

Although malnutrition was discovered in certain disadvantaged groups within the United States during the 1960's, the widespread introduction of feeding programs such as Women, Infants, and Children (WIC), school breakfast and lunch, and food stamps seems to have done much to eliminate overt malnutrition, especially in children. The principal group that is apparently suffering the effects of poor nutrition because of low income is the elderly, who receive their benefits in a nondirected form.

Income is positively correlated with nutritional status in the absence of food entitlement programs; the low-income groups have the least adequate diet and the greatest vulnerability to malnutrition. The prime causes of inadequate nutrition are lack of knowledge on nutritional requirements and nutritive content of foods, the unavailability of food, and the financial inability to purchase it. Food choices also are influenced by socioeconomic and cultural factors such as family lifestyle, health, and age of individuals and outside influences, including mass media, advertising, and food labeling. Research that provides better insight into the impact of these factors on the nutrition and health of various population groups benefits consumers. Both agricultural production technology research and post-harvest food technology research affect directly the nature and distribution of these benefits among groups of consumers.

A major benefit from food and agricultural research is the positive contribution of agricultural commodities to the U.S. international trade balance. An increasing volume of food exports from the United States has partially offset the rising volume of imports of oil and manufactured goods. In essence, agricultural commodities have provided much of the exchange necessary for the United States to import oil and manufactured goods. An increasing output of agricultural exports—necessary to sustain imports—is subsequently dependent on a continuous flow of production technology. Research and education undergird the advancement of production technology and sustain the strong competitive position of the United States in international food and fiber commodities markets.

Table 1 provides documentation for the importance of agricultural commodities in reducing the magnitude of the U.S. international trade balance. Agricultural exports increased from $7.2 billion in 1970 to $41.2 billion in 1980. The trade balance in agricultural commodities increased from $1.5 billion in 1970 to $23.8 billion in 1980. This contrasts with a rising international trade deficit in other commodities from a surplus of $1.2 billion in 1970 to a deficit of $48,6 billion in 1980. An international trade deficit places a downward pressure on a national currency, reduces gold reserves, provides exchange for alien ownership of physical assets, and contributes to national price inflation. These undesirable economic consequences lead in turn to a reduced standard of living and chronic high levels of unemployment.

A favorable trade balance in agricultural commodities contributes directly to the well-being of American farmers and commodity processors, handlers, and transporters. It also contributes to the well-being of American consumers by providing exchange for imports; and it lends stability to the American economy.

Table 1 .—Exports, Imports, and International Trade Balance in Agricultural and Other Commodities in the United States (in billions of dollars)

	Exports		Imports		Balance	
Year	Agricultural	Other	Agricultural	Other	Agricultural	Other
1950. .	$ 2.9	$ 7.3	$ 4.0	$ 4.8	($ - 1.1)	$ 2.5
1955. ,	3.2	12.2	4.0	7.4	(- 0.8)	4.9
1960. .	4.8	15.5	3.8	10.8	1.0	4.7
1965. .	6.2	20.9	4.1	17.3	2.1	3.6
1970. .	7.2	35.3	5.8	34.2	1.5	1.2
1975. .	21.9	84.2	9.5	86.6	12.4	(- 2.4)
1979. .	34.7	143.8	16.9	189.4	17.9	(- 45.6)
1980. .	41.2	175.2	17.4	223.8	23.8	(- 48.6)

SOURCE. Business Statistics, Biennial Edition. United States Department of Commerce, Off Ice of Business Economics,1961 and 1977. Survey of Current Business. United States Department of Commerce, Bureau of Economic Analysis, April 1980, vol. 60, no. 4. Agricultural Outlook, U .S. Department of Agriculture, March 1981

Expansion of food and agricultural production contributes to economic growth in two ways, First, a change in agricultural production is directly related to changes in that sector's development. For example, technological innovations cause a direct change in farm earnings, net farm income, farm-labor requirements, and hence farm earnings. Second, this change rebounds throughout the economy to produce changes in income in other sectors. Thus, food and agricultural research that results in changes in output of the agricultural sector has expansionary impacts on other sectors of the economy and attendant changes in incomes.

Although farm production continued to increase dramatically during the 20th century, the farm labor input reached a peak of 13.6 million farmworkers in 1916 and subsequently declined to less than 3.8 million in 1979 (USDA, 1980). This release of farm labor provided the labor necessary to implement and expand other economic sectors.

However, a substantial part of the labor displaced by increased productivity on the farm was needed for off-farm activities in the food and agricultural sector. Under the advancing technology in farm production, progressively larger quantities of farm inputs were purchased from the industrial sector. Today, the food and agricultural sector accounts for about 20 percent of total employment and 20 percent of total national income compared with an estimated 35 to 40 percent of total employment and national income in 1940.

Much of the increasing labor productivity in the food and agricultural sector is reflected in the small proportion of consumer income spent for food as noted earlier. This means that the remaining income is freed to apply toward other human wants.

One of the less quantifiable and less documented benefits of food and agricultural research is the reduction of drudgery and the increasing leisure time of farm operators and workers. Although these kinds of benefits do not carry monetary value, they are important in the advancement of the welfare of society. Such benefits have also been extended to workers in food-fiber processing, fabrication, storage, and distribution.

In some cases, output of farm products per unit of farm-labor input has increased up to 80 times what it was at the beginning of the 20th century (Cochrane, 1979). Increasing labor productivity on the farm is reflected in both the output per unit of labor input and a reduction in the intensity of the labor input. The increasing labor productivity also has provided more leisure time for the individual worker.

Uncertain Benefits and Burdens

One of the least documented effects of agricultural research has been its impact on environmental quality. Agriculture produced undesirable environmental side effects long before the rapid advance in agricultural production techniques that characterized agriculture in the second and third quarters of the 20th century. Much of the early cotton and tobacco farming in the South resulted in soil erosion, widespread silting of streams, and changes in ecosystems. Farmwork animals produced large amounts of waste that entailed health hazards to farm families because of inadequate methods for controlling pests attracted to such waste. The dust storms in the Plains States resulted in major environmental threats from attempts to cultivate marginal lands with inadequate soil and crop management technology.

It is still an open question as to whether, on balance, the modernization of agriculture has given rise to more environmental problems than it has solved. Ruttan (1971) and Schultz (1974) proposed that the technological advances of agriculture have enlarged measurably the biological possibilities of the natural environment, allowing us to eventually have more agricultural output and more environmental quality components. The development of agricultural technology and the resultant growth in agricultural productivity have allowed substantial reductions in the acreage of major crops such as corn, wheat, and cotton. Much of the reduced acreage came from marginal lands highly subject to soil erosion, and the return of much marginal cropland to pastures and forests reduced many of the kinds of environmental hazards arising from agriculture in the past (White, Eddleman, and Purcell, 1980).

The current environmental problems attributed to agriculture largely involve pest control practices, silt and water management systems, feed-lot waste disposal, and disposal of residue from food- and fiber-processing activities. Certainly these environmental problems are more widespread than those of the past. Agricultural technology has changed the form and place of the threats, and perhaps the number of people exposed to these threats. The most controversial issue pertains to the impact of chemical pesticides used for plant production and protection and of soil sedimentation on water quality.

Ruttan (1971) suggests that the failure to develop agricultural technology (e.g., pest control and soil management systems) that would minimize agriculture's impact on the natural environment resulted from an undervaluation of environmental resource amenities. In other words, the capacity of the natural environment to absorb the residuals from crop and livestock production has been treated as a free service. Scientific and technical innovations were overly biased toward the development of land substitutes (plant nutrients, chemical pesticides, and crop varieties and management systems) that reflected undervaluation of the social cost of the disposal of residuals from agricultural production processes. Recognition of undervaluation of the social value of environmental services, coupled with regulatory actions by Federal and State governments, has led to redirection of agricultural research efforts in response to the rising economic value of environmental resource amenities, Examples of this redirection include: 1) integrated pest management techniques; 2) reduced tillage and no-till crop production systems and other soil and water conservation management systems; 3) waste-disposal systems using deep lagoons; 4) recycling processed animal wastes through the animal-plant-soil system, as fertilizer and animal feeds for ruminants; 5) aquatic weed control techniques; 6) methods for disposal of urban-produced sewage and digested sludge on agricultural and forest land; 7) organic farming techniques; and 8) alternatives to burning grasslands for seed production and croplands for excessive crop residue removal, The aim of these research efforts is to maintain agricultural productivity and profitability while substantially reducing deterioration of the natural environment caused by agricultural production and processing activities. Agricultural producers and processors, as well as the public, are beneficiaries of this research.

Burdens

Farmers who are nonadopters of technology may rightfully regard some research as a burden, As the prices of farm products decline when more farmers adopt a cost-reducing technology and thereby increase supply, those who have not adopted the technology will be disadvantaged because their costs have not been lowered,

With the adoption of mechanization, labor efficiency has advanced, thus releasing labor from the agricultural sector to provide an array of higher order goods and services. Labor displacement and individual hardships have occurred in the process. Migration of unskilled persons from farms to cities has contributed to urban ghettos that persist to this date.

There have been few burdens from food and agricultural research on the consumer. One of the perceived problems is a result of the rapid changes that such research has brought to the growing, processing, and packaging of food. The use of inorganic chemicals in these processes is looked on with disfavor by certain segments of Society Others disavow highly processed food products in favor of more "natural" foods. Food attitudes are deeply rooted even in a technological culture such as prevails in the United States.

Transportation and storage requirements of our food distribution system have made necessary the development of varieties resistant to bruising and with long shelf life. Some sensory qualities were relinquished in order to achieve this. However, most consumers are not aware of this when they complain that the January supermarket tomato does not corn-pare to the one grown in their backyard in July.

Distribution of Benefits and Burdens

Analysis of the flow of benefits from food and agricultural research focuses primarily on the distribution of benefits between domestic producers and consumers. The analytical framework is the concept of "economic surplus," partitioned into that which accrues to buyers (consumer surplus) and that which accrues to sellers (producer surplus).[2]

Farm Producers

Benefits from agricultural research have different impacts on farms of different sizes and affect farmers according to how quickly they adopt new technology. Effects are determined by type of technology and often increase profits of some producers to the detriment of others. Technological advances in feed grain production, for example, would lower operating costs for beef, hogs, dairy, and poultry production.

Studies indicate that technology reduces per-unit production costs more on large farms than on small farms, indicating important economies of size (Jensen, 1977).

Technology affects farmers according to the speed with which new innovations are

[2]The concept of economic surplus as a measure of consumer and producer welfare is well-documented (Currie, Murphy, and Schmitz, 1971, Willig, 1976).

adopted. Cochrane (1958) grouped farmers into three categories—early adopters, followers, and laggards. Early adopters are able to increase their income with new technology that reduces cost of production. However, increased production resulting from new technology in the aggregate depresses prices, and followers gain less from it, Finally, laggards are forced to use the new technology in order to survive.

Effects are often determined by the type of technology. Certain mechanical innovations favor large-scale farms of the Corn Belt and Southwest over smaller farms in the South and East.

A technological change in the marketing sector, such as a reduction in waste or spoilage, affects the cost structure for marketing services. In such cases, retail and farm prices may be affected by reduced marketing margins. ” The farm price would be expected to increase and the retail price would be expected to decline with reduced marketing margins.

Competition in the marketing sector results in lower cost of marketing services being passed on to consumers or producers. The more competitive the industry, the less tendency there is for private research, because the benefits accrue to consumers and farmers. In a less competitive industry, private research is more profitable for the individual firm, and it may reduce the level of competition.

Technology that changes the relative productivity of resources shifts the distribution of income among resources (Heady, 1971). These changes have reduced the proportion of total farm income attributed to labor and increased the proportion attributed to capital. The impact of technological change on farmland's share of farm income is not easily determined.

*Both the derived supply at retail, dependent on farm supply and the marketing margin, and the derived demand at the farm level, dependent on retail demand and the marketing margin, would shift in a competitive market as a result of a reduction in marketing costs.

The demand for land is affected also by technological advances in agriculture. Herdt and Cochrane (1966) postulated that technological advance has benefited farmland owners, not necessarily farm operators. They said that farmers view technological change as reducing cost of production and hence are able to bid up the price of farmland accordingly.

Most improvements in agricultural production technology increase the productivity of capital and land relative to labor. They therefore generate incentives to substitute land and capital for labor. The story of the vastly increased capital requirements for successful farming is well-known. The decline in the relative importance of labor as a farm input also is well-known. Since many farmworkers owned only their labor, the value of their assets was decreased through innovations in production, and they were forced to look for alternatives. T. W. Schultz puts the actual outmigration of labor from American farms between 1930 and 1974 at 33 million people, the largest migration of modern times.

Many of those who migrated to the cities were able to make successful adjustments and obtain more productive and rewarding employment in nonfarm industries. However, for many the adjustments were painful and costly. The expanded pool of workers in the non farm sector depressed the nonfarm wage rate.

Many rural communities that served populous farming areas deteriorated as the number of farmworkers declined. The tendency for people to leave rural areas has affected the viability of many rural commercial enterprises, churches, community services, and in some cases entire communities.

Too little research was done on the processes of agricultural development as they affected rural America. Too often costs were ignored, especially if these costs were incurred in the migration to urban centers.

Consumers and the General Economy

As noted earlier, consumers benefit from food and agricultural research in many ways.

Some of these benefits appear to be concentrated among certain groups of American families. Agricultural research that improves the safety of food products is likely to affect consumers in all income categories, The benefits of such research include improved health and longer life.

The following analysis estimates the distribution of benefits from agricultural research on the basis of food expenditures. Family size and income characteristics for six income categories are shown in table 2. The six income classes ranged from under $5,000 to over $20,000, and the average-size family ranged from 2,93 persons in the lowest income class to 3.79 persons in the highest. The present value of average benefits per family for the various income classes also is shown. These estimates may be interpreted as the benefits accruing to each family as a result of food and agricultural research expenditures in that year. Comparison of consumer benefits indicated that average benefits per family increased with the level of family income and ranged from $16.20 in the lowest income category to $30.74 in the highest.

The ratio of benefits to family income was almost four times higher for the lowest income class than for the highest, indicating that food and agricultural research has a greater beneficial impact on low-income families than on high-income families in relation to family income. This conclusion supports the hypothesis that agricultural research tends to modify the existing income distribution in favor of the lower income strata (Pinstrup-Andersen, 1977).

The cost of food and agricultural research, as measured by production-oriented research expenditures, is reported on a household basis (table 3). Total agricultural research costs per household ranged from $1.31 for the lowest income class, under $5,000, to $25.60 for the highest, over $20,000. While benefits and costs increase with the level of income, tax incidence increases at a faster rate. Therefore, the benefit-cost ratio is highest in the low-income category. The benefit-cost ratio declined from 12.37 for low-income families to 1.20 for high-income families. Both benefits and costs of agricultural research expenditures tend to redistribute income from higher to lower income families. However, even those families in the highest income class receive net benefits from research investment on agricultural productivity.

Table 2.—Relationship Between Agricultural Food Research Benefits and Family Income

Income class (dollars)	Distribution of population (percent)	Average size family[b] (persons)	Average family income (dollars)	Average benefits per family[c] (present dollar value)
Under $5,000	18.190/o	2.93	$3,981	$16.20
$5,000-$8,000	14.14	3.15	7,922	19.06
$8,000-$12,000 . . .	21.17	3.28	10,528	20.63
$12,000-$15,000 . .	14.47	3.48	13,458	22.13
$15,000-$20,000 . .	16.07	3.68	17,371	25.91
Over $20,000	15.96	3.79	28,953	30.74

NOTE: These calculations represent an Investment in 1974 that will have its impact in 1987.

[a]Anthony E. Gallo and William T. Boehm, "Food Expenditures by Income Group," *National Food Review*, NFT-3, USDA, ESCS, Washington, D. C., June 1978.

[b]U.S. Department of Commerce, Bureau of the Census, *Current Population Reports*, Series p-60, no. 101, "Money Income in 1974 of Families and Persons in the U.S.," US. Government Printing Office, Washington, D. C., 1976.

[c]Total consumer benefits are calculated according to the equation

$$TB_C = 1/2 \times MVP_R \times RE \times D$$

where TB_C is total consumer benefits from agricultural-food research; MVP_R is marginal value product of research (Davis), RE is production-oriented research expenditures in 1974 (Budget of the U.S. Government; USDA, *Inventory of* Agricultural *Research;* U.S. Department of the Treasury); and D is the discount factor over 13 years at 10°/0 (Lu, Cline, and Quance). Total consumer benefits are allocated to income classes according to the level of food expenditures

"These calculations represent an Investment in 1974 that will have its impact in 1987.

SOURCE: Fred C White, B. R Eddleman, and J. C. Purcell, "Nature and Flow of Benefits From Agriculture-Food Research," OTA background paper, 1980.

Table 3.—Relationship of Costs and Benefits of Agricultural Research to Family Income

Income class	Average family income[a]	Average benefits per family[b]	Federal taxes for agricultural research per family[c]	State taxes for agricultural research per family[d]	Total taxes for agricultural research per family[e]	Benefit-cost ratio[f]
Under $5,000	$ 3,981	$16.20	$ 0.43	$0.88	$ 1.31	$12.37
$5,000-$8,000	7,922	19.06	1.77	2.05	3.82	4.99
$8,000-$ 12,000	10,528	20.63	3.19	2.85	6.04	3.42
$12,000-$ 15,000	13,458	22.13	5.29	3.97	9.26	2.39
$15,000 -$20,000	17,371	25.91	8.40	5.59	13.99	1.85
Over $20,000	28,953	30.74	15.78	9.82	25.60	1.20

[a] U.S. Department of Commerce, Bureau of the Census, *Current Population Reports*, series P-60, no. 101, "Money Income in 1974 of Families and Persons in the U.S.," U.S. Government Printing Office, Washington, D. C., 1976,
[b] Expressed in present value. See table 2 for details of Calculation procedure.
[c] Production-oriented research expenditures for Agricultural Research Service, Economic Research Service and the Federal Government's Share of State Agricultural Experiment Stations are allocated among income groups according to the distribution of Federal personal income taxes (U.S. Advisory Commission on Intergovernmental Relations, 1974).
[d] State funded production.oriented agricultural research expenditures are allocated among income groups according to the distribution of State personal income and general sales taxes (U.S. Adwsory Commission on Intergovernmental Relations, 1974).
[e] Summation of Federal and State taxes for agricultural research Per family.
[f] Average benefits from agricultural research expenditures per family divided by total taxes for agricultural research Per family,

SOURCE: Fred C White, B R. Eddleman, and J C Purcell, '(Nature and Flow of Benefits From Agriculture-Food Research, " OTA background paper, 1980

Research investment in the food and agricultural sector has led to new products and technology that increased agricultural productivity and allowed labor to flow from the farm to the nonfarm sectors. These adjustments in the labor force have raised national income because average nonfarm income is typically above average farm income. Tweeten and Hines (1965) approximated the contribution of agricultural productivity changes since 1910 accruing to the national income in 1963. Estimates for the 1940-79 period were calculated using a similar procedure (table 4). With only 3.5 percent of the population living on farms in 1979, the actual national income was $1,924,8 billion. Assuming that farm changes had not taken place since 1940, and that in 1979 (as in 1940), 21.3 percent of the population had lived on the farm, national income would have been $111.8 billion (or 5.8 percent) lower.

Table 4.—Estimates of the Contribution of U.S. Agricultural Productivity Change to the 1979 National income Since 1940 (in billions of 1979 dollars)

Decade or years	Contribution to 1979 national income
1940-50	$44.6
1950 -60	36.6
1960-70	24.6
1970-75	2.9
1975-79	3.1
Total 1940-79	$111.8

SOURCE Fred C. White, B R Eddleman, and J C Purcell, "Nature and Flow of Benefits From Agriculture-Food Research, " OTA background paper, 1980.

Effect on Social and Economic Organization

Technological changes have thus had far-reaching effects on the development of rural America. In retrospect, the food and agricultural research institutions have not been as alert as they should have been in anticipating these effects and in developing means of coping with undesirable effects. As a minimum, the secondary effects of changes associated with the application of knowledge generated through the food and agricultural research programs should be identified. This is difficult to do because of the pervasiveness of the effects.

On occasion, scientists have called attention of the public to special social problems that would occur as a result of scientific breakthroughs. An example of this is the development of the cottonpicker which scientists knew would replace a large number of workers in the South (Johnson, 1952). This was well-publicized prior to the full impact which released thousands of workers and resulted in migration to the cities for those who could no longer find work on the farm.

It was erroneously assumed that development of technology to enhance the supply of products would automatically enhance national well-being and that a desirable economic and social structure would be worked out through the market forces. In many instances, this did not follow. Serious problems of national consequence emerged that were largely external to the specialized systems of research and decisionmaking, which led to the development and introduction of the new technology.

The continuing concern over urban and rural development, resource conservation, environmental quality, structure of agriculture, and the quality of life generally derives from other than fear of inability to produce sufficient food and agricultural products to meet national needs. The food and agricultural institutions in this country have demonstrated beyond question their efficiency in generating and applying knowledge to achieve increased production of commodities.

The concerns over national development derive largely from the social costs of technological development that have been largely ignored in the past. They reflect continuing questions with respect to how people fare under conditions of national economic growth.

Fundamental questions concerning these social issues are important. Can the answers to these concerns be consistent with reasonably efficient production of goods and services? If not, what kind of tradeoffs appear possible and desired? Conflicts, real or imagined, must be recognized and studied, and rational conclusions must be reached.

Public food and agricultural research institutions were not created to chart a course for national development. Indeed, they are ill-suited to do so. However, as centers of learning, dedicated to the discovery of truth, they do have a responsibility to examine critically the functioning of American society, to explore alternatives, and to interpret their findings to the people. This is a most important responsibility. Unless it is done well, the quality of life is likely to be treated as secondary to the problems of organization for the production of goods. Even when done well, it is the responsibility of the people through their elected officials to articulate the decisions and programs desired.

Researchers and Research Institutions

Researchers and research institutions can, in a sense, benefit from the results of research. Sometimes research is perceived to be directed for the benefit of the individual researcher or the institution. When this is the case, research tends to be self-serving.

Administrators of public agricultural research agencies are motivated to optimize some combination of continuing institutional budget support and discretionary funds from State sources or from Federal and private grant sources. These discretionary funds are often used to support the more basic research that has a longer term payoff both in terms of the productivity of the applied research (Evenson, Waggoner, and Ruttan, 1979) and in the prestige of the research agency.

To the extent that the research efforts are successful and appropriate, recognition accrues to the agency or scientist conducting the research, and further increases in support in terms of institutional and discretionary funding are assured. In this sense, both public research agencies and the scientists conducting the research are direct beneficiaries of the results of the research. (For further discussion on this point see White, Eddleman, and Purcell, 1980).

Benefits and Funding Sources

In State government funding, food and agricultural research financed by one State may benefit or harm the residents of other States. * For example, an improved crop variety developed in one State may be adopted in neighboring States to increase yields and total production. However, in some cases an action by a State may adversely affect residents of another State. Producers in regions other than where the improved crop variety was developed and where that particular variety would be unsuitable for adoption might pay lower prices as the result of increased aggregate production.

State boundaries do not coincide with homogeneous agricultural production regions. Research projects in one State, which are addressed to specific local problems, likely will produce results applicable to other States within the same homogeneous production region. Furthermore, knowledge gained from public research is disseminated without regard to geographic boundaries.

Spillover benefits generated by State A that accrue to the residents of State B generally are not accounted for by State A policymakers. The earlier argument concerning neglect of these external benefits has been that State A will provide a smaller level of research expenditures than would be efficient from society's perspective. Given the possibility of negotiation between States, State B may find it advantageous to pay A to increase its level of research activities. Such a subsidy will reduce A's research costs and lead to a higher level of research activities. The negotiation process likely will be complicated by the fact that spillovers flow in both directions between the two States. Furthermore, the outcome will depend on the relative bargaining strength of the two States and will not lead necessarily to an efficient solution to the external benefit problem (Musgrave and Musgrave, 1973).

*Benefits from scientific or technical progress, originating from a private firm or the public sector, that flow to other firms or consumers without compensation to the firm or public sector component originating the research are called externalities. Obviously, these effects may have either positive or negative impact.

If only a few States produce a given commodity, one of the States might conduct the research for it with the research effort supported by the other States. However, attempting to coordinate these activities involves decisionmaking costs that include the value of time, effort, and direct outlays related to the bargaining process. For those cases in which external benefits from agricultural research affect a large number of decisionmaking units, total decisionmaking costs of effective coordinated action are likely to be quite large. When the impact on consumers is considered, a large number of States would be concerned with almost all aspects of agricultural research.

When a public benefit equally affects the residents of the Nation, funding for such research can usually be provided more efficiently by the Federal Government.

Partial funding by the Federal Government affords one solution to attaining the nationally desired level of regional research expenditures. An often-used technique to increase State expenditures for government services is the matching grant, in which the recipient State government is required to match Federal funds with funds from its own sources according to some specified formula. While some Federal grants to States for food and agricultural research require matching funds, most States invest more in food and agricultural research than just that required to match grants.

The formula for matching funding should be based on the relative importance of external and internal benefits. If these grant programs are properly designed, they should direct State expenditures toward levels considered optimal from the viewpoint of society. An appropriate matching grant program obviously requires identifying and quantifying State benefits and spillovers from agricultural research expenditures. There have been some recent developments concerning the measurement of spillovers. Evenson, et al. (1979), estimated that, on the average, 55 percent of the change in productivity attributed to technology-oriented research was realized within the State conducting the research. The remaining 45 percent was realized in other States. Interregional spillovers of the benefits from food and agricultural research were estimated by White and Havlicek (1980) (table 5). These estimates indicate that the aggregate ratio of spillovers to regional benefits is 1.73. The Northeast and the Appalachian regions have the lowest ratio of spillovers to regional benefits. Four regions (Lake States, Corn Belt, Delta, and Southern Plains) have spillover-to-regional benefit ratios higher than 2 to 1.

The ratio of Federal to State expenditures for food and agricultural research and extension can be compared with the ratio of spillovers to regional benefits to determine whether the Federal Government actually financed the spillovers (table 5). * These results indicate that the Federal Government financed all of the spillovers in only three regions (Northern Plains, Appalachian, and Mountain). In aggregate, the ratio of Federal to State expenditures is only 1.38 compared to 1.73 for the ratio of spillovers to regional benefits. Thus, the Federal Government's contribution to production-oriented food and agricultural research and extension should be increased 25 percent to aline regional funding with regional benefits, on the average. Several regions would require a greater increase in Federal expenditures to yield an equitable distribution across all regions.

* Federal expenditures are not limited to those funds going to the SAES and cooperative extension services under formula and grant programs; they also include the funding of agricultural research in each region through the USDA agricultural research agencies of SEA / AR, USDA / ESS, and USDA / Soil Conservation Service.

Table 5.—Regional Estimates of External-to-Internal Ratios Related to Benefits and Funding of Production-Oriented Agricultural Research and Extension

Region	Ratio of spillovers to regional benefits	Ratio of Federal-State expenditures
Northeast.	1.31	0.97
Lake States	2.73	1.10
Corn Belt	2.04	1.25
Northern Plains.	1.40	1.63
Appalachian	1.19	1.60
Southeast	1.40	1.37
Delta.	2.48	1.80
Southern Plains.	2.80	2.10
Mountain	1.60	2.35
Pacific	1.89	0.90
Aggregate	1.73	1.38

[a] Includes Federal funding of production-oriented agricultural research and extension in each region through SEA/CR, SEA/Aft, SEA/EXT, USDA/ESCS, and USDA/SCS relative to State expenditures for agricultural research and extension in each region.

SOURCE: Fred C. White and Joseph Havlicek, Jr., "Interregional Spillover of Agricultural Research Results and Intergovernmental Finance. " Paper presented at Symposium on Methodology for Evaluation of Agricultural Research, Minneapolis, Minn., May 12-13, 1980.

Private-Sector Funding Related to Flow of Benefits

One continuing issue is: Who captures the benefits from public sector and private sector research? Presumably, the issue relates to the question of whether a particular problem area should be addressed through public research if the gains from the research are embodied in private firms' products. In general, there are spillovers or indirect benefits from public-sector research to the private sector and from private-sector research to society. If the benefits from research can be captured by the private sector, there is an incentive for private firms to invest in R&D activities.

The private sector may invest in R&D activities in which spillover or indirect benefits accrue to society. No specific case studies have been made for the agricultural input or food-processing industries. a Studies by Mansfield, et al. (1977), Terleckyj (1974), and Griliches (1977) of the distribution of gains from private R&D in manufacturing and nonmanufacturing industries indicate that the spillover effects are at least as large as the direct benefits going to the firms conducting the R&D. Thus, the social returns tend to be roughly double that of private returns to the investment. In this regard, substantial social benefits are derived from private industry investments in R&D activities.

The USDA (1979) assessment of post-harvest technology research identified four distinguishing characteristics of private-sector research in food processing, handling, and

[3] Some of the conceptual considerations, however, have been outlined in a note by Peterson, 1976,

marketing. These were: 1) most private-sector research tends to be focused on short-term applied problems for which there is expectation of an acceptable return on the research investment; 2) longer term basic inquiry into how biological, economic, and social systems function would not be picked up by the private research sector if it were dropped by the public research agencies; 3) even though there may be substantial social benefits from private research activities through spillover effects, private industry generally is not concerned with the concepts of consumer surplus or net social benefits from their research endeavors: and 4) most private firms are reluctant to reveal knowledge that might cause existing technologies or processes to become obsolete prior to extracting the flow of economic returns from past investments in these techniques. Thus, there is incentive to delay publication of knowledge possessing this potential impact, even if the research might have been carried out partially under the auspices of public funding.

Public-sector support for basic research generally benefits both society and the private sector. Since the results of basin research are difficult to internalize to any particuiar private firm without public support, underinvestment in basic research would result. However, in the case of applied and developmental research, the appropriate mix of public and private research investments becomes an important issue. The private sector will stand to benefit from public investments in those research outputs that are embodied in private-sector products.

Public R&17 may be justified on at least three grounds: 1) as a result of the spillover effects, substantial social benefits are derived from the mixture of public and private research; 2) in the absence of public-sector support, the direction of the research might be biased strongly toward proprietary mechanical and chemical technologies; and 3) for those situations where private research might have a detrimental effect on the structure of the industry (making a competitive structure noncompetitive, or a noncompetitive structure still more imperfect). A mix of public and private research may preserve competition or reduce the amount 01 concentration. The importance of this last basis for public research investments is that most competitive industries provide a larger quantity of the product at a lower cost to consumers than would be expected from monopolistic industry.

For many biological research activities, because of the ease of imitation and the lack of patent enforceability, it is likely that the private sector would substantially underinvest in R&D. Thus, much of the biological research is supported by the public sector, even in those areas where there are substantial inducements for product development by the private sector. Few seed companies, for example, carry out much research in plant pathology, plant physiology, genetics, crop management systems, or farm management. But since output of the public-sector research is a public good, it is available to large and small input suppliers alike. Because of the difficulty of patenting hybrids by public research institutions, small seed companies have been able to exist along with large firms. Thus, it has been generally in the best interest of society to support public investments in these types of research activities, since the social benefits would outweigh the costs incurred from increased concentration in the industry. A recent decision by the U.S. Supreme Court related to patentability of biological research requires careful reexamination of current policies of the public food and agricultural research agencies.

Direct or Checkoff Funds

In producer checkoff funding, several private firms or commodity groups pursue their best interests by collectively supporting public research activities. Contributors t. research probably have less control over the specific projects to be funded than would occur with an industrial firm. But the usual process is for the recipient public research agency to issue a portfolio of potential research projects for which the funds could be used. Then a governing board (often labeled a specific commodity research promotion board) selects from among the portfolio those projects that best coincide with its constituency's interest within available funds. The public research administrator then "awards" the funds to those projects and scientists proposing the specific R&D activities.

Thus, there is a tendency to focus the research toward short-term, applied R&D activities that hold promise for benefiting the clientele providing the funds. Heavy reliance on this type of funding source for public research support would bias the direction of the research toward those techniques most beneficial to the group providing the funds.

Measuring Returns to Research Investment

Most evaluations of food and agricultural research indicate a favorable internal rate of return.[4] This rate can be defined as that discount rate that equates the present value of the expected cash outflows (costs) with the present value of the inflows (benefits).

The acceptance criterion for a research proposal is based on the relationship of the internal rate of return to a required rate of return. For a private firm, the required rate might be the cost of capital, while for the public sector, it might be some long-term interest or social discount rate. If the internal rate of return is higher than the required rate, the investment should be undertaken.

Several studies that have empirically estimated rates of return on agricultural research investment are summarized in table 6. For aggregate investment, rate-of-return estimates are predominately in the range of 30 to 40 percent. However, the lowest estimate for this category is 23.5 percent compared to the highest estimate of 100 percent. Some of the returns on individual commodities are outside this latter range. The most obvious conclusion from these consistently high rates of return is that agricultural research is very profitable.

Table 6.—Empirical Rate of Return Estimates for Agricultural Research investment

Study	Commodity	Time period	Internal rate of return (percent)
index number approach			
Griliches (1956)	Hybrid corn	1940-55	35-40
Griliches (1958)	Hybrid sorghum	1940-57	20
Peterson (1967)	Poultry	1915-60	21-25
Schmitz and Seckler (1970)	Tomato harvester	1958-67	37-46
			16-29[a]
Peterson and Fitzharris (1975)	Aggregate	1937-42	50
		1947-57	51
		1957-62	49
		1967-72	34
Regression analysis approach			
Griliches (1964)	Aggregate	1949-59	35-40
Peterson (1966)	Poultry	1915-60	21
Evenson (1968)	Aggregate	1949-59	47
Lu and Cline (1977)	Aggregate	1938-48	30.5
		1949-59	27.5
		1959-69	25.5
		1969-72	23.5
Knutson (1977)	Aggregate	1939-48	49.7
		1949-58	47.4
		1959-68	39.4
		1969-72	35.5
White, Havlicek and Otto (1978)	Aggregate	1929-41	36.5[b]
		1942-57	32.2[b]
		1958-77	27.8[b]
Davis (1979)	Aggregate	1949	100[c]
		1954	79[c]
		1959	66[c]
		1964	37[c]
		1969	37[c]
		1974	37[c]
Bredahl and Peterson (1976)	Cash grains	1969	36
	Poultry	1969	37
	Dairy	1969	46
	Livestock	1969	47
Norton (1980)	Cash grains	1974	35[d]
	Poultry	1974	46[d]
	Dairy	1974	51[d]
	Livestock	1974	88[d]

[a] Estimates account for compensation of displaced workers.
[b] The estimates were reduced by one-third to correct for the omission of Private research
[c] Estimates are based on cross section using real output and deflated research Estimates are high because extension is omitted and a small adjustment for private research is used. If adjustments are made these rates would be around 20 percent for 1964-79
[d] These estimates correspond to the mean lags used by Bredahl and Peterson (1976).

SOURCE Fred C White, B R Eddleman, and J. C. Purcell, "Nature and Flow of Benefits From Agriculture.Food Research, " OTA background paper, 1980.

4 Havlicek and Otto note that research concerned with measuring impacts of agricultural research has focused on either total or production-oriented research and the impact this research has on productivity, output, or value at the producer level. However, effects of all agricultural research are not always to increase productivity, output, or value, nor is the output of all agricultural research measurable and perceived in the marketplace. In addition, these studies for the most part have not taken into account such externalities as environmental and social impacts. Alternative measures are discussed in the Havlicek and Otto background paper, 1980.

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Four of the studies show that returns to agricultural research were higher in the early part of the century and have recently declined slightly. A likely explanation is that now there are fewer opportunities to substitute new technology for labor. However, the rates of return in the most recent periods are still quite high. Davis (1979) noted that since 1964 the marginal internal rate of return has remained surprisingly constant and may have stopped declining.

The high rate of returns are evidence of a resource allocation problem. Economic efficiency calls for investment funds to be allocated in such a manner that the marginal returns in all categories are the same. The high rate of return on agricultural research indicates underinvestment by the public sector. In other words, additional resources should be allocated to agricultural research in order to bring its rate of return in line with the returns from other public investments. Why has there been an apparent underinvestment in agricultural research?

At the symposium on Methodology for Evaluation of Agricultural Research held in Minneapolis, Minn., in May 1980, a government official said, "It is clear that the role of the Federal Government is not to turn a profit . . ." (Franz). While this statement may represent the sentiments of many legislators and other government officials as related to the high returns on agricultural research investment, it warrants further elaboration and interpretation. Economic growth traditionally has been fostered in this country as a means to progress. Furthermore, economic efficiency is a means to achieve economic growth, and it would be improper to ignore the rate of return of estimates as an indicator of economic efficiency. Complications arise, however, as society attempts to achieve a variety of goals.

The social optimum actually may involve a tradeoff between goals. For example, the public sector might choose to limit expenditures in a particular category below the level called for by economic efficiency if such expenditures would affect adversely the distribution of income. This particular relationship is commonly referred to as the tradeoff between efficiency and equity.

Agricultural research expenditures over the last half century may have been limited by policy makers' perception of excess capacity in agriculture. Congress continually battled with the problem of depressed farm prices caused by excess production at prices considered to be socially acceptable. Policy makers were probably aware of the dilemma that if research investment increased supplies, costs of maintaining farm prices would increase. The problem facing policymakers in this area revolves around what will happen to agricultural supplies and farm prices in the future. If excess capacity is projected to continue into the next century, policymakers will limit agricultural research expenditures. However, if increased agricultural productivity will be needed to furnish adequate supplies for domestic consumers and foreign trade, a greater level of research investment would be warranted.

Policymakers may limit agricultural research expenditures because of the uncertainties about future benefits from agricultural research. The estimated rates of return are based on historical relationships that may not hold in the future. Even though expected returns may be high, policy makers may perceive a wide standard deviation around the expected returns, believing that they are not measured precisely. Although there is some controversy in this area, there appears to be widespread support for the proposition that the public sector should invest on the basis of emphasis on expected returns rather than on risk factors (White, Eddleman, Purcell, 1980). However, policymakers may contend that expected returns are not measured accurately enough to guide decisions on the optimal level of public investment in food and agricultural research.

QUALITATIVE MEASURES

Quality is an important aspect of all research and is a well-accepted concept. While difficult to measure from a quantitative standpoint, there are certain aspects of quality that most scientists would agree are essential to reach a minimum acceptable level. These include dealing with adequate numbers of samples, reproducing data, recording data so that it can be understood and evaluated by others, organizing and conducting research so that it is amenable to statistical analyses, etc. Difficulties arise when an attempt is made to evaluate the relative degree or level of quality among a group of scientists or among a series of researchers within or between disciplines or areas of research. Difficulty also arises in evaluating the relative contribution a piece of research makes to the advancement of the field of study.

Pound Report

Quality is addressed because it became, perhaps unintentionally, one of the major messages to come out of the so-called Pound Report of 1972 ("Report of the Committee on Research Advisory to the U.S. Department of Agriculture," NAS). This report has been referred to by the Office of Management and Budget (OMB) and others as an authoritative source on the measurement of the quality of agricultural research and, thus, a rationale for nonsupport of agricultural research. The committee, which was composed primarily of bench scientists closely oriented more toward basic aspects of agricultural research, took as its major guideline the question: "Is the quality of science being used in solution of agricultural problems consistent with the public needs and scientific possibilities?" (p. 10).

In its general summary about the quality of the research effort, it concluded that ". . . much of agricultural research is outmoded, pedestrian, and inefficient" (p. 11) and that ". . . far too much of the research is of low scientific quality. . . ." (p. 12). Under the question: "Does the research by agricultural scientists reflect the highest standards of the community?" it concluded that:

> Most of the specific disciplinary research studies made by the Committee and its panels reveal a shocking amount of low quality research in agriculture. Admittedly, quality is a judgment factor but the regularity with which the Committee came up with judgments of low quality, including both SAES and USDA research, is significant and appalling (p. 70),

This criticism was emphasized in two articles in Science magazine (Jan. 5, 1973; Apr. 27, 1973). The articles were given wide publicity and used against agricultural research by OMB and other groups.

The Pound report did not give a precise definition of "agricultural science" or "quality;" nevertheless judgments were made that involved both. The group mainly asked certain peer group panels to rate some specific research project summaries contained in USDA's Current Research Information System in certain areas of work, such as forest insect research, reproductive physiology, and molecular biology, that had been written for general descriptive purposes (p. 70). Additionally, the reactions of some other scientists to agricultural research quality were collected in an informal manner. Therefore, the adequacy of this evaluation itself is in question.

Other Reports

Other assessments of published output of scientists have been used to evaluate certain aspects of agricultural research, most notably productivity (e.g., Salisbury). The use of this technique or variations of it for determining quality is a more recent innovation. Two examples are cited.

Shaw Report

B. T. Shaw, former administrator of ARS, analyzed the use of publication as a criterion for evaluating scientists and the quality of research, Three evaluation approaches were tried in the analysis:

1. a peer group of scientists reading the publication,
2. number of publications, and
3. publication outlet.

The first approach was found to be the only satisfactory method. However, it would not have been feasible for the Pound committee, because it would have required reading some 3,500 ARS publications.

As a compromise, each scientist for the Shaw report was asked to rank his own publication by assigning it to one of the following categories, in decreasing order of scoring:

1. Original research in terms of its impact on science, agriculture, and general welfare:
   —very great (100 to 81),
   —great (80 to 61), and
   —moderate to limited (60 to 51).
2. Reviews:
   –for scientists (50 to 41), and
   –for laymen (40 to 31).

Division directors then were asked to rank the 118 papers: 10 ranked 95 or higher, and 105 ranked 55 or higher. This rating system gives greater weight to original research than to reviews and tries to emphasize impact of research.

Evenson and Wright

Two economists, Evenson and Wright, attempted a somewhat different approach as a special project for this (the OTA) study. They evaluated citations of: 1) publications in peer-reviewed journals and z) patents. Examples of patents were drawn from the field of post-harvest technology and, therefore, may not be applicable to production technology.

In the case of publication citations, two comparisons were made: between the State and USDA, and changes over time between 1966 and 1978. In both cases, no significant differences were found. One USDA center having the lowest journal citation score had the strongest performance in patenting. When expenditures per scientist man-year (SMY) were factored in as a measure of support per scientist in terms of equipment, assistants, etc., it did not affect publications per SMY but it did positively affect citations per publication and total citations per SMY.

In the case of patents, the study was limited to USDA (the four regional utilization laboratories) with a sample comparison with private U.S. companies and foreign firms. Comparisons then were made of citations in subsequent patents. The three groups were shown to be roughly comparable for food, but private firms rated higher on textile patents.

General Comments

The number of publications or patents and the number of citations do not give a quantitative indication of quality. Quality is not necessarily a function of numbers of publications or patents. NAS considers peer review probably the best method of estimating quality. Even here, attempting to use the same criteria or the same scientists across disciplines is hazardous. Estimating quality in agricultural research, which most frequently is mission oriented, ranging from the most basic to the most applied, requires great care. The same criteria or the same scientists cannot be used for evaluating the basic research as are used for evaluating the applied.

Consider the work of Dr. Norman Borlaug. Borlaug did not break new paths in fundamental science or in the basic theory of plant breeding. Rather, he applied well-known techniques of plant breeding, along with a few innovations in testing, to create a line of improved wheat varieties that were used to increase food production rapidly in many of the world's developing countries. Also, he did not publish much before receiving his Nobel prize, and those papers he did write were not classified as basic research.

It is possible for peers to evaluate agricultural research quality, even though such evaluations are largely subjective. Peer review is review of a scientist's research only by researchers within the same general area, discipline or mission. For example, in the continuum of basic to applied research, peers of scientists working in basic research can effectively review quality of scientists working in similar basic areas of research. Scientists working in applied areas can evaluate quality of other scientists working on similar applied problems. However, it is generally meaningless for a group of scientists working in basic research to evaluate the quality of those working in the applied area and vice versa.

While quality is important, it can be measured only in a very narrow sense. To measure the value of food and agricultural research to society, which is the measurement of output to input, it should be cumulatively examined across the full spectrum of activity —i.e., discipline to discipline, basic to applied. This is best done by analyzing what has happened to the industry. And by any measurement, U.S. agriculture has been extremely productive.

PRINCIPAL **FINDINGS**

- USDA research expenditures are the lowest total Federal expenditures by a major Federal research agency for R&D. In 1978 USDA's share of Federal expenditures for R&D was 1.5 percent of total expenditures compared to DOD—45 percent, DOE—16 percent, and HEW—12 percent,

- Increase in purchasing power of total SAES and USDA agricultural research expenditures increased only 23 percent in constant dollars from 1966 to 1979,

- Constant dollar agricultural research expenditures of USDA for in-house research increased only 1 percent between 1966 and 1979, while those in the SAES increased 40 percent.

- State appropriations are the major source of research funding at the SAES, and in constant dollars increased 57 percent from 1966 to 1979. Federal Hatch funds account for 20 percent of SAES funding, and in constant terms have increased on the average 1.5 percent a year from 1966 to 1979, or 20 percent for this time period.

- Private research funds for agricultural research at SAES are small relative to State appropriations and Federal formula funds. They have steadily increased since 1966—63 percent in constant dollars—and are becoming an important source of agricultural research funds.

- Private industry agricultural research is a major contributor to total agricultural research in the United States. It is estimated that total expenditures by private enterprise are about three-quarters of the expenditures of the State and Federal governments combined.

- The justification of public funding of food and agricultural research is based on benefits well in excess of costs. Issues of equity, because of the interstate flow of food and related commodities and the spillover effect of research from one geographic region to another, are also cited. Producers benefit from expanding demand and from reduced costs. The distribution of consuming population among States, however, is related to the distribution of agricultural production only to a very limited degree, From the equity consideration of the geographic distribution of costs associated with research and the benefits flowing from this research, substantial Federal funding of food and agricultural research is considered the most equitable. Paradoxically, Federal funding relative to State funding of research has decreased as the interstate flow of commodities has increased. Therefore, taxpayers in food-surplus States are subsidizing consumers in food-deficit States, and the degree of subsidization is increasing steadily.

. Evaluation of the quality of research, both basic and applied, although difficult, is essential. The peer-review method appears to be the best method available, but requires that the peers be truly peers, selected from the same basic disciplines or mission area being evaluated.

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Chapter V

Roles of Research Participants

Contents

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Roles of Research Participants

Food and agricultural research in the United States is supported by the public and private sectors. The major participants in the public sector are the U.S. Department of Agriculture (USDA) and the State agricultural experiment stations (SAES), although sizable investments are also made by a number of other Federal agencies. In addition, certain non-land-grant universities—including those publicly and privately financed–have substantial food and agricultural research programs supported by public funds. Also, but to a lesser degree, the 1890 land-grant colleges and Tuskegee Institute are research participants.

Research participants in the private sector include foundations, industry, and industry associations. In some areas of activity, their financial investments exceed those of the public sector.

All of these participants—public and private—represent major forces in the U.S. food and agricultural research system. Their particular roles, however, have never been fully articulated. In some cases, the relationships among them are somewhat complicated and controversial. This segment of the OTA assessment presents an analysis of the roles of participants in the national agricultural system and identifies the relevant issues that need to be considered in improving the system.

U.S. DEPARTMENT OF AGRICULTURE

The genesis of food and agricultural research in the public sector lies in Federal legislation enacted in the second year of the Civil War when USDA was created. It was given broad authorization "To acquire . . . useful information on subjects concerned with agriculture in the most general and comprehensive sense of the word . . . ." Isaac Newton, first Commissioner of Agriculture, was directed to acquire and preserve all information concerning practical and scientific agriculture by conducting experiments. As outlined in chapter 111 of this report, the research base of USDA broadened over the years, and more intensive and varied research programs were enacted so that by the beginning of the 20th century, USDA had taken the lead in the most effective emphasis on farm production research the world had ever seen.

The 15 years immediately following World War II were marked by continuing changes for strengthening USDA and State research in order to keep pace with and guide the rapidly modernizing U.S. agriculture. This period also was marked by the USDA reorganization in 1953, which not only had serious repercussions on the functions and capabilities of USDA research but also disrupted Federal/State relationships (Moseman, et al., 1981).

USDA's Changing Role

The next 20 years—from 1960 to 1980—comprised an era of rapid change in which USDA's role in food and agricultural research became altered by the impact of social forces on research priorities. These forces, combined with numerous assessments of research, have had a cumulative effect of reshaping the national agricultural system and capabilities.

The unsettled situation in USDA research in the 1950's and somewhat similar conditions in other Federal agencies led indirectly to an investigation by President Kennedy's Science Advisory Committee (PSAC) into the capability and quality of research in the

Federal Government. As a result, a panel of PSAC conducted a review of science and agriculture that focused primarily on USDA (Science and Agriculture, 1962).

The panel's recommendations were generally constructive and positive; however, the review was conducted within an environment that was somewhat critical and hostile toward USDA. One of the main reasons for this situation was that no member of the panel had any active experience in USDA/State research programs that had major impacts in advancing agriculture in the previous three decades.

Among the few recommendations that were adopted was the appointment by Secretary Freeman of a USDA committee on agricultural science. The makeup of this committee, the membership of the PSAC agricultural panel, and the attitude of the White House Office of Science and Technology combined to reflect a low esteem of research in USDA. Also reflected was the viewpoint that university personnel should have a dominant role in planning and directing USDA research.

Nevertheless, a number of significant steps were taken under Secretary Freeman in 1963: a) greater emphasis was placed on upgrading and expanding USDA and State research facilities; b) funds were increased for the study of pesticides; c) a concept developed that Beltsville should be increasingly concerned with basic research; and d) administration of grants to State experiment stations and coordination of State/Federal research were once again placed in the hands of a separate agency—the Cooperative State Research Service—comparable to the old Office of Experiment Stations.

In 1969, Secretary of Agriculture Clifford Hardin requested the National Academy of Sciences/National Research Council (NAS/NRC) to appoint a committee to: a) evaluate the quality of science in agricultural research, b) ascertain gaps in agricultural research and make appropriate recommendations, and c) ascertain the extent to which scientists in the basic disciplines relate their research to agriculture and the extent to which they contribute to the basic sciences. The committee was chaired by Dr. Glenn S. Pound, dean and director of the College of Agricultural and Life Sciences, University of Wisconsin. Oddly, the committee was heavily dominated by personnel from the land-grant universities (primarily bench scientists), despite the fact that it was supposed to review USDA research as well as that of State stations.

Although the committee said it found many excellent programs, together with well-trained scientists and sensible research, it also found reason to believe that much of agricultural research was outmoded, pedestrian, and inefficient. A careful and unprejudiced reading of the NAS committee's report discloses many constructively critical analyses and recommendations that would serve to strengthen the national agricultural system. (Further discussion of the Pound report is given in ch. IV of this report.)

USDA research administrators, in a move unrelated to the Pound report, in 1972 announced a reorganization of research functions in USDA. The major thrust was to assign line-operating authority to the field under four regional deputy administrators. The national program staff, which formerly had responsibility for one, or a few, commodities or program areas, was suddenly expected to properly manage a broad scope of research programs. This led to an inability to maintain an in-depth understanding of the work under way, since the national program staff was isolated from line research functions and responsibilities,

Role Strengthened

In an effort to strengthen the role of USDA and more effectively coordinate its activities, the 95th Congress, in enacting the Food and Agriculture Act of 1977, designated USDA as the principal agency of the Federal Government for agricultural research, and directed the Secretary of Agriculture to coordinate all agricultural research, extension, and teaching activities conducted or financed by Federal funds.

Specifically, the act describes the research role of USDA as including the following:

- to fulfill the needs of farmers and consumers by focusing its resources on problems of national interest and concern;
- to participate with other sectors of the agricultural research system in planning, coordinating, and executing national and regional programs;
- to conduct research and development (R&D) programs to meet international needs as determined by U.S. Government policy and the increasingly global nature of production agriculture;
- to conduct basic and applied human nutrition research necessary to assess and improve the nutritional quality of human diets; and
- to develop human nutrition information and education programs and deliver this information to the public.

The act of 1977 designates USDA as the lead agency of the Federal Government for agricultural research, extension, and teaching in the food and agricultural sciences. * It also gives guidance on strengthening the coordinating activities of USDA, but little guidance is given to the role of USDA v. the SAES.

The law also provided that the Secretary of Agriculture establish within USDA a Joint Council on Food and Agricultural Sciences and a National Agricultural Research and Extension Users Advisory Board. The progress of these two advisory groups is discussed in chapter VII of this report.

*This excludes the biomedical aspects of human nutrition concerned with diagnosis or treatment of disease.

STATE AGRICULTURAL EXPERIMENT STATIONS

The origin of the role of the SAES under the Hatch Act of 1887 and subsequent legislation has been documented in chapter 111 of this report.

As a part of the land-grant university in each State, SAES researchers often play a vital role in the training of scientists. Many SAES researchers have joint appointments with the university. They may teach, which allows students to learn the latest in agriculturally important knowledge and skills directly from scientists who are discovering and perfecting this knowledge. And they may also direct graduate student research. This close arrangement between researcher and student makes it possible to obtain relatively inexpensive but capable staff assistants and at the same time provide the added function of training additional scientists.

Although the SAES still retain their traditional focus in serving farmers and the agricultural sector of their States, their role has been modified by a number of factors in the past two decades. The Research and Marketing Act of 1946 increased Federal funds to the States on a formula basis and made provision for regional research by the SAES with Federal funds. In 1965, the Special Research Grants Act authorized grants to the State stations, other public institutions, and individuals to perform research on problems of concern to USDA. In some respects, this act introduced chances for duplication of effort, but at the same time, it offered a vehicle for concentrating special efforts on commodity-based problems or problems of special interest groups, thus largely avoiding earmarking of formula funds to special interest concerns.

Title V of the 1972 Rural Development Act was another attempt to emphasize an area of special concern—namely, the economic and social problems of rural people and communities. This program, however, has not received significant funding,

Title XIV of the 1977 Farm Bill also became a vehicle for authorizing a variety of special-interest programs. Most important of these are:

- institutionalizing research and extension in the 1890 land-grant colleges and Tuskegee Institute, whose participation in USDA funding really began in the early 1970's;
- placing greater emphasis on food and nutrition research and extension in USDA in cooperation with the States; and
- authorizing competitive grant programs in research to all colleges and universities, Federal agencies, and private institutions.

Two factors that are modifying roles of State stations—changes in funding and management—deserve special discussion in this assessment.

Funding

One of the sources of funding for the SAES is Federal funding on a formula basis. This provides funds to the States on the basis of, among other things, size of rural population, number of farms, etc. States with large rural populations, therefore, tend to receive more Federal grant money than those with lesser numbers of farmers. This formula uses the same principle—population size—that determines the number of Representatives in Congress to which each State is entitled. It is a principle deeply rooted in the founding of our country and expresses one aspect of the philosophy of "government by the people."

Over the years, as the purchasing power of both Hatch and State funds declined, scientists and administrators sought new funding sources. To a certain degree, Congress furthered this trend by appropriating funds for special and competitive grants.

Grant funds provide resources for high-priority research to further the programs of USDA. The Secretary may make grants up to 5 years for either competitive or special research grants. Al] colleges, universities, Federal agencies, and private institutions are eligible for competitive research grants. While the law provides for flexibility in the determination of the specific research efforts for competitive grant funds, the intent was that the following types of research be given priority consideration:

1. basic research aimed at the discovery of new scientific principles and techniques that may be applicable in agriculture and forestry;
2. research aimed at the development of new and innovative products, methods, and technologies relating to biological nitrogen fixation, photosynthesis, and other fields that will improve and increase the productivity of agriculture and forestry resources;
3. basic and applied research in the field of human nutrition; and
4. research to develop and demonstrate new, promising crops, including guayule and jojoba.

In the special research grants program the law authorizes the Secretary to make grants without regard to matching funds to:

1. land-grant colleges and universities, SAES, and all colleges and universities having a demonstrable capacity in agricultural research, as determined by the Secretary, to carry out research to facilitate or expand promising breakthroughs in knowledge; and
z. land-grant colleges and universities and SAES to facilitate or expand State-Federal research programs that promote: a) excellence in research, b) development of regional research centers, or c) the research partnership between USDA and such colleges or SAES.

Proponents of formula funding saw the introduction of competitive grants as an eroding force on the clout of land-grant universities and their agricultural experiment stations. Others reasoned that excellence in food and agricultural research might very well exist in institutions other than those in the land-grant system.

One mechanism provided by Congress that lent further justification to seeking wide participation in the program was the provision for a peer-review system of research proposals to further guarantee excellence in performing the research. The World Food and Nutrition Study under the aegis of NAS endorsed the competitive grant system, as did the OTA report Organizing and Financing Basic Research To Increase Food Production (1977).

Management

The shift to special and competitive grants as a means of funding research has had several effects when compared to formula funding. First, formula funds do not pay overhead costs; most grants do. For a given level of funding, this reduces the amount available to research scientists, It does, however, make possible more direction of research to specific needs. Second, the availability of special and competitive grants encourages faculty members to seek such outside funds. The director of the SAES frequently has little opportunity to exert management or program guidance on these programs. This has positive and negative connotations. Often, the research has little significance to local or State problems. Third, the individuals who make decisions on funding under the grant system are not always accountable to legislative and agricultural interests.

Relationships between USDA and SAES at the administrative level are unnecessarily competitive and in some cases destructive (Moseman, et al., 1981; Knutson, et al., 1980). But of even greater significance is the effect of the dispersal of USDA research resources and authorities and the resultant substantial autonomy in regional and area offices. This situation represents a degeneration of the operational and coordinating functions that traditionally have been carried out by USDA for national and regional programs.

OTHER FEDERAL AGENCIES

At least 10 Federal agencies other than USDA fund or conduct some kind of food and agricultural research. These include the Departments of Commerce, Defense, Energy, Health and Human Services, Interior, and State; Agency for International Development; Environmental Protection Agency; National Science Foundation (NSF); and Tennessee Valley Authority (TVA). No accurate figures are available for the extent of dollar investment in food and agricultural research by these agencies. Some of the budgets are quite large; others are very small and are actually advisory in nature.

In most instances, food and agricultural research conducted by these Federal agencies is considered complementary to that of USDA; overlapping efforts are not thought to be great. Because the mechanism for coordination with USDA as the lead agency is not functioning well, however, the degree of overlap and coordination cannot be determined at this time. In some cases, the research program is the type that either is inadequately covered by USDA or is more suited to the mission of the other agency, The food research program of the Department of Defense is a good example of the latter type, since it deals with providing a wholesome and nutritious food supply to servicemen and servicewomen under field and military-base conditions. TVA conducts research on development of fertilizers because both USDA and most of the private sector discontinued such activity nearly 20 years ago.

To improve coordination of the research activity of USDA and the other 10 Federal agencies involved in food and agricultural research, Congress mandated the establishment of the Committee on Food and Renewable Resources (CFRR).* The committee,

*This was authorized under the National Agricultural Research, Extension, and Teaching Policy Act of 1977 and established under FCCSET.

which is chaired by USDA, "is to review Federal research and development programs relevant to domestic and world food production and distribution, promote planning and coordination of this research in the Federal Government, and recommend policies and other measures concerning the food and agricultural sciences for the consideration of the Council. "

The purpose of CFRR is to increase the overall effectiveness and productivity of Federal R&D efforts in the areas of food, nutrition, and renewable resources. The committee is charged with improving planning, coordination, and communication among Federal agencies; developing and updating plans for Federal research programs; collecting, compiling, and disseminating information on food and renewable resources research; and preparing reports describing activities, findings, and recommendations of the committee.

CFRR has not yet satisfactorily fulfilled its role (OTA letters of inquiry to Federal agencies, 1980). As of early 1981, CFRR did not have a classification of the food and agricultural research conducted or funded by these agencies nor the amount of funds allocated for such research. It does not yet actively coordinate interagency activities. One reason is that the committee is a relatively new feature within a well-entrenched bureaucracy. Furthermore, it needs more specific, highly defined objectives to be more effective, And finally, the committee does not have the authority of individual agencies that might be addressing the same problems from more authoritative positions.

THE 1890 LAND-GRANT COLLEGES

In 1890, Congress passed an act that granted to certain Negro colleges and universities the same privileges as those provided by the Merrill Act of 1862. However, as discussed in chapter III, equitable funding of the 1890 institutions, including Tuskegee Institute, has been a problem. It was not until 1972 that they received significant funding for research and extension by congressional act. Under the Food and Agriculture Act of 1977, these institutions acquired expanded authority and responsibility. Although they are funded almost wholly by Federal agencies, they are cooperating with the SAES on certain regional projects.

The role and functions of the 1890 land-grant institutions include:

- meeting the needs of those people whom the system was designed to serve;
- focusing sharply on needs of people who have been disadvantaged by systems and circumstances over which they have no control;
- using unique methods to assist "hard-to-reach" clientele;
- maintaining a well-structured educational system through teaching, research, and extension; and
- providing educational programs that prepare individuals to function intelligently in a democratic society.

According to the chairman of the Association of Research Coordinators of the 1890 Schools, "the most pressing deficiency of the 1890 Schools in fulfilling their obligation in food and fiber research is pauperized laboratory facilities" (OTA letter of inquiry, 1980).

NONLAND-GRANT UNIVERSITIES

For the purposes of this report, the term "nonland-grant university" encompasses two kinds of institutions: a) private universities such as Harvard and Stanford that conduct research which may have implications for food and agriculture but whose main direction is elsewhere, and b) public State universities such as the California Polytechnic State Universities or Texas Tech University that have clearly identified food and agriculture programs including research.

Historically, nonland-grant universities have not been considered as part of the traditional U.S. agricultural research system, nor have they had specific legislation or Federal funds for agricultural research. As late as 1977', Congress reaffirmed the role of USDA as the lead agency in U.S. agricultural research and charged it with coordination functions identifying specifically the traditional agricultural research institutions. So, in general, the nonland-grant universities, from the congressional standpoint, seem to be outside the traditional agricultural research system. * Congress has, however, recognized their capability as research institutions, and they have been funded through such agencies as the National Institutes of Health, NSF, etc. Further, Congress has also recognized their potential value to U.S. agricultural research. The special grants program makes provision for those with recognized agricultural research capabilities, and the competitive grants program makes all of them eligible to compete for such grants.

*This includes public State universities which receive funds from State legislatures for teaching and training of agriculturalists, but not for agricultural research.

Private Universities

Many of- the private institutions conduct in-depth research in the basic sciences of chemistry, physics, mathematics, etc., which form the basis of most biological research on which agricultural research is founded. Many have strong departments in such sciences as plant physiology, entomology, animal physiology, etc. (as do many land-grant universities), but their research usually is more basic and may have no immediate application to the solution of practical food and agricultural problems. Such research, however, frequently provides many of the breakthroughs so important to the continued advances of agricultural research. Their resources and expertise should be considered as valuable resources to the U.S. agricultural research system and used as funds and interest permit.

Private universities, unlike the public State universities which receive substantial State support, receive no general Federal or State assistance and support their scientific research almost entirely from government grants, endowments, and corporate contracts. A relatively small group—about 36 institutions—account for about 60 percent of total Federal research expenditures in universities. The chief barrier to the performance of sizable amounts of agricultural research in these universities is lack of resources and the fact that status and reward within science disciplines put strong pressure on performing basic, rather than applied, research.

Because the paucity of agricultural research in private universities is largely a consequence of the status and reward structure in scientists' professions, it is not likely that funding alone can make significant changes. A frequently made charge, where the only

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control is through grant funding, is that large amounts of money for agricultural research made available to basic scientists will often be directed to different types of research (Lewontin, 1980).

Nevertheless, there are a number of scientists in private universities who would carry out relevant agriculturally related research if they had the funds to do so. For example, there are engineering, chemistry, and business schools at these universities that could conduct product development and management studies in agriculturally related areas. An expanded competitive grants program in agriculture would be helpful in funding such projects and perhaps in beginning to give legitimacy to agricultural research in private universities. Such a program should be in the hands of a peer-review system so that the criterion of excellence and relevance could be enforced in spirit as well as in letter.

Public State Universities

This group includes about 180 institutions in 19 States; 58 of them have agricultural programs. These 58 institutions perceive their roles as providing teaching, research, and public service to their regions and States in accordance with guidelines set forth by State legislatures. Compared with SAES, these institutions are small. Most of them have become involved in food and agricultural research during the last 30 years and their research is concentrated mainly on local problems. A 1979 survey showed that State appropriations provided 30 percent of their total research funds; associations and private grants, about 39 percent; Federal sources other than USDA, 21 percent; and USDA and land-grant universities provided the rest (Smallwood, 1980).

Generally there has been little coordination among the land-grant universities, USDA, and the nonland-grant State universities, The primary deterrent to cooperation has been a lack of format for exchanging information or for planning and communicating. This situation improved somewhat with the passage of the Food and Agriculture Act of 1977 and the establishment of the Joint Council on Food and Agricultural Sciences. Furthermore, most of these nonland-grant universities have no Federal or State charter for research, thus making financing difficult except for competitive grant activities.

RESEARCH IN THE PRIVATE SECTOR

Foundations

Foundations award grants to performers of agricultural research. There are some 400 American philanthropic foundations that award grants of $5,000 or more (Hildreth and MacLean, 1981). The nature and purpose of the grants vary with the interest and purpose of the granting foundations. Three of the largest foundations are Ford, Rockefeller, and Kellogg. Of these, only Rockefeller is sponsoring agricultural research related to U.S. agriculture. Although the Ford Foundation has supported agricultural research since 1950, it has gone primarily to programs in the developing countries, rather than to grant recipients in the United States. Interests of the W. K. Kellogg Foundation have been concentrated in extension, outreach, and training areas.

Compared with the quantity of funds available to the performers of agricultural research from public sources, the amounts provided by foundations are indeed modest. The decision to make each grant is based on policies established by the individual foundation's governing board. Each foundation seeks to be at the forefront of the areas chosen for emphasis. As such, these grants, while modest, may well play a significant role in the continuing development and adjustment of the performers of agricultural research to meet the emerging problems in food and agricultural science.

Private Enterprise

Food and agricultural industries contribute significantly to the productivity and efficiency of American agriculture in a number of ways: a) invention, improvement, and manufacture of farm machines; b) selection and improvement of crop plants and animals; c) development and production of a wide range of agricultural chemicals such as insecticides, fungicides, fertilizers, antibiotics, etc.; d) processing, preservation, and production of animal feed and human food; and e) development and improvement of a wide variety of farm structures.

Accurate figures on the size and scope of industry's input to agricultural research, as discussed in chapter IV, are unavailable, although several attempts have been made in the past to determine this information. In 1966, the Agricultural Research Institute (ARI) conducted an extensive survey of 825 private companies that were known to have agricultural research programs. Only 40 percent of the companies responded. The results indicated that the private sector was expending about $460 million annually for agricultural research. Of this amount, 9 percent went for basic research, 50 percent for applied, and 41 percent for engineering and development. Major fields of interest in industry research at the time of the survey were chemicals, feed, pesticides, fertilizers, and machinery (Moseman, et al., 1981). Food research was concentrated largely on product development and food processing.

In 1976, ARI attempted to update the 1966 data, but the response to questionnaires again was not wholly satisfactory. Of the 240 companies reporting, total R&D expenditures were $575 million. ARI felt the survey returns were insufficient to justify extrapolation to the entire industry, so the results were presented on the basis of only those companies reporting. A new factor turning up in the 1976 survey was that many companies were spending sizable amounts for "defensive research"—i.e., research required to meet Government regulations or undertaken in defense of existing products (Moseman, et al., 1981).

Although different segments of the agricultural industry perceive their roles differently, most of them are generally motivated by economic reasons. If management can foresee a profit from their research efforts, funds are set aside for the research program. In many cases, industry research results in payoffs for both the farm sector and consumers.

In recent years, the Office of Management and Budget (OMB) has adopted a policy of determining which research areas should be performed primarily by industry. OMB has done this with the concurrence of USDA and with little or no discussion with industry itself. The assumption by OMB of the authority to determine unilaterally what work should be done by industry has resulted in less cooperation from industry and in the omission of some necessary types of research. OMB judgments have little effect on the types of research industry undertakes. A result of this situation is that there are certain areas of research in which both agriculture and the consuming public are not being served as they should. One of these areas is the post-harvest technology research program (Irving, et al., 1981).

Although there are mixed views about USDA conducting post-harvest technology research, industries are generally in agreement with each other that much of this type of research should be performed by the public sector (USDA, 1979). Some of the critical elements in such research are reducing energy consumption in food processing, extending product shelf life, reducing transportation and storage costs, and minimizing processing losses. It is doubtful that the private sector is capable of doing the complete research needed in this area. Basic principles of post-harvest technology should be researched by the public sector for the benefit of consumers. In turn, industry should follow through on adaptive R&D as needed (Moseman et al., 1981).

Another area in which agriculture is not being fully served is that of improving efficiencies on farms through mechanization research. This was most clearly stated by Secretary of Agriculture Bergland who declared that no Federal funds (excluding Hatch funds) should be used for this purpose if it displaced labor. Since the major part of agricultural mechanization has resulted from industry efforts, it is likely that such a USDA policy would adversely affect small industry types that would have insufficient financial resources for developing more effective farm equipment for specific crops and specific localities.

The above policies are viewed by some as leading toward a concentration of R&D in the hands of larger industrial corporations. Thus, small companies and small farms—which are supposed to be helped by USDA policy—are left without the help they should have. Basically, then, it is important to recognize that private industry contributes a substantial amount to research and technology development in the United States.

Those that have their own research programs tend to view their role in R&D primarily from a business investment standpoint. They conduct research in areas of interest to the company and in areas which may give it proprietary advantages. Much of the research conducted by agribusiness has general use and is of great value to the public, but agribusiness cannot be depended on to conduct a wide array of research in any given area. It is likely that industry might underinvest in research if the public sector were conducting similar research, It is difficult for the public sector (and probably for the industrial firms themselves) to anticipate the exact research area and the effort that will be expended on research of importance to agribusiness. Therefore, the public sector must maintain a research effort commensurate with public interest in such areas.

The greatest need seems to be a wider interchange of ideas at the planning level among USDA, SAES, and industry, The primary needs, therefore, appear to be communication, mutual respect, and a recognition that the solution of food and agricultural problems is of national importance and must be approached on a cooperative basis.

ROLE OF SAES AND USDA

During the early history of the development of the SAES there was concern about the relationship of the research stations to the land-grant colleges, There was an even greater concern about the acquisition of Federal funding through USDA for support of SAES, free from excessive domination by the Federal Commissioner of Agriculture. The Hatch Act of 1887 resolved many of these issues and provided for a high degree of autonomy by the individual States in designing and conducting research.

Additional legislation providing support for the establishment and strengthening of the SAES clearly recognizes the stations as distinct entities in the land-grant colleges. In the early years, the SAES were concerned almost totally with State and local research problems. However, as they grew and additional acts were passed by Congress providing wider use of funds, their research broadened to include regional, national, and international activities,

Meanwhile, USDA has developed a wide range of research laboratories, stations, and activities that not only includes national, regional, and international activities but at times involves strictly local problems.

This broad base for application of Federal and State resources to research problems has led some, including Congress, to question the degree of research planning and coordination that exists, especially at the top levels of administration. There seems to be considerable duplication of effort and vying for funds. The question of research priorities continues to be a subject of disagreement—basic v. applied, commodity v. discipline, marketing v. production, etc.—and Congress and other interested groups have increasingly been concerned.

Most agricultural research administrators —whether SAES, USDA, or other—recognize there is not unanimity of thought in how best to manage and carry out U.S. agricultural research and the appropriate roles of the various actors for an effective and efficient research system.

Organization and Facilities

James Kendrick, vice president for agricultural and university services, University of California, recently suggested a plan to revitalize our agricultural research system and at the same time strengthen the partnership between Federal and State educational institutions. He said:

> The core of this plan would be a USDA-developed National Research Institute for Agriculture and Food Sciences. Founded with the very best of facilities and scientific expertise, the Institute should be established with a goal of making it the world's foremost center for basic research in agriculture and food science. It should provide support and stimulation which no other organization or agency could duplicate. It should have the capacity to attract the most competent scientists and specialists, not only for permanent affiliation, but also for short-term projects. As an integral and indispensable part of this plan, the Institute should establish a number of prestigious resident professional fellowships in the agricultural and food sciences, to be offered annually on a competitive basis to the scientific community at large.
>
> As important as such an Institute would be to our future basic research needs, it should not be expected to satisfy the total requirements for a comprehensive research program, The diversity in both commodities and geography which characterizes U.S. agriculture makes the problem too complex for a single-program approach. Regional USDA programs and State agricultural research, teaching, and extension activities must also be maintained and strengthened if we are to move from theory to practice without undue delay.

The PSAC panel of 1962 recognized the importance of having a strong and reputable national agricultural research center commensurate with the stature of U.S. agricultural research in international agriculture. The continued reluctance of USDA in recent years to support research facilities or staffing at the Beltsville Research Center has rendered the center less effective in furnishing research leadership and scientific inputs. It has also reduced the efficiency of conducting research at this location because of inadequate technical and support staff (Science and Agriculture, 1962).

The location of new laboratories and allocation of more resources to Beltsville, as contrasted with alternate locations, requires a sense of conviction on the part of the leadership of SEA as well as a commitment to research by the Secretary of Agriculture (Pound, 1980). The USDA library was erected at Beltsville, Md., in the mid-1960's when the Secretary of Agriculture took the position that "the location of USDA research facilities would not be determined by the White House staff, OMB, or others, but by the Department" (Moseman, et al., 1981).

The justification for strengthening other national and regional research stations and laboratories is that these facilities exist, they were designed to serve national and regional requirements, and they should be put to good use in meeting the needs of USDA and the SAES in improving the Nation's agriculture.

A major factor in the close cooperation of USDA and the SAES has been the association of research staff working either in Federal laboratories or in State-owned facilities at the cooperating SAES. This has been basic in maintaining strong cooperative relations and in sustaining mutual respect of the cooperating partners and should be given high priority in future strengthening of the national agricultural system.

Partnership Difficulties

Don Paarlberg, at the 1980 Agricultural Outlook Conference, made the following statement:

> The need for some degree of relatedness in the various agricultural research undertakings is clear.
>
> The Agricultural Experiment Stations are perhaps unique among the tax-supported research institutions. They were set up nearly a century ago, when the prevailing mood was more individualistic than it has recently become. Modern macro concepts had not been invented. The States were more important then. Central direction was anathema. Volunteerism and cooperation were in vogue. The experiment stations reflected their times. Traditionally, decision-making was shared among the clientele groups, the individual researcher, his department head, his director of research, his dean, the university president, the State legislature, and the Congress. With formula funding, the Department of Agriculture had limited input,
>
> The recent surge of tax-supported research in fields other than agriculture and in agencies other than the experiment stations is the product of different times: more central direction, more team activity, more macro and less micro, more concern about externalities, less emphasis on the criterion long used by the land grant colleges–efficiency.
>
> There is now an effort, on the part of those who provide the Federal funds, to bring the experiment stations and agricultural research generally into the modern setting, with more central direction, to have it conform to the current mood. The experiment stations, with their proud history, understandably resist this effort.
>
> Some form of leadership is essential. Strong central direction and coercion are repugnant for a number of good reasons. A loose voluntary cooperative type of guidance is desirable. The accepted though much scorned word for this is "coordination." It must be exercised if the research community is to appear to the appropriations committees as something other than a group of bureaucratic self-seekers. Who should supply this coordination? In my view, the Science and Education Administration of the Department of Agriculture should exercise the coordinating role, with input from the directors of research at the experiment stations and other institutions with research capability in agriculture.
>
> The Department of Agriculture is central, it is directly involved in the acquisition and distribution of Federal funds, and it comes closer to perceiving the broad public interest than does any other unit in the system. The exercise of this role is extremely difficult. An experienced administrator will take on this role with some reluctance, as an exercise of responsibility, not assertively, as an expression of power (Paarlberg, 1980).

Emery Castle, in an address to the National Association of State Universities and Land-Grant Colleges in November 1980, said:

> Federalism is undergoing constant evaluation on many fronts but the unique historic relationship between the USDA and the land-grants has evolved into a set of institutional relations that are unrivaled in complexity. The question should be faced squarely as to whether the historic partnership between the USDA and the land-grants remains viable. The Food and Agriculture Act of 1977, the numerous constituencies that must be served by USDA, together with the multiple ties between higher education and the Federal Government, raise questions as to whether the partners still are marching to the same drummer. What happens during the next four years probably will decide whether the point of no return on the road to dissolution of the partnership has been passed, or whether recent events will be viewed only as a series of family spats, not unlike a political party's national convention—a necessary prelude to battle against a common enemy (Castle, 1980).

Funding and Roles

Many comment that the problem is a result of the continuing tight budget and that all problems would be solved if only there were enough money. While undoubtedly the problems are exacerbated by a continuing tight budget, this is only a superficial answer. The facts are that at the administrative level, there is, in a general sense, no agreement on the roles of the SAES and USDA, and until there is some understanding and agreement of the roles of these two primary public actors in U.S. food and agricultural research, there can be no effective agreement on overall cooperation in the very important aspects of U.S. agricultural research. Effective cooperation between any two people, organizations, or nations requires agreement on the subjects on which to cooperate and on the roles of each, and each must cooperate from a base of relative strength. To an outsider of the system, it does not appear that this should be a difficult task if the actors can realistically evaluate their roles, strengths, and responsibilities in an atmosphere free of bureaucratic considerations.

Federal formula funds allocated to the States are used primarily to supplement funding of State programs designed to solve problems of State and local needs. The director of the SAES is accountable for all such funds going to the State experiment station. Most of these programs contribute to solving problems of regional and national importance, but Federal formula funds do not have regional or national problem solution as their primary objective, nor is priority determined by such needs.

State legislatures appropriate funds to their SAES to solve State and local problems. Again, accountability for their expenditure usually lies with the director of the SAES. Undoubtedly, most State research has contributed to the solution of regional and national problems, but such contributions have been adjuncts to solving State and local problems. It is also common for two or more States to pool resources to work on regional problems of common interest to them. But even in these instances, control and accountability are not centralized in any one person or institution.

Hence it appears that under the present system, it would be difficult for one or several SAES to plan and conduct a full effective program responsible for the solution of regional or national problems even though they may contribute significantly to the solution of such problems. Some SAES directors do not agree with this statement, but they have yet to devise a plan that would give assurance to the contrary.

Federal funds are allocated to Agriculture Research (AR) primarily for problems of regional or national importance, where the nature or magnitude of the problem is such that a single State cannot provide the resources for its solution and where there is some regional or national concern for the problem, or from an industrial standpoint where the risk is too high or demanding for any one industrial component. AR programs include those involving resources and activities that are jointly developed by AR and SAES. AR also has responsibility for servicing the research needs of action agencies within USDA. AR is accountable to the executive and legislative branches of Government for the administration and national coordination of such programs.

It appears that insofar as Federal formula funds are concerned, the role of the SAES should be primarily concerned with State and local problems and those problems of a regional, national, or international nature that are an extension of their State and local problems. Insofar as special grant or other grant funds are concerned, SAES should compete on their ability to perform the needed tasks effectively.

AR should concentrate on agricultural problems important to the Nation that no one State or private group has the resources, facilities, need, or incentive to solve and those research programs as required to fulfill the stated objectives of Congress, the President, and the Secretary of Agriculture. AR should carry out its role by working as a partner with SAES to achieve complementarily and, through cooperation with private universities and industry, to coordinate its own contribution to achieve national goals most effectively. This should be done with effort by both USDA and SAES to collaborate when appropriate in such a way to assist the research performance and respect the integrity, role, and decisionmaking responsibilities of the institutions.

PRINCIPAL FINDINGS

- There is a role for a strong national USDA research program. This role has been carried out in the past by USDA and Federal funding to SAES. Historically, the USDA role was associated with broad regional, national, and international activities. The role of SAES, insofar as Federal funds are concerned, has been primarily for local, State, and regional problems. These roles are becoming confused.

- Grant funds provide resources to further the programs of USDA. SAES, nonland-grant universities, and others compete for these funds on the basis of their interest in and ability to do Federal research. This is a desirable aspect of the total research effort.

- The Committee on Food and Renewable Resources has not yet satisfactorily fulfilled its role, This is because it is a relatively new feature in a well-entrenched bureaucracy; it needs more specific, highly defined objectives; and it does not have the authority of individual agencies that might be addressing the same problems from more authoritative positions.

- Under the 1977 Food and Agriculture Act, the 1890 land-grant institutions participate in research and receive most of their funds from Federal resources. They have pressing needs; one of the more important is improved facilities. Coordination with the rest of the system is less than adequate.

- The private sector tends to view its role primarily from a profit potential. It conducts research in areas of interest to the companies and in areas that may give them proprietary advantages. There are significant research areas of interest to the public that are not receiving and will not receive adequate research attention if left to the private sector,

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Chapter VI

Management, Structure, and Policy

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Management, Structure, and Policy

Of all the past assessments of the U.S. food and agricultural research system, few have made a serious attempt to evaluate the problems inherent to management policy. Yet today, as research missions become more varied, as new priorities vie for attention, and as funding becomes more stringent, the need arises for finding ways to strengthen leadership standards and performance at all levels of operation. Accomplishing such goals requires a thorough and honest analysis of management, structure, and policy within the Federal/State agricultural research system.

This study evaluates four research agencies within the U.S. Department of Agriculture (USDA): the Science and Education Administration's (SEA) Agricultural Research (AR), Cooperative Research (CR), Human Nutrition (HN), and the social science research programs conducted by the Economics and Statistics Service (ESS). Included also is an overview of how the State agricultural experiment stations (SAES) are organized and managed. All of these agencies are experiencing changing roles and may need to consider new policy options that would maximize their research potential.

In striving for effective research management, one important component to consider is a planned systematic classification of the research problems at hand. OTA's study describes the criteria for categorizing the various levels of fund allocation and for assessing the responsibility and accountability of those who must make the ultimate decisions.

RESEARCH CLASSIFICATION FOR MANAGEMENT PURPOSES

Classification of agricultural research problems for management use is a complex process. Three broad areas or levels of activity are in the hands of different decisionmakers. The classification system for each area may vary, and, although there may be some overlapping among areas, the principal responsibilities are clear-cut. These three areas are: a) broad national policy issues including agriculture, b) issues solely within agricultural research, and c) issues within major research activities.

National Policy Issues, Issues at the national level relate primarily to management problems such as responsibility, accountability, and funding. Here, the importance of research and development (R&D) at the Federal level is evaluated in relation to other federally funded activities and the relative level of importance of agricultural R&D v. R&D in other sectors (such as defense or energy). For the most part, these major policy decisions are made outside the realm of the agricultural sector. They are primarily political decisions made by the President in his annual budget, with help from the Office of Management and Budget (OMB), the Office of Science and Technology Policy (OSTP), and Congress.

As a general rule, decisions affecting this broad area are not conscious decisions directed specifically, for example, at the percentage of the Federal budget for R&D or agricultural R&D. They come about as part of larger decisions concerning perception relating to national issues or the well-being of the country. Furthermore, these changes come about gradually. They are incremental. Criteria used at this level are primarily related to national concerns of the various sectors of the economy and the relative importance of each. Other criteria have been involved at this level in the past. For example, when Sputnik first rose above the horizon in the late 1950's, there was a clamor for more basic research—almost across the board.

Within Agricultural Research. Issues at the second level—within agricultural research—relate to programs, funding levels, management of Federal funds, accountability, and decisions on who does what and the relationships to other research factors.

The Secretary of Agriculture, his senior staff, SAES directors, OSTP, OMB, and Congress have varying degrees of input at this level,

Scientists may have some input at the second level, but by the time it reaches the final decision level in USDA, most of their input cannot be identified. SAES have significant input in the programs and budgets that go to the Secretary for formula and competitive grant funding. The SAES also have input through lobbying at the congressional level.

USDA research administrators, likewise, have significant input within the Department in those programs and budgets relating to their areas of activity. Although OMB usually sets limits on total funding for USDA, the Secretary has some discretion in allocating levels of funding for activities in his Department. In other words, he can give research high or low priority. Congress has the final word for broad priority areas and funding levels, Thus, a wide array of factors is involved, almost exclusively outside the working scientist's level.

Organized groups such as producers, consumers, and environmentalists also have influence at the second level. Budgets and programs approved by Congress are usually specific as to the general intent of their use. The major issues relate to criteria for priority setting—i.e., responsibility, accountability, and further emphasis on who does what.

Within Research Activities, At the third, or lowest, level of decisionmaking, research administrators and their scientific staff make the major decisions on programs and budget allocations. Nearly always, it is the research scientist who decides how to conduct such research. SAES directors working with their department heads have a fairly free hand in allocating formula funds and State funds.

Criteria Used for Classifying Research

Four major criteria are used for classifying agricultural research activity: 1) the geographical area involved in the research problems, 2) the kind of research required to solve the problems—e.g., basic, applied, etc.; 3) research problem area—e.g., appraisal of soil resources; and 4) program structure—i.e., relating research problems to agency goals and missions, There are some additional minor criteria often used in classifying research (see Flatt, et al., 1980).

Geographical Area

A common criterion for classifying research is to consider the geographical area involved. Five such areas are recognized: local, State, regional, National, and international,

Any problem related to agriculture that occurs within a State or a portion of a State is classified as a State or local problem. One example of this might be determination of crop and animal adaptability to various locations and soil types within a State.

Any problem related to agriculture that extends over a major portion of two or more States—or affects the economy, environment, or social conditions of the major portion of two or more States—is classified as a regional research problem, Region does not refer to SAES or SEA/AR regional areas, but to problem areas. One example of a regional research problem would be development of a soybean variety suitable for the Coastal Plains area of the Southeastern United States,

Any agricultural problem that extends over a considerable portion of more than one region or has a major impact on the economy, environment, or social conditions of more than one region is classified as a national research problem. Examples include a migratory pest or disease that affects major portions of two or more regions and human nutrition.

Problems that affect the agriculture of two or more countries and can be solved by the cooperation of the countries affected are classified as international research problems. An example is the control or eradication of the screwworm, an ectoparasite of livestock, which overwinters in Mexico and, if not controlled, spreads into the United States. It is being attacked in Mexico by a joint effort of government agencies in Mexico and the United States.

The advantage, for management purposes, of differentiating research problems as international, National, regional, State, or local is accountability for funds. It may be used in a general way to arbitrarily distinguish between the major roles to be assumed by State research agencies as compared to Federal agencies such as SEA/AR. State-appropriated funds are often intended to be used to support research that would have a direct bearing on solving local and State problems. Federal formula funds (Hatch) appropriated to States are used primarily to solve problems of the State or region. But collectively, in coordination with SEA/AR and other groups, they contribute to the solution of problems of national and international concern.

Another advantage of the State/National/regional classification is that it tends to increase the desire of Federal and State scientists to cooperate. Professional recognition and promotion in academic rank in some State universities are related to national and international accomplishments; this classification can be of benefit under such conditions.

A disadvantage of using this classification at the State level is that most research is concerned with State problems, even though that same research may have regional, national, or international significance, So, within a State, additional classifications are needed.

From a Federal standpoint, the advantage for management purposes of differentiating research problems as international, National, regional, State, or local is to reach an understanding as to who will accept the primary responsibility for solving a research problem, SEA/AR, for instance, has the primary responsibility for conducting research that is national or regional in scope. To do this it is necessary to define as precisely as possible what the geographical criteria are.

For example, assume that the boll weevil has spread across the Southeastern Cotton Belt and is seriously damaging cotton in 12 States. Also assume that in all 12 States SEA/AR and ESS have various research programs related to the control of the boll weevil. While the cotton in each State is being affected, and thus to that State it is a State research problem, it is by definition a regional problem. Therefore, if a coordinated regional research thrust is initiated, it would be highly desirable for SEA/AR to furnish a scientist to coordinate the regional research effort, assuming that SEA/AR had, or could employ, a competent scientist who was an effective leader. The SEA/AR scientist would normally have fewer problems traveling anywhere in the region at any time needed to do the coordination.

Two disadvantages for management purposes of using the geographical criterion for classifying research problems are: 1) science knows no boundaries; therefore, it is difficult to limit scientific thought to one classification system; and 2) some State scientists, especially those using contractor grant funds, maybe working on problems that are insignificant to the State. They may or may not be interested in cooperating on the solution to regional or national problems.

Kind of Research

Another common criterion for classifying research is by the kind of approach or type of endeavor needed to solve the problem. The three classifications generally used are basic, applied, and developmental.

Basic research is directed toward increased knowledge in science where the investigator is concerned primarily with gaining a fuller knowledge or understanding of the subject under study.

Applied research is directed toward practical application of knowledge where the investigator is primarily interested in a practical use of the knowledge or understanding for the purpose of meeting a recognized need.

Developmental research is the systematic use of scientific knowledge and understanding gained from research directed toward the production of useful materials, devices, systems, or methods, including design and development of prototypes and processes.

The major advantage of using these criteria to classify research is for funding by Federal agencies such as the National Science Foundation. USDA has become aware in recent years of the need for more basic research, and such a classification system enables it to allocate funds in this manner across disciplines and political boundaries. Most USDA research is mission oriented, which is defined as the aim of achieving a worthwhile goal—e.g., controlling harmful insects or increasing the per-acre yield of soybeans. In the process of achieving such a mission or goal, scientists may conduct research that embodies all three components—basic, applied, and developmental. Today there are so many problems of agricultural production, harvesting, conservation, processing, marketing, and transportation that research classified as "applied" will continue to be stressed by State and Federal leaders.

A disadvantage of using these criteria is one of semantics. What one person perceives as being basic research is viewed by another equally qualified person as being applied. Research is a continuum rather than being clearly defined. Attempts to draw a line of demarcation between basic and applied research are illusory (Pino, 1980). Pasteur once remarked that "there is no pure science or applied science—only science and the application of science. " More important is that the research, whatever its classification, can have an ultimate beneficial effect for mankind.

Research Problem Area

A third criterion used for classifying agricultural research is to group problems in an area in which all of them have one or more common characteristics. This criterion is used by the Current Research Information System (CRIS), which is a computerized storage and retrieval system developed by USDA and the SAES. An example of a research problem area (RPA) used by CRIS is development of domestic markets for farm products. Because CRIS recognizes 98 RPAs, they are grouped together under nine goals to facilitate easier storage and retrieval, (For further elaboration, see Flatt, et al., 1980.)

Each CRIS project is also classified by activity, commodity, and field of science. Below is an example of the use of the CRIS classification system for the research project "coating cotton for open-end spinning. "

Goal V: Improve Efficiency in the Marketing System,
Research Problem Area (RPA) 501, Improvement of grades and standards—crop and animal products.
Activity 5600, Chemical and physical properties of nonfood products.
Commodity 2100, Cotton,
Field of Science, 1525, Chemistry—inorganic.

In preparing inventories for planning purposes, the CRIS reporting units are usually aggregated into 48 research programs and these in turn are aggregated into nine research program groups.

CRIS is used to report all current research projects of USDA agencies, SAES, and parts of other agricultural research conducted by nonland-grant universities. It is useful for State, National, and regional planning purposes.

Theoretically, CRIS provides information on what research is being done by whom and where. It also provides information on methods and procedures, scope of the research, and progress to date. CRIS can be faulted, however, for the fact that some of the data it provides are usually 2 to 3 years out of date. Nevertheless, CRIS is extremely useful in identifying what is being or has been done and by whom. Since most research is continuous, even though modified, information retrieved from CRIS has current aspects.

Despite its drawbacks, CRIS gives managers a tool to assist them in planning programs and the ability, if the information is updated, to avoid unnecessary duplication.

Program Structure

The Agricultural Research Service (ARS) developed the Management and Planning System (MAPS) which described its component research programs for planning and evaluation. Essentially, MAPS is a program *structure* device for organizing the subject matter of research so that it relates most effectively to the activities and plans of the agency. It provides the framework for the supporting systems and information needed for planning, reporting, evaluating, budgeting, and executing research.

MAPS is a logical continuation of the developmental program structure that extends to the individual research project. It consists of missions, goals, programs, work-reporting units, and research projects. It relies heavily on reports from national research program coordinators which are used to provide a summary national report. This report, along with periodic site visits and national program reviews, facilitates tracking all research, assessing progress, keeping abreast of developing technologies, and sensing the importance of developing research problems.

Actually, MAPS is an adjunct to CRIS and in some areas of activity uses the computer facilities of CRIS. There is merit in a possible combination of CRIS and MAPS into one classification system. The CRIS system is used as the basic input for State, Federal, and some private agricultural research organizations, but the method of aggregation for planning and management purposes differs among the major performers. A modified system of classification could be beneficial.

Principal Findings

- No one system of research classification is sufficient for all management purposes. Some systems work better than others, and certain combinations of systems can be effective. Insofar as USDA is concerned, the local, State, regional, National, and international classification systems along with MAPS, appear to be an effective way to manage research. USDA also uses CRIS as a way of maintaining knowledge of research being done by other institutions and the scientists involved. This classification system is effective in allocating Federal funds to States through CR. There is little management of the formula funds, but contract and grant funds, with the help of MAPS, can also be managed in this manner.

- This system is also of importance to SAES, since most of their funds come from State legislatures and are primarily for local and State problems. Federal formula funds are also primarily for problems of local and State importance but can be used on problems of regional, national, or international significance. But even here, such problems also have facets of local and State concern, and generally it is these aspects that are of major concern to the State scientists.

EVALUATION OF USDA MANAGEMENT AND POLICY PROGRAMS

The diversity, complexity, and broad scope of problems in agricultural research were recognized by Congress in 1977 when it defined the food and agricultural sciences in title XIV of Public Law 95-113. Title XIV states:

> Sciences related to food and agriculture in the broadest sense, include the social, economic, and political considerations of:
>
> - Agriculture, including soil and water conservation and use, the use of organic waste materials to improve soil tilth and fertility, plant and animal production and protection, and plant and animal health.
> - The processing, distributing, marketing, and utilization of foods and agricultural products.

- Forestry, including range management, production of forest and range products, multiple use of forest and range lands, and urban forestry.
- Aquiculture.
- Home economics, human nutrition, and family life.
- Rural and community development.

The situation is further complicated by the fact that research programs must take into account the attendant problems in exporting food and agricultural products and some of the problems associated with U.S. aid to developing countries. As stated in the National Academy of Sciences (NAS) Committee Report of April 1972:

> Agricultural research cannot be restricted to empirical comparisons of methods to increase productivity. The agricultural industry requires research, policy, and programs sufficient to challenge the best efforts and minds of America, On its success depends in large part the welfare of the people of the United States and of the world. It must be given the attention, careful and imaginative planning, and best judgment of the government and of scientists,

Over the years, policy changes within USDA have affected the organizational structure of USDA. Moreover, environmental and social issues have, at various times, had sharp impacts not only on management methods but also on social perception of the Federal agricultural system. Many of these changes and the resultant impacts have involved USDA's main research agency, the Science and Education Administration,

Science and Education Administration

SEA was created in 1977 by USDA in an attempt to improve coordination of research and extension at all levels of Government. Through early 1981 SEA included what was formerly ARS, the Cooperative State Research Service (CSRS), the Extension Service (ES), and the National Agricultural Library, Additional responsibilities in human nutrition, technical information systems, higher education, and program management, planning, and evaluation were assigned to it by the Secretary, The functional research units of SEA include AR, CR, and HN. *

SEA management includes a program analysis staff whose function is largely one of fostering coordination, and a program planning staff whose major role is to help develop an integrated budget for SEA,

Internal SEA decisions are made by the director and associate director in consultation with the management team. The team consists of the heads of AR, CR, ES, HN, Technical Information, Joint Planning and Evaluation, Higher Education, Special Programs, and Administrative Management. In addition, representatives of subunits usually attend as nonvoting but often participating members. In reality, therefore, more than the above 11 attend. The management team's function is to provide coordination and establish policy that affects the subunits. To date, one of its main activities has been related to budget preparation. Three of the above agencies are of special concern to this study and addressed in some detail, They are: SEA-AR, SEA-CR, and SEA-HN.

Agricultural Research

USDA, in the recent publication "The Mission of the Science and Education Administration—Agricultural Research," outlines the mission and goals, the role and special capability of SEA/AR, the organization and functions, and gives a description of a wide range of research programs. It also includes a compilation of the statutes relating to the agricultural research activities of the SEA/AR.

The foregoing statements and document identify the scope and complexity of the agricultural sector and the research required to serve it. The publication further describes:

*In June 1981, USDA announced a reorganization that eliminated SEA and reestablished ARS, CSRS, and ES. Most of HN was merged into ARS. USDA established an Office of Science and Education to establish broad agricultural research policies, planning, and coordination. These changes are discussed in ch. X and app. A.

a) the SEA/AR responsibilities for the national program, b) the partnership with the SAES, and c) the association with industry. The document provides a good framework for the assessment of the national research system. The critical questions, however, are whether the system is functioning as the paper purports; whether the responsibilities of USDA, SAES, and the private sector are as clearly defined as indicated; whether the relationships are actually as stated; and whether the organization, operations, and leadership are of the nature and caliber to make the system work.

The USDA report furnishes the following guidance with respect to national and regional programs:

1. As the USDA's in-house agricultural research unit, SEA/AR has major responsibilities for conducting and leading the national agricultural research effort.
2. The SAES, with mainly local and regional interests, work in cooperation on national and broad regional research efforts.

The foregoing are the longstanding definitions of the respective USDA and SAES primary responsibilities and areas of concern. However, because of the blurring of these national and regional generalized responsibilities and problems relating to funding at the Federal level, the partnership has become somewhat confused and increasingly uncertain in the last decade.

It is necessary to adapt and adjust the national research capabilities to meet continually changing requirements of those served by agricultural research. This has been particularly critical in the past few decades as the continuing needs of farmers for improved technology were joined by the new and increasingly persistent demands of other sectors of society for answers to environment and consumer interest problems.

Reorganization of 1972

As discussed in chapter III, the reorganization of USDA's ARS in 1972 called for two major staff units at the headquarters to support the administrator's office. The first staff unit would be composed of the national program staff (NPS), four assistant administrators and their staff specialists. It would be concerned with policy and program development, evaluation, and coordination. The second major staff unit would be concerned with business administration, under a deputy administrator for administrative management. Smaller support staffs were to be responsible for national phases of information, international programs, and similar assignments.

The major thrust of the reorganization was to assign the line operating authority to the field, with four regional deputy administrators, and four associate deputies, to be located within each of the four SAES regions. Each regional deputy administrator would have an administrative services staff, together with a program planning, development, and evaluation staff, and information and biometrical service support.

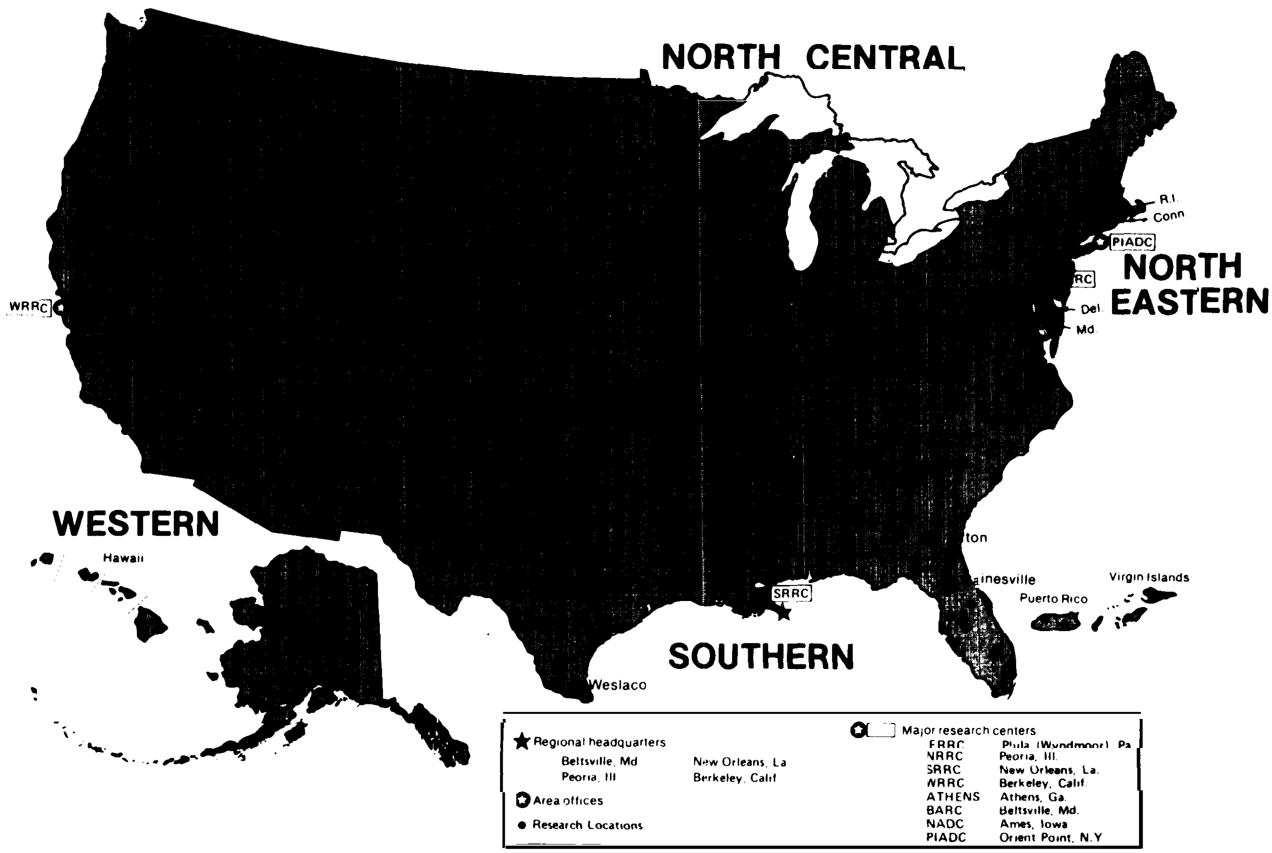
Each of the four regions was further subdivided into a series of research area centers, under a research area director (fig. 22).

The effect of the reorganization was to reassign the former national program investigations leaders to NPS positions, removing their line responsibility and authority with respect to program development, budgeting, selection of staff, etc. The emphasis was placed on the geographical boundaries rather than broad research issues. The national perspective was diminished. By focusing on local and State problems, it became more difficult to emphasize basic research, because of pressure by local groups desiring that research be concentrated on practical problems.

Because the reorganization of ARS has been in effect for nearly 8 years, it appears that sufficient time has clasped to justify an assessment of the current structure with respect to the overall national research system.

The significant feature of USDA research prior to 1972 was that investigation leaders of the ARS branches guided ARS's regional and national research efforts to solutions of re-

Figure 22.—USDA Agricultural Research System



SOURCE: U.S. Department of Agriculture.

gional and national problems in cooperation with State and regional efforts. The investigation leaders were national leaders from the ARS standpoint. Most enjoyed good cooperation and respect by researchers at SAES and industry (Moseman, et al., 1981). This organizational structure provided an overlay of research support that included scientists, equipment, and operating budgets for research that transcended State boundaries and was of concern in the various farming areas. Research on cotton was conducted and strengthened or modified where that crop was grown. Sugarcane germ plasm and breeding research was concentrated at Canal Point, Fla., and in Hawaii. Potato genetics was centered at Sturgeon Bay, Wis. National or regional investigation leaders were specialists in commodity or problem areas and had in-depth knowledge of their research activities, including the expertise of the USDA and SAES. They-also knew their subject and geographical territory.

Nearly all of the investigation leaders had access to "soft" money, with which they could contract with SAES for special research to round out specific aspects of the national program. Cooperation and participation by State scientists was thus encouraged, but this aspect of the program has largely disappeared.

The present "regional" structure of USDA research is superficial with respect to the agriculture of the United States—if considered from the standpoint of production, processing, marketing, or distribution or from the standpoint of national resource use and management, environmental factors, or consumer concerns. In contrast, the SAES regions furnish a mechanism for interaction between States sharing a general geographic area of the United States to relate to common operation and management problems as well as subject areas of mutual concern. The strength of the former ARS organizational structure was its ability to relate to an individual State and to the group of States within the SAES regions, and then to transcend these boundaries and furnish the cohesive and coordinating services and functions on a nationwide scale.

Under the present organizational structure, responsibility for a given commodity program is highly decentralized. Although NPS provide technical leadership, they function as staff members and do not have line authority. They can advise and exert some influence, but do not have authority to make decisions concerning resource allocation. In the latter case, many others are involved in terms of a national program. Consider, for example, the case of wheat. It would appear necessary to conduct, for example, the hard red winter wheat research program through the concurrence of the AR deputy administrators for the Southern, Western, and North-Central regions. It would be necessary also to work through and with 7 area research directors and the directors of 11 SAES. The interaction with other regions of the United States where wheat is grown would require an extended gauntlet of regional deputy administrators, area directors, and SAES directors. This organizational structure has resulted in a dilution of national leadership for national programs and, in effect, substituted a series of programs oriented to local, State, or several State areas.

The planning and coordination of research in specific research problem areas should be done by knowledgeable scientists. This becomes more important when the number of locations is large and consolidation desirable. AR has more field locations than necessary to conduct effective national and regional research, within the present limitation of funds and personnel ceiling (NAS, 1972; Moseman, et al., 1981). Further, at a number of these locations, the research programs are primarily concerned with local and State problems. In some cases, efforts have been made to close such locations. These efforts have met strong political opposition from the local community and their congressional representatives (Moseman, et al., 1981). Usually, this has been sufficient to prevent their closing. Area directors and local AR administrators also frequently work against closing any research effort in their "domain." Area directors appear to have no function from a technical or scientific standpoint. They could be more productive in a field station or laboratory where their scientific expertise could relate to their assignment (Moseman, et al., 1981).

Congressional and Professional Reaction

In hearings before a subcommittee of the House Appropriations Committee, Chairman Whitten repeatedly quizzed USDA representatives on the **1972 reorganization** of ARS. He was most critical of the new regional structure. Examples of some comments are:

> Mr. Administer: Mr. Chairman, we are charged with the operation of a national program of research to meet the national needs.
>
> Mr. Whitten: That is what you were charged with before. But, as you changed, you gave that responsibility to the men at Beltsville, and the men in Peoria, and the men in Berkeley, and the men in New Orleans, having assigned them your responsibility, why do we need you . , . every time you have a region you have a breakdown point between the people and the Members of Congress who represent them. You have a breakdown between the Secretary of Agriculture and the field where the work is. The more regional people they have to go through the worse it is—when you delegate it, have a straight line to the man who does the work—don't have it broken in Peoria.
>
> Mr. Long: May I add one other comment, Mr. Chairman, that relates to Mr. Edminister's response to your question?
>
> The regionalization of ARS took place before I came on the scene. However, I have had a chance to observe the results in the field and from here for some months now.

Though I don't pose as an expert on the difference that exists between now and then, I do observe one thing that I think is important. Regionalization, I believe, has given us assistance in the area of close coordination with the university system, It is an extremely important element. There are no dollars in this budget indicating what we are gaining here in terms of coordination and cooperation.

We have a lot of work to do but we are making headway and I think the regionalization is broadly helping us in this area to work more closely with the universities and other research facilities in the country, I could go into more detail on this but I think it is an element we ought to weigh.

Mr. Whitten. I have a high regard for the universities in this country but this is not meant to be an aid to the university program. This is meant to be the U.S. Department of Agriculture research program. We have all sorts of regional research; we have had experiment stations; the land-grant college grants, the various programs that make money available for research, I repeat, this is not an aid to the Extension Service nor to the experiment stations, but the Federal research program . . . .

I think I have made it quite clear that we are not particularly pleased with the new organization.

Many scientists, not just USDA scientists, were disturbed by the 1972 reorganization. Entomologists were sufficiently disturbed to ask the Entomological Society of America to name a committee to study the impact of USDA-ARS reorganization on the entomology profession.

The committee took the following approaches in this study:

1. Personal interviews of ARS entomologists, administrators, and State personnel.
2. Personal letters to entomologists on NPS and PAC staff and entomologists currently assigned as assistant area directors or area directors.
3. Questionnaires were developed and sent to all ARS entomologists GS-9 and above, selected laboratory directors and research leaders, SAES directors, and all heads or chairmen of entomology departments.

The response was summarized in four tables. The committee felt the results were self-explanatory and did not discuss them in detail.

The number of USDA entomologists responding was 215 and nearly all were negative to the reorganization (table 7). In general,

Table 7.—USDA Entomologists' Response to 1972 USDA Reorganization (215 reporting)

1. Do you feel that you have as a scientist, more or less restrictions on your research activity?
   More—44.2% Less—29.8% No change—26.00/0
2. Are you involved more or less in preparing reports and other paperwork since the reorganization?
   More—38.0% Less—13.4% About the same—48.6%
3. Do you feel that you have been able to communicate your needs better under the new organization than the old?
   Yes—28.8% No —61.0% No change—10.20/0
4. Has the new organization been more responsive to your research needs than under the old system?
   Yes—27.0% NO—61.0% No change—12.0%
5. Do you feel that the new organization has been properly and thoroughly explained to you as a research scientist?
   Yes—56.70/0 No—41.40/o No answer—1 .9°/0
6. Do you feel that communication between entomologists within the USDA under the new system is adequate?
   Yes—28.80/0 No—69.30/o No change—1.9%
7. Do you feel that the reorganization has promoted a closer cooperation and alignment with State entomologists?
   Yes—1 1.20/0 No—26.50/o About the same—62.30/0
8. Do you personally feel that your opportunities for advancement in your field have been enhanced by the reorganization?
   Yes—1 1 .2% NO—80.0% No change—9.80/0
9. Do you feel that the prestige and effectiveness of entomology as a discipline within the USDA system has been adversely affected by the reorganization?
   Yes—73.0% No—23.0% No change—4.00/0
10. Do you feel that the reorganization has affected significantly the recruitment of outstanding young entomologists into USDA?
    Yes—30.3% No—55.6% No change (too early to assess) 14.1%
11. Do you feel that the reorganization will affect significantly implementation o-f future large-scale experiments and area suppression/eradication programs?
    Yes—52.50/0 No—38.1 0/0 No change—9.40/0

SOURCE: Entomological Society of America, vol. 20, No. 1, March 1974.

they felt that: a) communication within USDA among entomologists was inadequate under the new system, b) opportunity for advancement in their field had not been enhanced by the reorganization, c) prestige and effectiveness of entomology as a discipline within USDA had been adversely affected by the reorganization, and d) closer cooperation with State entomologists, a major reason for the reorganization, was about the same.

Twenty-two USDA research leaders and laboratory directors answering the questionnaire found few positive attributes to the reorganization (table 8). They were concerned about: a) more paperwork and budgetary work, b) no better line of communication to higher administration. c) less response to entomological needs, d) inadequacy of NPS in overall planning at the national level, and e) cooperation and coordination with State entomologists, a major reason for the reorganization, being no better than before.

Table 8.—USDA Research Leaders' and Laboratory Directors' Response to 1972 USDA Reorganization (22 reporting)

1. Do you find yourself doing more or less paperwork and budgetary work since the reorganization?
   More—77.3% Less—4.5% About the same—18.2%
2. Do you feel that you now have a better line of communication to the higher administration than before the reorganization?
   Yes—27.3% No—45.55 About the same—27.2%
3. Do you feel that you are adequately able to transmit your unit's research and budgetary needs through current organization as well as through the old organization?
   Yes—40.9% No—36.4% About the same—22.7%
4. Is the new organization more or less responsive to entomological needs than before reorganization?
   More—9.1 % Less—59.1% About the same—31.8%
5. Do you feel that the NPS and PAC staffs are adequate for overall planning at the national level, program review and evaluation, and coordination?
   Yes—22.7% No—72.7% No opinion—4.5%
6. Do you feel that you have a sufficiently close relationship with NPS and PAC staffs to effectively communicate research needs in entomology?
   No—72.8% Yes—27.2%
7. Do you feel that more cooperation and coordinated efforts have developed with State entomologists and other personnel since the reorganization?
   Yes—22.7% No—50.0% About the same—27.3%

SOURCE: Entomological Society of America, vol. 20, No 1, March 1974

Thirty-four SAES directors responded (table 9]. Their response indicated that at the administrative level, but not necessarily at the scientist level, communication was improved at least from a cooperative State-Federal team approach, and that USDA was responding more to local and State research needs.

The chairmen and heads of departments of entomology (36) gave responses that were the most negative of those contacted (table 10). They felt that: a) their departments' relations with USDA entomologists had not improved,

Table 9.—Experiment Station Directors' Response to 1972 USDA Reorganization (34 reporting)

1. Has communication improved between your office and USDA Administrators since the reorganization?
   Yes—73.5% No—20.5% No change—6.0%
2. Has USDA been more or less responsive to local and State research needs since the reorganization?
   More—44.1% Less—3.0% About the same—52.9%
3. Has the new reorganization catalyzed any significant cooperative State-Federal team approaches to solving local or regional problems in your State?
   Yes—44.1% No—47.0% About the same—8.9%
4. Do you feel that the reorganization has affected the ability of any one discipline in carrying out programs, i.e., entomology, agronomy, agricultural engineering, etc.?
   Yes 14.7 "/0 No 82.30/o No change or opinion 3.0 "/0
5. Have you noted a closer and more cooperative relationship between individual State and Federal disciplinary scientists since the reorganization?
   Yes—23.50/0 No— 17.5?40 About the same—59.0%
6. Did you have prior knowledge of the reorganization before it occurred?
   No—55.90/o Yes—44.90/0
7. Did you have an opportunity to express your opinions to USDA officials?
   Yes—32.4% No—67.6%
8. Do you now feel that the reorganization has strengthened or weakened the USDA in research effectiveness?
   Strengthened 41.2% Weakened 11 .8% About the same 47.0%
9. Did the reorganization significantly affect your station's mode of research operation?
   NO —88.1 % Yes—8.9% No opinion—3.0%
10. Do you feel that the reorganization has affected the training of graduate students significantly at your university?
    Significantly 0% Not significantly 97.0% No opinion 3.0%

SOURCE: Entomological Society of America, vol. 20, No 1, March 1974

Table 10.–Chairmen and Heads of the Entomology Department's Response to 1972 USDA Reorganization (36 reporting)

1. In your opinion, has the USDA reorganization improved your department's relations with USDA entomologists?
   Yes—1 1.1% No—72.2% No change—16.7%
2. Do you feel that locally USDA entomologists are more or less responsive to entomological problems in your area, State, and region?
   Yes—50.0% No—16.7% No change—33.3%
3. Has the USDA reorganization had a significant impact on your State research programs?
   Yes—16.7% NO —80.6% No change—2.7%
4. Do you feel that the reorganization has improved or impaired employment opportunities for your entomology students?

Improved	Impaired	No change
2.7%	44.5 %	52.8%

5. in your professional opinion, do you feel that the image of USDA entomologists has been damaged by the reorganization?
   Yes—72.2% No —25.0% No difference—2.7%
6. Do you feel that it is easier or harder to get entomology research projects funded through ARS, USDA since the reorganization?
   Easier—5.5% Harder—55.5% No difference—39.0%
7. in your contacts with USDA entomology personnel, what would be your current assessment of their reaction to the reorganization after approximately 1 year?

Favorable	Unfavorable	No opinion
5.5%	80.5%	14.0%

8. Do you feel that the reorganization has with ARS
   Decreased research productivity—19.4%
   Research productivity has remained about the same—80.6%
9. Do you feel that the reorganization has
   Improved the security and opportunity for entomologists—5.5%
   Lessened the security and opportunity for entomologists—83.3%
   No change—11.2%

SOURCE: Entomological Society of America, vol. 20, No. 1, March 1974.

b) there had been no significant impact on State research programs, c) the image of USDA entomologists had been damaged, and d) it was more difficult to get entomology research projects funded through USDA since the reorganization.

As indicated earlier, the committee did not analyze the data in detail. It did make a few general comments which clearly indicated its belief that the new organization was less effective than the former. The following is one such comment:

> The reorganization has fragmented the largest body of entomologists in the world working effectively together as a single unit. The role that this unit once served as an organization structure and communication trunkline for nationwide entomological research is no more. The advantages or disadvantages of the reorganization and its impact on the profession can at this point only be debated, and only time will enable us to fully evaluate the full significance of the reorganization (pp. 51-52).

Time has shown that the new organization, as now functioning, is probably less effective than the committee anticipated.

Regional Boundaries and National Needs

The geographical area covered by each regional deputy administrator was chosen to coincide with the SAES regional areas and, consequently, to aid in communicating and working with the SAES. However, these areas have no significance to truly regional research problems. Such problems do not follow State lines, nor do most groups of regional problems fall within the same cluster of States. AR regional administrators most likely do not possess the technical expertise needed to make sound judgments on the technical components of their varied research portfolio because of the wide-ranging subjects, which may include poultry, beef cattle, corn, soil erosion, and plant disease.

The present organizational structure does provide the environment for interdisciplinary research. This is a positive aspect of the organization if a national research focus as opposed to a local one exists. However, maintaining a national focus is difficult with the present organization and there is nothing to preclude NPS from being organized along interdisciplinary lines.

The development of strong, efficient research programs directed toward the solution of regional and national problems requires strong technical leadership at the national level. Such leaders must have full knowledge of the technical and scientific aspects of the problems they face. Such leaders must have the ability to work with other scientists in a cooperative and technical capacity. They must also have an in-depth knowledge of all physical, personnel, and financial resources of AR for their areas of expertise and should be responsible for making final recommendations on allocation of these resources after being given a budget allocation from a higher authority. In other words, they should have line authority.

AR scientists located in the various laboratories and field locations of all regions must have the opportunity to work directly with the national program leaders in finding the best way for their efforts to become effective and useful parts of the national and regional efforts. These scientists' responsibilities are primarily to carry out the national and regional programs jointly developed and to coordinate these activities with directors of SAES and other interested parties.

A recent letter from the administrator of AR directed to regional administrators, deputy administrators, NPS, and NPS chiefs attempts to correct the problems addressed above (Kinney, 1981). However, more formal changes will have to be articulated into the organization charts and job descriptions to carry out effectively what appears to be the intent of the letter.

There are other issues that need study and evaluation. There is a real question as to the need for area administrators. They frequently work against closing any research effort in their domain. As noted earlier, area directors appear to have no function from a technical or scientific standpoint. Study is needed on how to use them in a more effective way.

Cooperative Research

CR is responsible for administering Federal funds that go to States for agricultural research. Traditionally CR has developed a close working relationship with the SAES, the schools of forestry, and the 1890 colleges and Tuskegee Institute. Many of the staff were former scientists at these universities.

The administrator is a member of the Experiment Station Committee on Organization and Policy and meets regularly with it on research matters of interest to the States and USDA.

As a part of the CR staff's responsibilities toward coordination of research among the States and between the States and USDA, they represent the States. This representation involves budgets, research priorities, formula v. grant funds, coordination, and in fact most problems the SAES have.

The CR staff is also charged with the responsibility of developing a budget that reflects the State's input. At that point CR, like AR, has only minimal control over, and input to, the USDA research budget that is submitted to OMB and ultimately Congress. This is a Government-wide practice. However, AR and CR complain of too much staff time being spent in preparing the SEA budget and little or no input after it is combined into the SEA budget (Lovvorn, 1980).

The Hatch Act gives the Secretary of Agriculture broad power and responsibility in administering funds to the States. CR performs these functions on behalf of the Secretary. The SAES directors, however, have never been willing to fully use CR in terms of the agency being their Washington representative. In the name of States' rights, they have prevented CR from performing many functions that would assist their own programs. CR should have the necessary authority to represent the States (Lovvorn, 1980).

Review Function

CR conducts onsite systematic subject matter reviews in all of the States. These reviews include not only research funded by Hatch or grant funds but, by mutual consent, all of the research, regardless of the source of funding.

Review teams include experts from universities as well as from the USDA and the private sector. At the close of the review, they report to the scientists, department head, and SAES director. The reviews generally cover broad subject areas such as crop science and soil science, They are usually conducted every 3 to 5 years, and their purpose is to serve the needs of the research group that requested it (Special Review Process, USDA, 1980). They deal only briefly with the past and emphasize approaches to program improvement and plans for future endeavors. After giving an oral and a subsequent written statement of the review, there is no further followup. Acceptance of recommendations is an option of the client institution. If a request is not made for a review of an area of work within 3 to 4 years, CR may suggest that a review be undertaken. There are no legal requirements for reviews; they are conducted as part of CR's responsibility for coordination of research sponsored by Hatch funds. However, most SAES personnel believe they are beneficial (Lovvorn, 1980).

All Hatch-supported projects are sent to CR for review and approval or disapproval. By mutual consent between CR and the SAES directors, all State-supported projects are also sent to CR. Thus, the CR staff is knowledgeable of all activities at the State level. This desk project review process is not always productive. Most SAES directors submit good outlines; some do not. Some CR staff members make excellent contributions to the outline; others do not (Lovvorn, 1980).

The House Science and Technology Committee—in 1976 hearings on agricultural R&D—found that the special and onsite reviews of SAES performed by CR should be strengthened and more widely used. They also suggested that, where appropriate, increased use of qualified scientists from outside the USDA-SAES system should be encouraged. These recommendations appear to be still valid.

Administration of Grants

CR also administers a research-grants program that uses the competitive process in the selection of grantees. These programs are:

1. competitive research grants program to support basic research in the food and agricultural sciences,
2. special research grants program to support research deemed by Congress and USDA to be of particular importance to the Nation,
3. alcohols and industrial hydrocarbons program, and
4. native latex research program.

A comparable grant program for the Solar Energy Systems for Agriculture Program is administered by SEA's Southern Energy Center in Tifton, Ga. Guidelines for grants to be awarded competitively are published annually in the Federal Register.

A CR program manager is selected who chairs the peer panel and reviews and scores proposals for special grants. Each panel consists of eight members, including the chairperson. The panel is selected from: a) USDA and other Federal agencies (minimum of one); b) SAES, forestry schools, schools of veterinary medicine, and colleges of 1890 and Tuskegee Institute (minimum of three); c) scientists of nonland-grant institutions with food and agricultural research capabilities (minimum of one); and d) scientists with needed expertise not covered by a member listed above or by the chairperson. The program manager summarizes the panel's findings, and on the recommendations of the CR administrator, the SEA director signs off on the proposal (Policies and Procedures for Special Grants, USDA, 1980). The CR administrator could make this decision without this extra layer of administration.

Regional Research

Section 3(c)3 of the Hatch Act provides that up to 25 percent of the funds may be used for regional research to "stimulate and facilitate interstate cooperation on research of a regional and national character both among SAES and with the United States Department of Agriculture" (USDA Food and Agricultural Research Grants, 1980).

CR has the responsibility for administering these funds. Advisory to CR is the Committee of Nine, a committee specified by law to include eight SAES directors and one home economics research administrator. The concept is good and it has encouraged cooperation among States, but the SAES directors have not allowed the committee enough authority to plan and carry out strong regional programs (Lovvorn, 1980).

The regional projects carried out under the SAES basically constitute a group of scientists working on a problem of importance to more than one State. The funds for the regional projects give these scientists an opportunity to get together and exchange information. Some change in direction or emphasis of their research may take place as a result of such meetings, but there is no one with authority to allocate resources (personnel and funds) to any given area of activity. There is no one source of accountability, and there is no assurance that all aspects of the needed research will be covered. Notwithstanding, these regional funds have been extremely useful. Not only do they benefit the work that is important to each of the cooperating States, but usually the net result is a greater and more coordinated effort than it would have been without such funds.

SAES-sponsored regional research should be cooperative with AR where the problem is of sufficient regional or national importance to require AR input. With interest and capable technical leadership, AR should be able to adjust its resource input to give assurance that all necessary aspects of the problem are covered. Thus, the SAES would be contributing to those aspects that are most useful and of most interest to them, but the total effort should lead to a fully rounded research attack on the regional or national problem. Prior to the 1972 reorganization of ARS, most ARS cooperative research with the SAES took this form of cooperation (Moseman, et al., 1981).

evaluation

Attempting to evaluate the administrative and management aspect of CR is difficult considering the long history of legislation and the independent nature of each of the SAES. The original Hatch Act makes the directors of the SAES responsible and accountable for the Hatch funds they receive. From the legislation and the manner in which CR (and its predecessors) operates, it appears that CR is an agency only for transmitting funds and for coordination. CR operates as though it were under the supervision of the SAES directors, rather than the administrator of SEA.

There is no doubt that strengthening the research base and basic research of all the SAES is desirable and in the public interest, and it should be done through the Hatch process. It is difficult for SAES to agree on budgets or programs that do not provide something for everyone. However, in times of stringent budgets it is difficult, if not impossible, to convince everyone, especially Congress, that this is the most efficient way to solve agricultural research problems, A quick glance at the Food and Agricultural Research Grants, fiscal year 1980, shows most of them to be small and spread over a large number of institutions (USDA Food and Agricultural Research Grants, 1980), Since competitive and special grants were not meant to take the place of formula funding, they should be built more around major new priority problems that would enable new thrusts to be initiated until ongoing programs can be shifted.

Questions have been raised as to whether CR is the appropriate agency to administer the competitive research grants program. All U.S. research institutions and scientists that have expertise and capabilities are supposed to be [and should be) considered equally as possible grantees. Having one agency, whose main function and purpose is so closely tied **to one** segment of the research community (and which receives a large share of the grants), administer these grants gives reason for concern. In 1980, out of a total of 207 grants, 114 went to land-grant institutions, 13 to Federal agencies, and 80 to nonland-grant institutions (USDA, Food and Agricultural Research Grants, 1980). This is consistent with the ratio of applications to grants received.

There would be less criticism and at least the appearance of more objectivity if these grants were administered by a separate office within SEA that had no allegiance to any special facet of the agricultural research community. This office would include the administration of the competitive grants for the Solar Energy System for Agriculture Program (now administered directly by SEA's Southern Energy Center).

Human Nutrition

Authorization for Federal human nutrition research of importance to U.S. citizens is principally the province of USDA and the Department of Health and Human Services (DHHS). Within DHHS, it is funded or conducted mainly by National Institutes of Health (NIH) and to a lesser extent by the Food and Drug Administration (FDA) and Center for Disease Control (CDC). Other agencies (IDCA/AID, DOC/NOAA, DOD, NASA, NSF, and VA) are involved to lesser degrees in certain aspects of human nutrition research.

Although human nutrition research had been done by USDA under an 1862 congressional mandate until the passage of the 1977 farm bill, direct Federal effort was confined to very few issues which related to national problems concerned with nutrition. The 1977 farm bill specifically singled out certain mission-oriented research which was needed to conduct large national intervention programs involving nutrition and to solve national issues concerned with diet in health promotion. In addition, it specified that coordination and communication within and among Federal agencies on the subject of human nutrition take place.

Human Nutrition Research in USDA

During the 95th Congress, the displeasure of Congress with the state of Federal human nutrition research became apparent. At one point in the drafting of the 1977 farm bill, all nutrition research was placed within the purview of USDA. This language did not survive the conference committee, but the National Agriculture Research, Extension, and Teaching Policy Act of 1977, Public Law 95-113, established "firmly the Department of Agriculture as the lead agency in the Federal Government for the food and agricultural sciences, " and furthermore that "the Department of Agriculture is designated as the lead agency of the Federal Government for agricultural research (except with respect to the biomedical aspects of human nutrition concerned with diagnosis or treatment of disease) . . . ." Specifically, the law states: "The Secretary shall establish research into food and human nutrition as a separate and distinct mission of the Department of Agriculture, and the Secretary shall increase support for such research to a level that provides resources adequate to meet the policy of this subtitle. " In addition, the Secretary of Agriculture was directed to "establish jointly with the Secretary of HEW procedures for coordination with respect to nutrition research in areas of mutual interest, " and to "coordinate all agricultural research, extension, and teaching activity conducted or financed by the Department of Agriculture and, to the maximum extent practicable, by other agencies of the executive branch of the United States Government. "

The USDA was specifically delegated the following research goals:

1. research on human nutritional requirements;
2. research on the nutrient composition of foods and the effects of agricultural practices, handling, food processing, and cooking on the nutrients they contain;

3. surveillance of the nutritional benefits provided to participants in the food programs administered by USDA;
4. research on the factors affecting food preference and habits; and
5. the development of techniques and equipment to assist consumers in the home or in institutions in selecting food that supplies a nutritionally adequate diet.

In response to the 1977 farm bill, HN was established as an administratively independent unit of SEA. However, its budget authority was based in AR. Through early 1981, it was headed by an administrator and consisted of six research centers. * The HN administrative and technical staff are professionally trained in nutrition or a related discipline. The administrator of HN and the directors of the centers are scientists with international reputations in nutrition research. The regional human nutrition research centers programs are national in scope and mission oriented. The concept of the centers was established in the 1977 farm bill, and three existing institutions—the USDA Nutrition Institute at Beltsville, the Human Nutrition Laboratory at Grand Forks, and the Consumer Nutrition Center at Hyattsville, which had been mandated by FUS SC427 and public Law 89-316 respectively—became the first centers. In 1978, Congress mandated two additional centers—the Children's Nutrition Research Center at Baylor and the Human Nutrition Research Center on Aging at Tufts—in Public Law 95-448 of 1978. Additionally, Public Law 96-154 of 1979 mandated "that the Department of the Army transfer to USDA 19 positions at the Institute (LAIR) currently dedicated to nutrition research. USDA is to develop a program for a Western Nutrition Center . . . ," thus establishing the sixth center.

The functioning of the centers has been hampered by low levels of funding overall (fig. 23). The three newest centers are particularly hard-hit, since they have had to be developed de novo and have had a severely restricted number of slots for professional staff. Through early 1981, USDA professional staff at all three of the new centers totaled 6; an additional 12 civil service positions remained to be filled. The bulk of the work at two of the centers is being carried out by non-USDA contract personnel. At the Center on Aging at Tufts, of the 10 professional staff only 1, the director, is a USDA civil service employee, while at the Children's Nutrition Research Center, none of the 16 professional staff are USDA civil service employees.

Restricted funding has led to some anomalous situations. For example, a large research building is being constructed for the HN Center on Aging; however, only five slots have been allotted for professional USDA staff. While at the Western Nutrition Center, only half a floor has been allocated for all administrative, management and research activities. Neither the floor space nor the eight professional slots appear to be adequate for the proposed mission of the Western Nutrition Center. Part of that mission is to act as the technical resource and research group for the National Nutrition Status Monitoring System which will be jointly administered by USDA and DHHS. For the three newest centers, neither proposed funding nor staffing allotments appear to be adequate to allow these centers to conduct meaningful research.

Implementation of a research center's mission is the primary responsibility of the center's director and his or her research leader. They make use of recommendations from an executive committee established for each research center and a Board of Scientific Counselors, who continuously monitor the program. The executive committee (which includes representatives of the center's cooperating institutions) reviews the broad scientific program within the center and deals with issues that affect the coordination of the research between participating agencies and institutions and with other aspects of research management. The Board of Scientific Counselors to HN (operating on an ad hoc basis

*As noted earlier, in June 1981 USDA eliminated HN as an administrative unit and merged most of it with ARS. This change is discussed in ch. X and app. A.

Figure 23.—USDA Human Nutrition Research Centers

Research center	Established*	Enabling legislation*	Collaborator	USDA scientists professional staff (FY1981)	Non-USDA scientists professional staff**	Scientists professional staff positions	FY 1980 budget (dollars in thousands)	FY 1981 budget (dollars in thousands)	FY 1982 budget (dollars in thousands)	Physical plant
Beltsville HN Research center	1941	7USC427	None	46	0	46	$6,435	$6,943	$7,506	HN
Consumer Nutrition Center	1954	7USC427	None	31	0	31	8,532	8,146	8,458	Commercial leased
Grand Forks HN Center	1966	PL89-316	Univ. of ND	10	1	10	2,408	2,788	3,292	HN
HN Res. Center on Aging at Tufts	1978	CR95-1579 on PL95-448	Tufts Univ.	1	9	5	2,000	3,704	3,845	Cooperator
Children's Nutrition Res. Center	1978	CR95-1579 on PL95-448	Baylor Col. of Medicine	0	16	5	2,500	2,800	2,905	Cooperator
Western HN Res. Center	1979	SR95-553 on PL96-154	UC Berkeley	5	0	8	1,000	2,010	2,087	Fed. Dept. Army

"Original human nutrition research dates back to 1893 based on a Congressional Directive in 1862.
•● USDA contact personnel.

SOURCE: U.S. Department of Agriculture, 1981.

and made up of scientific experts from outside USDA) reviews the scientific and technical aspects of the program.

Administratively, the coordination, direction, and monitoring of the centers are carried out by the HN Administrator's staff through onsite visits and analysis of annual reports and plans from the centers and their advisory and oversight bodies. These analyses are the basis for the Administrator's selection of priority problems to meet national needs. It is unclear, however, how a director of a research center who is not a USDA employee, but rather an employee of the cooperating institution, would interact with the Administrator and his or her staff. The relationship would seem to be that of a contractor-contractee rather than that of the usual chain of command. It is also not clear what lines of authority and responsibility exist between a director or research leader of a center if they are not USDA employees and their USDA staff.

In addition to the research work of the centers, HN has the responsibility to: 1) support extramural research in human nutrition; 2) develop and disseminate to the public and user groups nutrition information through appropriate educational programs; 3) develop effective coordination mechanisms with other agencies concerned with human nutrition; 4) conduct technical clearance of all human nutrition education and information materials; and 5) ensure that human nutrition programs and policy decisions at USDA refleet and are consistent with scientific consensus.

The human nutrition component of the competitive grants program, while coordinated with HN, is funded and administered through CR. The fiscal year 1981 budget allowed $2.9 million for the program. This reflects an absolute drop of $0.1 million since the program's inception in 1978. At this level and with the allowable research topics limited to a few narrow areas, it does not seem that this grants program will be capable of stimulating significant creative research efforts in nutrition.

Finally, SAES, 1890 land-grant colleges and Tuskegee Institute, carry out nutrition research with Hatch Act or other Federal funds. Determination of research direction is largely determined at a local level.

Each of the above USDA activities in human nutrition research is earmarked and budgeted for human nutrition research in a prospective manner. Related work in animals or plants would not be counted toward human nutrition research. The definition used for human nutrition at USDA is defined, clear-cut, and narrow.

Coordination With Other Federal Agencies

A Human Nutrition Policy Committee, established by USDA, oversees all nutrition efforts within USDA; coordinates and integrates the human nutrition research, education, and information activities within USDA; and cooperates with other Government agencies in coordinating their activities with those of USDA.

The basic attempt at coordination of human nutrition research within the Federal Government has been the Joint Subcommittee on Human Nutrition Research of the Committee on Health and Medicine (JSHNR) and the Committee on Food and Renewable Resources, Federal Coordinating Council on Science, Engineering, and Technology, OSTP. The committee meets at fairly regular intervals and has high-ranking representatives from all Federal agencies involved with human nutrition research.

The USDA HN Administrator and the chair of the DHHS NIH's Nutrition Coordinating Committee are the cochairs of this joint subcommittee; however, all the staff work is provided by DHHS NIH. During the 2½ years of its existence, the subcommittee has enunciated a Federal definition of human nutrition research; it is an extremely broad definition which encompasses much of the basic research in cell biology, molecular biochemistry, membrane transport, etc., which the DHHS NIH classifies as human nutrition research. In fact, the JSHNR definition virtually duplicates the definition for human nutrition research that NIH first expounded in 1977. JSHNR has also produced the first of a three-part report entitled *Federally Supported Human Nutrition Research and Training and Education Update for the 1980's, Part 1: Human Nutrition Research and Training*. Parts II and III will focus on international nutrition research and nutrition education research, education for professionals and for the public. JSHNR has been ineffective in furthering the development of the congressionally mandated National Status Monitoring System. Also, effective advance coordination of Federal research projects has yet to be demonstrated.

Human Nutrition Research in DHHS

The overall role of DHHS in human nutrition research was broadly mandated, although never specifically mentioned in the Public Health Service Act of 1944 (Public Law 410). However, after passage of the 1977 farm bill, DHHS's role in human nutrition research and education was precisely defined by Public Law 95-622, the Biomedical Research and Training Amendments of 1978. Of DHHS's many divisions, only FDA has separate statutory authority to conduct human nutrition research to regulate the safety and labeling of foods.

DHHS has a very different management setup from USDA. At the department level, DHHS employs an executive secretary for its department-wide Nutrition Coordinating Committee; this position has no line management or budgetary authority but is a staff advisory post which reports to the Deputy Assistant Secretary for Health. Since 1977, this post has been held by professors of medicine on leave from their respective medical schools for a year.

DHHS's portion of the Federal human nutrition research budget is figured at $137.3 million by JSHNR or greater than 76 percent of the Federal Government's effort in this area. However, this figure is compiled by using the broad definition of human nutrition research discussed in the previous section. Relatively limited amounts, less than 2.5 percent of the DHHS's total effort, of money are allocated to the mission-oriented human nutrition research programs in FDA, CDC, and the National Center for Health Statistics. These are mainly intramural programs, although FDA has recently expanded its contracted research, and are staffed by professionals expert in human nutrition research who have clear-cut programs with defined management structure.

The bulk of human nutrition research funded by DHHS (over 93 percent) is administered by NIH. At the institute-wide level there is a special assistant to the director who acts as the chair of the NIH Nutrition Coordinating Committee (NCC). This committee is composed of one representative from each of the institutes conducting research, administering research, or having an interest in nutrition. With the exception of the newly funded Clinical Nutrition Research Unit (CNRU), NCC has no line management or budgetary authority over any nutrition research. Even in the case of CNRU the funds are provided by three of the institutes (National Cancer Institute (NCI), National Heart, Lung, and Blood Institute, and National Institute of Arthritis, Metabolism, and Digestive Diseases).

Grants make up the largest share of human nutrition research dollars at NIH and are administered by the Division of Research Grants, This group is totally independent of any of the institutes. The staff does not review grant applications but sets up outside study sections and coordinates their activities through a staff executive secretary. Study sections composed of outside expert reviewers are set up to review each area of biomedical research including nutrition. After grants are funded for the year, the abstracts of these grants are reviewed by the relevant institutes and NCC, and the nutrition-related moneys in these grants assigned. Thus, an NIH grant can be anywhere from 1 to 100 percent nutrition. More than 75 percent of the grants designated nutrition related are reviewed by study sections other than nutrition. Therefore, the major emphasis of these grants is not nutrition. In contrast to USDA, grant moneys from NIH are determined to be nutrition related after the fact, rather than before the grant is made.

Institutes (or groups of institutes under coordination of NCC) may put out a request for application (RFA) for grants in the specific neglected areas of nutrition; proposals that are funded under this mechanism are considered to be 100 percent nutrition related. Six such RFAs have been released from June 1977 to June 1980. Program announcements (PAs) are similarly released, but they are much less specific in the research requested; eight such announcements were released from June 1977 to June 1980. All funded proposals to such an announcement would be considered 100 percent nutrition related. (No dollar figures are set aside for the grants funded through RFAs and PAs.) A given RFA might result in no funding whatsoever.

In contrast, request for proposals (RFPs) have budgeted amounts within individual Institutes. With the exception of NCI's Diet, Nutrition, and Cancer Program (DNCP), there is no entity within any of the institutes whose main emphasis is nutrition and which has funding for that purpose. Even DNCP no longer has management or budget authority. Thus, any contracted research in nutrition must originate from nonnutrition administrative entities. Of the nine research RFPs issued by the institutes from June 1977 to June 1980, three were issued by DNCP when they still had independent funding authority. Thus, there is no NIH-wide budgetary or managerial control of nutrition research. Indeed, in many of the institutes there is no institute-wide control; these decisions are left to the division level or lower. NCC acts only in a staff advisory capacity to most of the nutrition research activity at NIH.

Since the province of NIH is biomedical research, the major emphasis of nutrition-related research is the role of nutrition in the causes, prevention, or treatment of disease. Thus, most of NIH's administrators and many of its intramural researchers in nutrition are M.D.'s with an interest in nutrition, rather than professional nutritionists.

In 1978, OTA issued the report Nutrition Research Alternatives which dealt with the interagency issues in nutrition research. The findings of the report are still valid, since many of the same problems between DHHS and USDA continue.

Need for Change in SEA Management

Title XIV of the National Agricultural Research, Extension, and Teaching Policy Act of 1977 designates USDA as the lead agency of the Federal Government for agricultural research (except for biomedical aspects of human nutrition), extension, and teaching in the food and agricultural sciences. As noted earlier, USDA created SEA to focus attention on the coordination of these three functions, partially in response to the legislation and to increase the credibility of management as viewed by OMB. The architects of the agency feel the credibility of research has increased in OMB and the White House (Lovvorn, 1980).

Lovvorn, in interviewing individuals within USDA as well as in the university community, gained the impression that the director of SEA is held in high esteem; he goes on to state:

> A good job is being done in budget preparation but at enormous manpower expense, and that progress is being made in the two advisory committees. Little progress seems to have been accomplished in long-range planning, in expediting decision making, and furthermore morale is low in the sub-agencies because of heavy drain on their limited personnel, thus preventing them from performing their necessary functions. The University half of the partnership concept is in disarray. They no longer see themselves as a viable and functional partner.

Until the early 1950's, research leaders of USDA, including the chiefs of bureaus and the head of the Office of Experiment Stations had direct contact with the Secretary of Agriculture through fortnightly staff meetings called by the Secretary. Secretary Benson terminated these meetings but had some continuing contact with the agricultural research administrator. However, the lines of communication with the research administrator (and occasionally some bureau chiefs) were primarily through the Assistant Secretary for Research and Extension. Following the reorganization of 1953, the directors of research and others at this level had less frequent and primarily informal contacts with the assistant secretary. By 1963, the position had been reduced to director of research and education.

In the PSAC Agriculture Panel report of January 1962, it was recommended that there should be appointed an Assistant Secretary for Science and Technology in USDA to devote full attention to USDA activities in domestic and foreign science and technology. The same recommendation was made 15 years later by the NAS study on world food and nutrition.

During the Nixon administration, the Director of Science and Education [S&E) position was abolished and responsibilities for S&E came under an assistant secretary who had responsibility for conservation, research, and education. This continued into the Carter administration. After a few months, the research and education responsibilities were split off and placed under a Director for SEA. Thus, the heads of the AR and the CR remained downgraded, serving under a Director of Research and Education.

The SEA Director wears two hats; he is chief executive officer of SEA, an operating agency. He is also science and education advisor to the Secretary and, as such, is equivalent to an Assistant Secretary, Within SEA, each of the programs is headed by an administrator (AR, CR, HN, ES, and Technical Information Systems) and each could operate more efficiently by having only policy guidance above them. The additional layer of administration has caused delays; many decisions formerly made by the administrators must now be forwarded to the SEA Director for final approval. The Director and Associate Director seem to be concerned with too many details on day-to-day operations. Their talents could best be directed toward policy matters (Lovvorn, 1980).

In view of the importance of a strong and responsive agricultural research program, both nationally and internationally, it seems essential to provide for a more direct relationship to the Office of Secretary.

Economics Research

Of the total research budget of USDA (excluding funds passed on to the States), economics research has a relatively small role. From 1972 to 1980, it accounted for only about 5.5 percent of USDA research expenditures. No trend was apparent in this proportion.

As USDA is organized, economics research is in a sense a synonym for social-science research. The economics research structure includes limited research in the other social sciences (particularly rural sociology) and in history. The economics research staff, however, is almost entirely composed of agricultural economists.

Historically, economics research has not typically been strongly favored by the agricultural committees in Congress. Other forms of social science research have been even less favored.

Institutional Development[1]

Agricultural economics research has existed in USDA since 1901, when a farm management branch was initiated under the leadership of an agronomist. In the next two decades, other lines of agricultural economics work were added, and in 1919, the Office of Farm Management was reestablished as the Office of Farm Management and Farm Economics.

In 1922, USDA economics and statistical activities were consolidated into a new organization, the Bureau of Agricultural Economics (BAE). During the first years of the Bureau, research emphasized the collection and analysis of data on production, prices, and markets for farm products. From 1922 to 1938, various activities were added to and removed from BAE's portfolio. Through the period, however, research funding was overshadowed by crop and livestock reporting and marketing services (such as the market news service) and regulatory functions.

In 1938, BAE was substantially reorganized in an effort to transform it into the general planning agency for USDA, Responsibility for marketing and regulatory work was transferred to other agencies. The research program and the statistical work were retained, The planning work proved to be highly controversial and was gradually cut back. Some research involving social matters also proved to be quite unpopular with certain Members of Congress.

In 1946-47, the work of the bureau was somewhat reorganized to reflect congressional preferences. Research staffing and studies were reduced, while the statistics staff was increased.

In 1953, with the arrival of a new administration, BAE was abolished and its functions were divided between two new agencies—ARS and the Agricultural Marketing Service (AMS). A Farm and Land Management Division was established in ARS and three others in AMS: Market Research, Agricultural

[1]This section is based on Baker and Rasmussen, pp. 53-72.

Economics, and Agricultural Estimates. Administrator Wells said he thought the reorganization offered agricultural economists more opportunity for research than any other form of organization proposed. Research appropriations did in fact increase substantially, though not without some congressional concerns.

In 1961, another new administration arrived, and agricultural economics work was again substantially reorganized. Work previously grouped in ARS and AMS, as well as some work carried out in the Foreign Agricultural Service, was regrouped into two new agencies: The Economics Research Service (ERS) and the Statistical Reporting Service (SRS), which were placed under a new Director of Agricultural Economics. A staff economists group was also established under the Director's supervision.

While the new arrangement was quite attractive to many agricultural economists, it evidently did not find great favor in Congress. Congressman Whitten said in 1967, quoting an earlier statement of his own:

> You insist on having a Bureau of Agricultural Economics. It is my judgement it costs you about a million or a million and a half dollars a year to carry that title, because it is hard to sell (Baker and Rasmussen, p. 67).

Only rarely did an appropriation increasing funds for a particular line of economic research get through Congress. As for the regular ERS budget, Congress continued to be critical. The Administrator sometimes seemed to be on a treadmill where great effort was required merely to remain in place (Baker and Rasmussen, p. 68).

In 1977, with the arrival of another new administration, further organizational changes were made. ERS and SRS, along with the Farmer Cooperative Service, were combined into a new agency, the Economics, Statistics, and Cooperatives Service (ESCS). It reported to a Director of Economics, Policy Analysis, and Budget. The actual operations of the three component agencies, however, did not change greatly; the main shift was in the top administrative structure. In 1980, the technical assistance functions relative to cooperatives were transferred out and ESCS was reestablished as ESS. Yet another administration arrived in early 1981. The first move was to replace the former Director by an Assistant Secretary for Economics. A second move was to separate ERS and SRS back out of ESS.

Current Status[1]

Structure and Budget. As of early 1981, ESS was divided into three main components: economics, statistics, and administration. Each was headed by a deputy administrator, In terms of total budget and total staffing as of November 1980, the statistics unit was somewhat larger than the economics unit: a budget of $50.6 million v. $35 million in fiscal year 1980, and a staff of 1.076 v. 784. Both units had staff divided between Washington and the field, though in quite different proportions. Statistics had 70 percent of its staff in the field v. 19 percent for economics.

The economics unit (now ERS) is divided into four main divisions: national economics, international economics, natural resources economics, and economic development. National economics is the largest in terms of budget and staff, and economic development is the smallest. On balance, about 78 percent of the funding is devoted to domestic economics and 22 percent to international economics.

As of November 1980, 149 economics staff members were located at 41 field locations in 31 States, generally in a department of agricultural economics at a State university.

Role of Research.—As noted earlier, about 5.5 percent of USDA research budget for 1972 to 1980 was spent on economics research. This figure was based on the total appropriated budget of the economics unit and its predecessor, ERS. Although the figure of 5.5

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[1]This section is largely based on "An Assessment . . Response to OIA Questions;" "Economics and Statistics: Programs Results and Plans"; and "Economic, and Statistic Service: Programs, Functions and Organization." It was prepared prior to tile recent division of ESS into ERS and SRS.

percent is not high, it overstates the actual status of economics research, In fact, much of the unit's efforts is devoted to economic analysis and data acquisition. *

It is interesting to note how ESS sorted out the activities of its economics unit. For fiscal year 1980, it estimated that only 35 percent went for research, 47 percent for analysis, and 18 percent for data acquisition. If these proportions are applied to the total fiscal year 1980 budget of $35 million, it meant that $12,25 million was spent on research, $16,45 million on analysis, and $6,3 million on data acquisition. Following this through suggests that only about 2 percent of the USDA research budget was spent on economics research, and that the other 3,5 percent was being spent on economics related activities. There are no widely accepted norms in these matters, but this seems a very small proportion for economics research,

The leadership of ESS was acutely aware of the situation. It acknowledged that "from a functional standpoint, the major emphasis of the agency is on economic analysis" (ESCS response to OTA inquiry, 1980). It stated that:

> . . . there has been a real cost in terms of research. Research resources have been preempted by the exigency of short-term economic analysis. We desperately need to restore the balance between research and analysis in order to build an improved research program upon which to base our analyses (p. 14).
>
> We are taking steps to increase the share of resources devoted to research. We believe that a greater share devoted to research is a necessary investment in our in-house capacity, expertise, and knowledge base, without which our ability to do economic analysis would eventually be eroded (p. 4).

*While difficult to draw sharp lines between research and analysis, ESS defines: a) research as all work that is intended to measure or uncover new socioeconomic relationships or that is directed to testing and improving the use of the relationships previously measured, and b) analysis as the application of currently available results of research and statistical measurement to current and prospective problems, issues, and decisions,

There are, however, limitations on how much can be done in the way of adjusting within the available resources. ESS notes several constraints in these terms (ESS, p. 9):

- Legislative commitments. By law, we must do an undefined minimum of work in several areas (cost of production, and crop and livestock statistics, for example].
- Budget commitments. (There is an) . . . increasing amount of work earmarked in the budget process. We honor such commitments for at least three years.
- Public expectations, The public and private sectors have become accustomed to having us provide some of the basic data and indicators on a regular basis.
- Researchers' adaptability. Extensive and rapid redirection is often limited by the ability of highly specialized researchers or statisticians to adjust quickly to the other lines of work.

In short, ESS appears to be in a very tight and difficult situation with respect to the research function. It can make some adjustments itself, but to do more research would likely require help from Congress.

Current Issues

According to data in the preceding section and in chapter IV, it seems that relatively limited funding is available for economics research as such. Research is part of a larger economic package involving data collection and analysis, A balance is needed among these activities, But assessments of what constitutes an appropriate balance vary, Thus, securing more funds for research by shifting resources from analysis would be a debatable strategy. In any case, it would be difficult to do because of the strong demand for analysis, Another approach would be for Congress to do less earmarking of funds or provide more funds for research as such. The probability of either happening, however, is not great at this point (for further discussion, see Ruttan, 1981).

The key issues raised more generally in the OTA study, such as: 1) delineating local/regional/national problems, 2) establishing research priorities, and 3) linking with other agencies—Federal, State, and local—are as relevant to ESS (and now ERS) as they are to AR.

In August 1979, ESCS convened a national committee of department chairmen and researchers to develop recommendations focusing on the agency's problems. The meeting resulted in two major findings (ESCS, 1979). The first was that there is no systematic process to coordinate efforts to identify important problems in agricultural economics on which future research should focus. It was recognized that there are many research planning efforts that have been and are being conducted. However, the classification used does not break out economics problems per se and, consequently, it is impossible to compare planned research with research needs for economics as a whole.

The second finding by this group was that there is considerable misunderstanding about similarities and differences in the role of ESS and the departments of agricultural economics in the land-grant universities. More important, perhaps, it was the view of some that this lack of understanding was a barrier to improving the linkages between ESS and universities. At the conference, several stereotypical descriptions indicated the perceptions of the group:

- ESS works on national problems, and universities work on local and regional problems;
- universities work on microproblems and ESS on macroproblems;
- universities should conduct basic and methodological research, and ESS should conduct applied research; and
- ESS serves national policy maker clientele, and universities serve farmers and State policy makers.

Apparently, there is a need to clarify roles and dispel misconceptions, so that it will be less difficult to identify areas of mutual interest where cooperative research stands a better chance of success. The findings in chapter V regarding USDA and SAES are appropriate here.

Three additional areas are worth noting in this discussion. In 1980 when the Farmer Cooperative Service was transferred out of ESCS, the economics unit of ESS was tentatively assigned the function of review and analysis of the Capper-Volsted Act for undue price enhancement by farmer cooperatives. Enforcement or investigation is incompatible with ESS economics research activities which rely on voluntary cooperation of clientele. ESS is not equipped to handle this function. It would seem more reasonable to locate this activity in a regulatory agency, such as AMS, not in an economics research agency.

ESS has as its primary objective the collection and analysis of economic data as an input into decisions by policy makers, producers, agribusiness, and consumers. Before 1976, ERS and SRS were separate agencies reporting to the Director of Agricultural Economics, Concern existed in early 1981—particularly in the statistical unit—that its combination with the economics unit had: a) caused confusion for the public between information reported by the statistical unit and the projections or forecasts of the economics unit, b) drained away vital financial and personnel resources to the Office of Administrator, and c) created in the Office of Administrator unproductive bureaucratic procedures and paperwork.

During the long existence of BAE and since 1961, agricultural economics research has been a separate component in USDA. One result of this type of organization has been some isolation from the rest of the agricultural research community. The discovery of new knowledge does not come as easily or in such small disciplinary packages as it once did, Modern agricultural research tends to be mission oriented and multidisciplinary—involving the commitment of large expenditures over time.

In ESS, there is some communication between economists and a few other social scientists, but very little cooperative work between ESS and AR. In fact, with the exception of some ad hoc groups that meet sporadically, there is no coordinating mechanism for planning and conducting multidisciplinary research between ESS and AR. Closer coordination and collaboration of research in the National Economics and the Natural Resource Economics Divisions with AR research is warranted.

principal Findings

. Through early 1981, the Director of SEA, with two responsibilities, did not give adequate attention to policy and coordinating functions. Operational details of SEA interfered with effective management at the individual agency administrator's level.

- NPS staff have insufficient authority and responsibility for providing effective leadership to regional and national research programs. A change in responsibility would be conducive to improved staff capability.

- Rationale for establishing AR regions along the same boundaries as SAES regions is managerial and has been beneficial for this purpose; however, they do not conform to types of farming or to regional or national research problems, and as AR is organized, are detrimental to the development of broad regional and national programs.

- There is little evidence of the need for the area director positions in AR.

- CR conducts Hatch-supported project reviews that are less than in-depth examinations. As a part of the process, onsite reviews are held every 3 to 5 years but with no required followup, except as would be done locally,

- CR lacks authority in dealing with the States, CR operates as though it were under the supervision of SAES directors rather than the Administrator of SEA.

- CR administers the competitive grants program. Its major clientele, SAES, compete for these grants; there is criticism of this arrangement.

- HN has not accomplished the intent of the Food and Agriculture Act of 1977 with respect to human nutrition research. SEA has established human nutrition research as a mission, but it has not established human nutrition as a separate budget item, nor has it properly funded and staffed the six research institutes to conduct meaningful research,

- Through early 1981, in ESS, concern existed that the combination of the statistical unit with the economics unit had caused confusion for the public between the statistical unit's information and the projections and forecasts of the economics research unit. A small proportion of the economics research budget is allocated to research, and there is very little cooperative effort with AR.

SAES MANAGEMENT AND POLICY PROGRAMS

It is not the purpose or the intent of this section to evaluate the management of the various SAES. Rather, it is to provide general information on how the SAES are organized and managed and on some of the changes that relate to their operation.

Structure of SAES

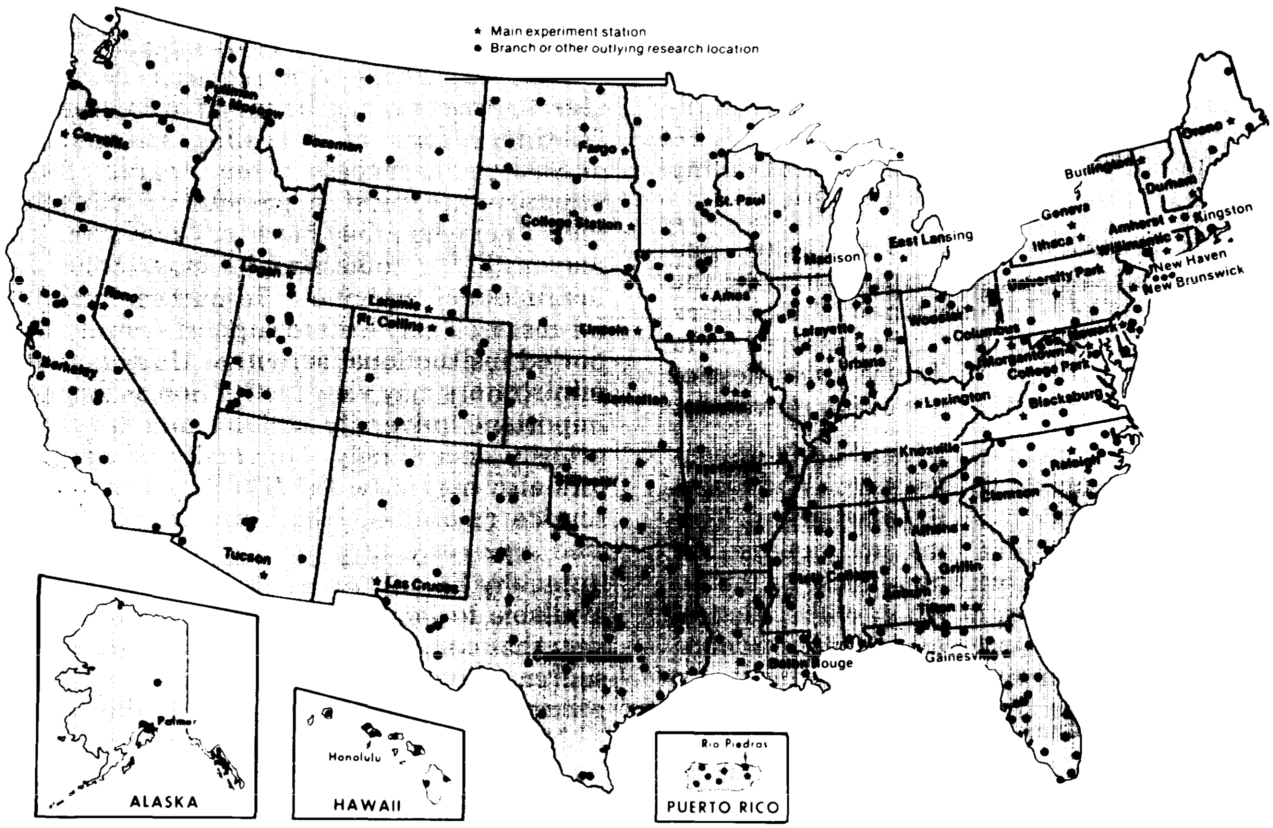
Over the years, neither the structure nor the names of the SAES have changed much, As reported earlier in this assessment, the movement to establish experiment stations in the United States drew its first inspiration from European experience. Samuel W. Johnson, one of America's foremost pioneers in the movement, went to the village of Moeckern on the outskirts of Leipzig, Germany, in February 1854, where he visited a new institution which its founders called an "agricultural experiment station." This station, Johnson learned, was the Saxon answer to the search for methods of applying science to agriculture. When the movement later gained momentum in the United States, the name experiment station stuck, and with only three exceptions–Ohio, North Carolina, and Washington—they are still called experiment stations.

The name "station" evokes for many persons a bucolic vision of scientists surrounded by experimental fields, orchards, barns, flocks, and herds. In most States, however, the scientists work in buildings on the land-grant university campus, and the experimental fields are some distance away.

SAES typically include a central station and headquarters at one location and a number of branch stations or other outlying units located strategically around the State (fig. 24). Stations are organized by departments according to the various scientific disciplines represented on the station staff—e.g., departments of animal science, entomology, agricultural economics, plant pathology, etc. The chief administrative officer of each department is usually referred to as "chairman" or "department head." This officer reports either to the director of the station or to the associate director, as in most States.

In the early days, the SAES director reported directly to the president of the university. Likewise, he defended his budget before the State legislature. The SAES was a substantial part of the college or university, and the director was a "big man on campus." Today, except in a few States, the station director reports to the dean of the college of agriculture. These deans are actually administrative officers with overall responsibility for

Figure 24.—State Agriculture Experiment Station System



SOURCE: U.S. Department of Agriculture.

research, teaching, and extension. Thus, the SAES director moved a notch lower in the administrative structure, These changes were made for the purpose of enhancing coordination and cooperation.

Although research programs of the SAES are managed in a collegial fashion to optimize individual initiative, the director has legal responsibility for funds and programs. The director, associate director, assistant directors, and the department heads often form an administrative council that oversees SAES operations.

As a statewide function, the SAES in most States is funded as a part of the general university budget, but separate from the general instructional fund. In a few States, the SAES budget is separate from the university budget. SAES receive supplemental funds from Federal sources.

Beginning in the **1950's,** as sources of non-State funding became available from agencies other than USDA, grants were not necessarily oriented toward the State program but toward the particular interest of the individual scientists. In spite of what station directors claimed, they were becoming less influential in terms of developing and leading their own programs (Lovvorn, 1980).

Thus, the status of SAES has risen, plateaued, and to a degree subsided during the first **100** years of their existence. Their contributions to society, however, has assured them an important role in the future, regardless of the organizational structure of the university.

Most faculty members of land-grant university departments do both research and teaching; some are also involved in extension. Theoretically, these functions are compatible. Teaching requires keeping abreast of the literature and keeping in touch with practical problems through interaction with students. Research requires keeping up with the literature in one's specific field and keeps one intellectually stimulated. Extension keeps one close to the problems. Some faculty members are incapable of performing all three functions, so administrators usually assign individuals to functions they do best—be it full-time teaching, full-time research, full-time extension, or, as in most instances, joint teaching and research.

The central station of all but a few SAES is on the campus of the State's land-grant university. The scientists of the SAES are members of the faculty of the university. The SAES gains from that association because it provides access to many Ph.D. scientists, specializing in different disciplines, whose services and counsel are easily available. It also provides access to university facilities such as libraries, computers, machine and electronic shops, analytical laboratories, and other specialized units.

SAES research programs also benefit greatly by the expansion of their options for employing scientific talents made possible through the graduate education programs at the M. S., Ph. D., and post-Ph.D. levels.

There are also some disadvantages. Teaching may interfere with research. Some research programs may be so important that the full-time efforts of a leading scientist are critical to the success of the program. Some scientists are most successful in managing their time when they have only one principal responsibility; some may be most suited for instructional activities. Resources intended for research may drift to support scantily supported instructional activities. University administrators may view instruction as the most important university activity and may give priority accordingly. University administrators also may view the SAES and extension service resources, which are usually budgeted separately, as providing more resources to faculty in colleges of agriculture than are available to faculty elsewhere in the university; that could have an adverse effect on resource allocation to the agricultural programs. SAES land that is close to the offices and laboratories of the station may be needed for instructional or recreational facilities for students (Huston, 1981).

The departments are the principal operational units of SAES and provide day-to-day research management. They usually have responsibility for undergraduate and graduate instruction and related scholarly research funded through the university instructional budget, for research of the SAES, for extension activities of the Cooperative Extension Service, and for modest international agricultural activities. Thus, the departments have much broader responsibilities and greater resources than are characteristic of other university departments. In those departments where education is a sizable activity, temporary contractions and expansions may occur in certain SAES research activities. Extension activities may also be affected during part of the year.

While the above describes the general organization and management characteristics of SAES, there obviously are differences among them. The relationship of the director to the dean or vice president for agriculture is an important one. The larger universities have more departments than the smaller ones. Some give more responsibilities to the departments than others, Some seek and use grant funding to a greater degree than others. All of these and other factors are important in determining the degree of authority the director of SAES has in carrying out State agricultural research programs and in cooperating with other research agencies.

Changing Role of SAES

Although the SAES retain their traditional focus in serving farmers and the agricultural sector of their States, their roles are changing. Some of the factors causing these changes include the following:

- Society's needs for the skills normally found in the SAES—and USDA—increasingly exceed the needs of farmers and the agricultural sector. Examples include chemistry and metabolism of pesticides and the use of soil descriptions in planning land use and in construction.
- Many new staff members have no background in agriculture. They see more opportunity for recognition and rewards in research that is not closely allied to needs of farmers.
- Limitations in funds available to the SAES from Hatch and State sources lead faculty to seek grants that may be available for nonagricultural topics. Because of this outside funding, SAES directors have lost some of their control over such programs.

Some of the States with limited resources or with a small agricultural industry—i.e., certain Northeastern, Wester, and Northern plains States—are finding it very difficult to adequately fund State agricultural universities and SAES that try to be all things to all people. There has been some discussion on the desirability of certain States that have similar agricultural problems in dividing the workload or concentrating on specific problems-–i.e., centers of emphasis–so that each State concentrates on certain problems and leaves the rest to other States. While from a scientific, technical, and resource standpoint this would seem feasible and desirable, sometimes it is not appreciated by specific vested interests in the States. Such an arrangement could allow each such State to develop centers of emphasis on specific problems, rather than to be spread so thin as to have programs of questionable value.

SAES-USDA Interactions

In many areas of research in crops, soils, etc., there have long been very closely knit cooperative relationships between the SAES and AR. About 500 USDA scientists are stationed in SAES buildings. A reverse exchange exists in that 100 or so SAES scientists are housed in USDA facilities (Huston, 1981). There also are a number of special purpose AR research units on university campuses, some housed in university buildings and others in AR buildings built on land donated through the SAES by the State. AR scientists hold courtesy ranks in the university departments and are free to participate in departmental and SAES activities.

SAES programs are built around full use of the resources of these scientists, and vice versa as far as AR regional and national research is concerned. If efforts by AR scientists or units can effectively serve user needs in that field of specialization, no State-supported scientists will be employed. If, however, the manpower commitment by AR is inadequate for State needs, additional State scientists will be employed. Even when AR units are remote from the central station, State programs are developed around those efforts. This joint endeavor permits SAES to meet user needs more fully by adding to the diversity of scientists available and by broadening the range of problems SAES can address. The same logic and planning by AR technical leaders assist AR in focusing their resources on regional and national problems.

Only a few ERS scientists are housed at SAES. Most ERS work in SAES is done by SAES economists on a cooperative agreement, contract, or grant. While the relationship between ERS and many agricultural economics departments has been close, that with the SAES administration has been distant.

This close working relationship among scientists of SAES and AR, as mentioned elsewhere in this report, has been one of the major strong points of the U.S. agricultural research system, It has resulted, generally, in high respect for each other at the scientist level. The major difficulty in the U.S. agricultural research system between USDA and the SAES is at the administrative level. This includes directors of SAES and sometimes heads of departments and administrators in USDA.

The root cause of nearly all the difficulties, centers around budgets. SAES fights for increased Federal funds for their research activities and USDA fights for additional funds for their in-house research. The budget problem distorts and tends to create problems in the stated roles of the two groups and in cooperation at the administrative level to such a point that, unfortunately, it sometimes permeates the whole system. The problem has always existed, but appears to be much more intense now, in times of stringent budgets for research, than in the past.

What appears to be at stake is whether the United States will be able to maintain a national research effort. As Castle stated in 1980: "The question should be faced squarely as to whether the historic partnership between the USDA and the land-grant universities remains viable. " Castle goes on to say that "the planning framework advanced by the joint council has not only brought Federal-State conflicts to the surface but has also intensified internal land-grant tensions, and these tensions are now being reflected at regional and national levels. "

In his Cosmos Club lecture of April 1980, Dr. John W. Gardner addressed the subject of "The War of the Parts Against the Whole." Dr. Gardner notes the continued development of various "groups" that have expanded in number and diversity following World War II—and in their capacity to organize for combat. The following comments from his paper are of special interest.

> In most of these groups the element of cohesion is supplied by a common economic activity or interest, But others seek redress of grievances that they have suffered at the hands of society. And then there are the "issue" groups, members of which may come from diverse social, economic, or occupational backgrounds, but have in common a shared concern for advancement of a particular public policy.
>
> I want to emphasize that most of the groups have legitimate concerns: some of them have concerns that are, by any standards, urgent. But as more and more of them learn how to organize for effective action, and how to slug it out on the adversary mode, what started as healthy competition has developed destructive aspects. If we can't face that fact, we're lost.
>
> The war of the parts against the whole is a central problem of pluralism today. We're

moving toward a society so intricately organized that the working of the whole system may be halted if one part stops functioning. Thus our capacity to frustrate one another through non-cooperation has increased dramatically. A part can hold the whole system up for ransom as the air traffic controllers, among others, have so vividly demonstrated.

All of this is ironic when one recognizes that never have so many of these groups been so highly organized and effective in action. They know how to lobby. They know how to "use" the media. They establish "beach heads" in government agencies, sometimes even force reorganization of an agency to suit their purposes. And they effect public policy.

It is entirely legitimate for such groups to organize themselves. It is their constitutional right to seek to influence government, and often what they want is not unreasonable. But what can we do when the factional strife becomes more than the system can bear?

All too rarely have any of the organized groups shown the slightest concern for the health of the political process. All too often they have been satisfied with incompetent, disorganized, or even corrupt government, provided that they could influence it.

Our pluralistic philosophy invites each organization, institution, or special group to develop and enhance its own potentialities. But the price of that treasured autonomy and self-preoccupation is that each institution concern itself also with the common good. That is not idealism: it is self-preservation. The argument is not moralistic. If the larger system fails, the subsystems fail. That should not be such a difficult concept for the contending groups to understand (Gardner, 1980).

It would be unfair and unrealistic to suggest that the competition between USDA and SAES is the only factor that has been deleterious to the operation of the national agricultural research system in recent years. But there is need for a serious self-assessment of the current organizations, operations, and policies of USDA and the SAES with respect to their basic charters and to relationships in programs of mutual concern (Moseman, et al., 1981).

Principal Findings

. The SAES research budget from other than grant resources has tightened and an overall dean or vice president of research coordinates research at most land-grant universities. This, in part, has diminished the stature and authority of the directors of SAES in directing State agricultural programs.

• At the scientist level, the SAES and USDA scientists enjoy good working relations and generally excellent cooperation, all to the benefit of the system, the States, and the Nation.

• At the administrative level of SAES and USDA, there is competition over funds and position.

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Chapter VII

Determining Research Priorities

Contents

Chapter VII

Determining Research Priorities

To establish research priorities, goals must be set. It is ironic that the United States has never had a well-articulated set of food and agricultural goals. Without such goals, the process of research priority determination is difficult.

Three kinds of priorities are evident in the U.S. food and agricultural research system. At the highest level is the determination by the Federal Government that it shall spend funds for a research program. This is a broad commitment that has its roots in Federal legislation enacted more than a century ago. The principle continues to be valid and viable.

Priorities at the second level involve broad commitments to specific national needs. They are relevant to problems that affect, directly or indirectly, large segments of the population—such as economic/environmental tradeoffs in river basin studies. The nature of priorities at this level determines what particular agencies shall address them. Their assessment and budgeting become the responsibility of top management.

Priorities at the third level are more specific and may deal with microaspects of broader national programs. Here, individual scientists or middle-management personnel actively participate in recommending action programs and in deciding the degree of funding required. Many of the priority decisions at this level are often influenced by external factors, not the least of which could be the needs of producers and consumers.

Anyone studying priority setting in the U.S. food and agricultural research system will discover a dichotomy of the professed procedures and actual practice. The fact that differences exist between the theory and reality of decisionmaking has no direct implications on the quality of the decisions that are made.

This chapter discusses the need for establishing agricultural policies and goals in order to determine priorities, then follows with: 1) priority setting as the agencies perceive their operations, 2) a review of the factors affecting research decisions and the ways in which they may alter outcome, 3) the roles of the Joint Council on Food and Agricultural Science (JC) and the National Agricultural Research and Extension Users Advisory Board (UAB) as they affect priority setting, and 4) discussion of new procedures that could enable the research system to improve its priority-setting judgments.

NEED FOR FOOD AND AGRICULTURAL GOALS

The food and agricultural research community is often criticized for not providing or developing a national plan for food and agricultural research.[1] Even though the Food and Agriculture Act of 1977 authorizes the establishment of the JC and UAB to assist in planning, criticism continues, Some may be justified; however, for effective long-term agricultural research plans to be developed and maintained, there is need for clear-cut food and agricultural goals.

A goal is defined as the end toward which effort is directed. The end must be definable and, at least in theory, achievable. Some people assume that the goal of U.S. agriculture is to provide an ample supply of nutritious food for the consumer at reasonable cost with a fair return to the farmer within an agricultural system that is sustainable in perpetuity.

‘Most recently this point was made by the General Accounting Office (GAO) in a report entitled “Long-Range Planning Can Improve the Efficiency of Agriculture Research and Development, ” 1981.

However, this "goal" is open-ended and, therefore, not achievable. For example, what is meant by an "ample supply?" Does it mean: a) produce to meet U.S. demands? b) produce to meet U.S. demands plus economic demands of the world market? or c) produce to meet U.S. and world market demand plus concessional food to poor countries? How would we know when an "ample supply" is achieved? What is "nutritious" food? How is it defined? Is a "reasonable cost" to consumers 15, 20, or 30 percent of disposable income or some other figure? Is a "fair return to the farmer" 10, 15, or 20 percent on investment? And when would this "fair return" be achieved . . . 1995, 2000, 2500? Is a sustainable system one that tolerates 5, 10, or 15 tons an acre of erosion annually?

These and other questions must be answered for a goal to have meaning and to be useful for the research community in planning a research agenda. With such questions unanswered, setting research priorities is a futile task.

In the past, Congress has set well-defined, achievable goals. Congress set a goal of putting a man on the Moon by a certain date; the goal was met. Congress has set goals for the level of gasoline consumption for different sizes of cars by certain dates. It should be possible for Congress to set well-defined, achievable goals for U.S. agriculture as well.

PRIORITY SETTNG IN USDA[2]

Science and Education Administration (SEA)

Information used in developing priorities is drawn from consumers, producers, in-house scientists, scientific societies, JC and UAB, action and regulatory agencies, cooperators, policy-level people in the executive branch, and Congress. This information is reviewed and summarized by staff and presented to SEA managers who, in close consultation with university cooperators, set the priorities that guide the upcoming planning year.

In Agricultural Research (AR), staff scientists on the national program staff (NPS) are responsible for interacting with administrators and scientists in the regions to maintain up-to-date programs and priorities and to ensure progress toward national priorities and objectives. Regional administrators in each of the four AR regions are responsible for seeing that research conducted within a region meets the national goals and priorities.

In Cooperative Research (CR), the administrator participates in meetings of State agricultural experiment station (SAES) directors' associations for the four regions and concurs in areas of research to be implemented. CR staff are active in regional technical committees that plan and conduct regional research projects.

In Human Nutrition (HN), research is carried out in six research centers.

SEA budgets are designed to reflect priorities. Budget requests are modified at various points, the changes being based on priorities as viewed by the decisionmakers involved and the fiscal constraints. Resources are then allocated to the SEA units in accordance with these documented plans, and usually on a program-by-program basis.

AR uses several mechanisms to assure that resources go to the priority problems: continuing review of annual program evaluation, and annual project reviews.

Regional priorities result from recommendations by JC, research planning committees, and their indications of need from research users and input from SAES directors, AR re-

[2]This information was provided by USDA in response to letters of inquiry from OTA.

gional administrators, and private industry representatives.

Many traditional agricultural groups have developed a way to interact with the U.S. Department of Agriculture (USDA) in discussing their priority research needs (i. e., Cotton Council, NASCD, etc.), but most nontraditional agricultural groups have not. There is a need for better and more positive methods of assuring that all interested groups have an opportunity to be involved in discussions concerning food and agricultural research priorities. With AR research being responsible primarily for broad regional and national issues, it is important that the interaction be with national and regional leaders of the interested organizations. AR could designate some staff to be responsible for developing procedures to assure that all interested organizations have an opportunity to express their views and concerns with respect to agricultural research priorities.

Economic Research Service (ERS)

ERS evaluates its programs in accordance with feedback from user groups and other information on current and future priorities, such as topics highlighted in the public media and personal communication with persons in Government and the private sector.

Each year, ERS conducts three or four workshops in different regions of the country with representatives of farm and commodity organizations to discuss their need for data as well as situation and outlook information on commodities.

ERS has met with UAB to review its work programs in relation to agriculture and farm markets. In addition, the agency meets with JC to obtain their reactions about research and data needs. ERS interacts regularly with the Federal agencies, State universities, professional associations, and State and local governments.

ERS provides flexibility for scientists to work on problems and issues which they see as important to decisionmakers. All work is subject to review to assure consistency with agency plans.

PRIORITY SETTING IN SAES[3]

In virtually all activities, including priority setting, SAES operate in a different manner than their USDA counterparts. Planning, priority setting, budgeting, and program development are functions of line administrators and scientists active in research. They are not functions assigned to special staff scientists, as some are in USDA agencies.

The goal of priority setting in the States is to aid in allocating scarce resources to develop and maintain an effective and responsive SAES program. Steps in priority setting are to: a) identify the research investigations and programs of greatest need and value to the State, b) examine the scientific and practical feasibility of those investigations relative to the resources available or required, and c) set priorities according to the needs and feasibility of the research investigations and programs.

There are various levels of priority setting at the SAES beginning with that of the scientist and continuing through the department (such as the animal science department), the department head or chairman, the experiment station as a whole, and the university itself,

Role of Scientists

At the scientist level, the process begins with an examination of user needs that relate

[3]The information presented in this section draws heavily on the report entitled "Priority Setting Processes in the State Agricultural Experiment Stations" prepared by Keith Huston for OTA.

to the scientist's discipline. Needs that can be met by existing knowledge or can be handled elsewhere are eliminated. The remainder are translated into approaches that might be used in meeting those needs, An examination of current pertinent knowledge and scientific feasibility of the approach is made, and the time and kind and amount of resources required is estimated. In addition, the importance of user needs is compared with those being addressed. And finally, colleagues and the department head may be consulted about the issues and approaches.

In arriving at priorities, a scientist makes many complex judgments. Scientific feasibility of a given priority setting is based on perceptions of the present state of knowledge relative to the issues and number, kind, and sequence of discoveries that need to be made, and the probability of making them, Scientific feasibility requires judgments about hypothetical discoveries; it makes heavy demands on intuition. And even the most gifted scientist has no assurance that his intuition will prove accurate,

Role of Department

Priority setting by a station department introduces additional considerations not found in the processes of individual scientists. Insofar as resource allocation is concerned, the central theme of priority setting within a department takes on a broader, more complex dimension. The predictable outcome is that one scientist will be allocated more resources than another.

In setting departmental research priorities, the involvement of individual scientists takes on a variety of patterns. In some departments, all scientists are involved; they reach a consensus about priorities and that consensus is subject to only moderate alteration by the department chairman. Matters discussed by the group include station or legislative mandates, restrictions based on resources or by grantors, research needed for instructional curriculum, differences in kinds and amounts of resources needed and available for each project, and the possibilities of change in current investigations.

Another pattern is one in which final setting of priorities is done by the department chairman after a consensus emerges among the staff. This is one of the most common patterns, Another approach is one in which the department head discusses issues with individual scientists and then establishes the priorities. These priorities may be submitted to the faculty for comments or ratification. This approach is also one of the more common patterns.

Role of Department Head

An SAES department head bears a singular role in setting departmental priorities, A prime responsibility is ensuring that the departmental research program responds to user needs. The intellectual efforts of the scientists are the department's principal resources. To meet program needs, resources must often be manipulated by forming teams of scientists or transferring funds, equipment, animals, or lands.

The department head must also consider the research activities supported by other agencies, such as field stations of USDA, because these resources may contribute to meeting user needs in the State and thus permit alternate use of department resources. It is necessary to keep abreast of the research of private firms because quite often this research is closely related to the research program of the SAES. A department head must also consider research needs as well as perceived needs of other groups such as organic farmers and environmentalists.

Department heads do not specifically state the rationale they use in ultimately resolving issues. They likely base their decisions on the general characteristics of user needs. Whether or not these needs will be met depends on a number of factors, not the least of which is the extent of human and financial resources available to carry on a program.

Other Priority-Setting Factors

Within a department, several scientists may be tackling a scientific problem that requires the efforts of several different disciplines. Again, the two major priority forces—user needs and matching scientific resources—provide a basis for priority setting. Other State agencies often provide input, as do annual planning conferences where staffs of branch stations and the central staff discuss factors that may bear heavily on priority setting.

Role of SAES in Priority Setting

Most general concerns of department heads are mirrored by the SAES and its director on a much broader scale. Although the priority-setting processes follow the same general steps as outlined earlier, both the process and the issues are much more complex at the SAES level.

SAES's priorities must address not only direct user needs but also State needs. Generally, a State's needs deviate from direct user needs only in requiring a somewhat greater attention to certain issues such as environmental quality. Special needs emerge gradually in the State. They reflect the general temper of the people of the State and of the times. Consequently, State scientists can generally perceive these needs quite readily.

Prior to the 1960's, SAES generally allocated most of their research resources to increasing food supplies. In the past 20 years, however, food supplies have been abundant and cheap. Consequently, society's priorities have shifted, and SAES have moved their resources to other issues. But the pendulum once again is swinging back to the uncertainty about the abundance of relatively low cost food continuing in the next 20 years. Rate and growth of agricultural productivity have slowed. International food supplies are once again in question. Costs of energy are likely to increase. Sales of food reserves to foreign countries will possibly increase. Perceptions of such factors most certainly affect decisions of a SAES director in setting State priorities.

Although SAES follow the same general steps of others at the State level, the patterns may differ, The factors affecting such changes include attitudes of State legislatures and Congress; priorities of the university; shifts of resources because of changing programs and resource availability; university, State, and Federal budgeting patterns and restrictions; and the interrelationship of these factors.

Role of University in Priority Setting

In most States, the SAES is funded as a part of the general university budget. Priorities that depend solely on allocation of funds under complete control of the SAES usually can be accommodated without undue difficulty. But sometimes priorities established within the SAES compete with priorities at a higher level of the university heirarchy. Thus, funds for new programs, new buildings, and support are occasionally at stake. Generally, agricultural colleges, because they have faculty employed as research scientists in the SAES, enjoy greater opportunity and resources than other colleges.

PRIORITY SETTING IN THE PRIVATE SECTOR[4]

In the private sector, market need and characteristics of existing products determine to a large degree the kinds of research priorities selected.

There appears to be no direct role which the public sector or consumers play in determining research priorities in the private sector. The public sector, however, has a responsibility to be familiar with the private sector's research efforts in order to avoid duplication of effort and costly oversights.

[4] This section is based on responses from the private sector to inquiries by OTA.

The public sector has a role, frequently a negative one, in establishing research priorities for the private sector through regulatory agencies. The activities of such agencies tend to reduce the amount of basic research that the private sector might do that relates to its own interests. The net effect is to add to the costs of doing research without enhancing research productivity.

Private companies engaged in manufacturing the same kinds of products, or related products, often form associations to gain more impact in their dealings with both consumers and governmental bodies. One example is the Institute of Food Technologists, which deals with priority matters through a research committee made up of representatives from member companies. Both the public sector and consumers provide important input to the work of this committee.

In addition, the private sector helps determine priorities by lending equipment to SAES providing grants, and serving on advisory committees.

The National Food Processors Association, in commenting on the issue of priority determination, issued the following statement (OTA letter of inquiry, 1980):

> The agricultural scientific community was once described as a "vast isolated island. " The recognition of new environmental and consumer issues should have enlarged the support base of this isolated island as new problems arose. Unfortunately support has been reduced,
>
> It now appears that not only has the public sector of agricultural research not been able to respond to these new issues, but that EPA [Environmental Protection Agency] grants are used to supplement the decreased public sector research funds, This means that EPA sets the priorities and can even withdraw support if meaningful research does not meet their intended goals. Scientists in support of food and agriculture should not be faced with this [condition],

FORCES AFFECTING RESEARCH DECISIONS[5]

A variety of external forces can exert influence on both the manner in which research priorities are made and the outcome of the research activity itself. Thus, research priorities may be established much differently from that described in the previous section. Some of these forces can be national in scope; others may concern only individual scientists in their decisionmaking process. A prime example of the former is the 1970 Southern corn leaf blight which reduced U.S. corn production 16 percent. Another example was the combination of unfavorable weather and purchasing strategies of certain foreign countries that led to low grain stocks and high prices from 1973 through 1975. These two events resulted in several assessments of the world food situation and the ability to feed an ever-increasing population. To cope with the new situation and its attendant problems, research priorities had to be adapted—some of them quickly and drastically.

Industrialization of Agriculture

Industrialization of agriculture affects the distribution of benefits from public research that supports or facilitates technological change. The first beneficiaries are the suppliers who sell new technology to producers. The second beneficiaries are the first adopters. These are frequently farmers who are more aggressive and have ready access to capital and information. Farmers who do not or cannot adopt new technology find themselves squeezed by the effect of lower prices. The ultimate beneficiaries are consumers. But even their benefits can be delayed by intervening processing and marketing factors.

[5]The material in this section draws heavily on the OTA resource paper, "Forces Affecting Food and Agricultural Research Decisions," prepared by Ron Knutson, Don Paarlberg, and Alex McCalla.

Trends toward industrialization of agriculture lend credibility to arguments expressing concern about close ties between large farms, large agribusiness firms, and the research establishment (Paarlberg, 1981). Reality suggests that:

1. Large farms have more influence than small farms on research and education programs in the land-grant system and USDA.
2. Development of technology has more frequently followed the demands and needs of the larger and more mechanized farms than those of small and less organized farming interests.
3. The private sector—i. e., farm input suppliers, etc.—benefit from public research.
4. Food processors, marketing firms, and retailers benefit from post-harvest research, and some have sufficient market influence to delay the benefits of research in reaching the public.

One of the important implications of the above situation is that research administrators and scientists should be aware of the need for public-interest objectivity in making research decisions.

New Issues

In addition to food shortages and the continuing process of industrialization, the 1970's were confronted with a host of new issues that will surely continue into the 1980's. Demands developed for more generous food programs, organization rights for farm labor, lower food prices, increased food safety, increased environmental protection, sharing water rights, equal rights for agricultural minorities, and improved nutrition.

These new issues are being funded at the expense of traditional agricultural interests. Concern exists within the agricultural research establishment that all areas will be increasingly underfunded as the research base continues to expand, unless new funds are made available.

Concern exists also that, without major scientific breakthroughs in agriculture's capacity to produce, the world may be unable to satisfy future food needs. It was only natural, therefore, that these concerns created a call for more research.

The Food and Agriculture Act of 1977 was responsive to the perceived need for more research. The act explicitly provided for creation of competitive research grants, using a system of peer review that was foreign to the traditional USDA research system where funds were allocated on a formula basis. The competitive grants program was opened up to proposals from scientists outside the agricultural research establishment.

The 1977 act also created the JC to oversee, advise, coordinate, and set research priorities. This structure was designed to replace the previous research policy committee referred to as ARPAC (Agricultural Research Policy Advisory Committee).

This combination of events has created considerable tension within the agricultural research establishment. Charges are made of attempts by special Federal interests to control agricultural research at both Federal and State levels. To an important extent, the problem is as much one of strategy to get the needed level and mix of support as it is of directing research to priority areas. One cannot disregard the fact that the two are interrelated.

Realities of Research Planning

The need for planning and coordinating the food and agricultural research system is obvious, Planning must be done to determine the size of the budget to carry out the research mission. Planning must be done to clarify where specific areas of research responsibility lie, to communicate what is being done, and to determine what needs exist. The question, therefore, is not whether planning is needed but: a) who should do what type of planning, b) how the results of planning should be translated into budget, and c) how planning and budget should be translated into research.

Planning within the food and agricultural research system has not come naturally. This fact has meant that research planning initiatives have tended to be mandated by Congress itself. The first such mandate was the Research and Marketing Act of 1946 which set up joint planning for regional research. The latest mandates were the creation of the JC and UAB. (These two groups are discussed fully in a later section of this chapter.)

It is important to ask why Congress in 1977 felt a need to enact these mandates. A number of reasons can be suggested:

1. Congress had no confidence in the recommendations it was getting on appropriations. The President's budget recommendations were suspected of being manipulated by the agencies, the Secretary, and the Office of Management and Budget. The recommendations of ARPAC were suspected of being the vested interests of the performers.
2. Because of an increasingly tight world food situation, it appeared that increased funding was going to be required. Congress desired to make sure that new money was spent in areas that had the potential for greatest payoff—the so-called high-priority research areas.
3. Concern existed that the food and agricultural research system was not adjusting its research program to evolving clientele needs.
4. The complexity of the research situation led to the conclusion that it was out of control, duplicating research, and unaccountable. Hearings tended to fortify rather than refute this conclusion.
5. Experience with earmarking funds for specific research had not always worked. The impression existed that projects were simply being renamed and the research program did not change.

Each of these reasons was at least partially true (Knutson, et al., 1980). Restoring confidence in the system will require a recognition of this fact. It will also require that the food and agricultural research establishment become organized in a manner whereby it can have a more decisive impact on and control over legislation enacted in its behalf,

Research Decisions of Scientists

Despite the existence of elaborate administrative structures in both USDA and the universities, the major decisions on what research is to be undertaken are made by research scientists. They develop project proposals, give reasons for the required level of support, and then, within the limits of the available budget, decide what specific research is to be undertaken.

Because of the increased complexity of research projects, research administrators are in a poor position to evaluate the relative merits of particular projects. Yet, they play a very important role in coordination, organization, and policy for research. However, the further removed the administrator is from the project—i.e., the higher the level of administrative bureaucracy—the greater the potential for being wrong on the relative merits of particular projects. Thus, the greatest potential for administrators influencing research decisions is through hiring staff and resource allocation to broad areas of research.

Motives influencing the research decisions of scientists may be grouped under four general headings: intellectual curiosity, availability of funds, responsiveness to clientele, and personal gain (Knutson, et al., 1980).

Intellectual curiosity is research motivation in its pure form. It is the motive that led Gregor Mendel to discover the principles of heredity and caused Darwin to persist in his studies until he formulated the theory of evolution. It is part of the motivation of every researcher worthy of the name. Administrative interruption of this process of discovering new knowledge can be costly. Likewise, a scientist is likely to be more productive working on a problem in which he or she has a direct interest.

Availability of funds can make the difference between meager research results and findings worthy of being converted to useful technology. Both new people and new money are needed to give research priorities a reasonable opportunity for success. If additional funds are allocated to a new high-priority project but additional people are not appointed, these new funds probably will be spread over ongoing projects.

A substitution of grant funds for formula funds does not necessarily solve this problem because in the face of reduced formula funding, grant money will likewise tend to be used to support ongoing research projects, while formula funds are shifted to areas where grants are unavailable. The lesson here is that the most effective means of initiating change is through increased incremental funding. Competitive grants, in addition to providing scientists an added base of financial support, often give them freedom to pursue their chosen field of research.

Responsiveness to clientele is not readily quantifiable. It cannot be denied, however, that there is far less responsiveness to sectors of agriculture that are poorly organized—part-time farmers, small farms, hired labor, and minority groups. Recent concern about social structure reflects the belief that a tax-supported research system owes the public more than to respond primarily to those clientele groups that are most affluent, most persuasive, and best organized.

A growing force in setting priorities—both in research and action programs—is the influence wielded by certain organizations and societies made up of users and consumers who have a vested interest in Government plans and programs that they believe oppose their own plans, ideals, or philosophy about the environment or the welfare of society. One of the prime concerns of such groups is wise husbandry of natural resources for use in perpetuity. A typical example is the possible environmental damage incurred by the continued damming of rivers to provide more water for agricultural irrigation, recreational use, or urban water supplies. They are also interested in the exploration of ways to help the food and agricultural system become less concentrated, less reliant on fossil fuel energy, less capital intensive, and less dependent on chemicals. These organizations—such as the Audubon Society and the Sierra Club—will undoubtedly continue to exert pressure on legislators to achieve their goals. Hence, they must be regarded as viable forces in the priority-setting process.

Personal gain—such as promotions, salary, and peer recognition—is an important motivator for scientists. Actually, this can be an excellent means to an end—that is, the discovery of new knowledge. For some researchers, however, personal gain is an end in itself.

Differences exist among universities and USDA agencies as to their ability to reward top-quality scientists. Also, substantial resource differences exist among universities for attracting scientific talent. These differences result from a combination of factors such as a State's population, income, resource base, and tax structure. They also result from the Federal system of allocating research dollars. For example, increased emphasis on competitive grants allocated strictly on the basis of proposal and scientific qualities will further concentrate research in those universities that have had the research dollars needed to attract top-quality basic scientists.

Despite its complexity, the U.S. food and agricultural research system operating in a relatively free-market agricultural setting has an enviable record of success. This success has been accomplished in a decentralized research setting where scientists in proximity to their agricultural clientele make the critical decisions on what research is to be done.

As both fear of and evidence of an increasingly tight world food supply-demand balance increase, as pressures to cut Federal spending mount, and as the size and complexity of the food and agricultural research establishment grow, Congress and State legislatures have become increasingly concerned about the performance of the food and agricultural research system. Incentives exist for increased planning, increased accountability, and greater control over what research is to be done.

ROLE OF THE JOINT COUNCIL ON FOOD AND AGRICULTURAL SCIENCE

The Food and Agriculture Act of 1977, gave the Secretary of Agriculture authority to appoint a Joint Council on Food and Agricultural Science. The JC was to include the traditional teaching, research, and extension partners as well as representatives from other public and private institutions. Primary responsibility of JC is to foster coordination of research, extension, and teaching activities of the Federal Government, the States, colleges and universities, and other public and private institutions involved in the food and agricultural sciences. The JC took over the functions of ARPAC.

The responsibilities of the JC as specified in the legislation suggest the formation of a central planning agency for research, extension, and teaching. The responsibilities include evaluation of program impacts, identification of high-priority research, developing memoranda of understanding among the participants, establishing priorities, recommending responsibility for research, and summarizing achievements. The Secretary is to use JC recommendations, as well as other input, in submitting to Congress a 5-year projection of national research priorities.

In a sense, all JC activities lead to priority setting. Recommended priorities form the basis for JC's annual report. The JC has released two reports on research planning and a planning report by the National Planning Committee. These reports basically summarize trends that affect food needs in the future and identify a long list of research priority areas. The reports do not establish objectives, rank priorities or develop implementing programs. Without these, JC reports will have only minimal impact on agricultural research planning (GAO, 1981).

JC's planning and coordination structure has evolved over a 3-year period. Considerable debate attended these efforts to broaden participation in planning and coordination and create a representative new structure. In the structure finally adopted by the JC, each of the four regions has three committees, one for teaching, one for research, one for extension. The three fall under a regional council. That is, all four regional research committees operate under a national research committee.

The JC's struggle to develop a workable planning structure sometimes evoked images of overorganization or tenuous communication links. In contrast, ARPAC, a product of many years of development, sometimes seemed a better planning structure (Mahlstede, 1980).

The JC faced a problem ARPAC had not encountered. In attempting to make teaching, extension, and research equal partners in research planning, it sought a program structure common to the three functions. However, it found that each function had a unique structure, developed to suit its needs. When the JC identified an area for which coordination across the three functions should have high priority, these structures did not lend themselves to examination of existing interrelationships or establishment of new ones (Mahlstede, 1980).

There seems to be a perception—even among some who make up its membership—that the JC is not fulfilling its intended role. One of its problems, according to USDA, is lack of sufficient resources, particularly staff support. USDA's Economics and Statistics Service stated that the JC suffers from the dual role of supporter of the food and agricultural science system and evaluator of the system, The private sector is particularly critical of the JC, believing that too much effort is devoted to "lubricating the machinery" rather than identifying desired results and existing impediments to their achievement.

Within the administrative segments of the JC itself, some dissension has developed. For example, on July 31, 1980, the North Central Regional Experiment Station Directors Association voted unanimously to suspend participation in the JC planning process. Their concern was that USDA did not use State input in budgeting and the Association did not understand the role of the regional councils. They also disapproved of the membership and size of the JC national research planning committee, The Association recently resumed participation in the JC's activities.

JC's success has also been limited by a lack of clear direction by the whole Council to its role. Individual members define JC's coordination role in widely differing terms from "facilitating exchange of information" to acting "as an oversight council" and "setting research priorities. " Adding to this confusion, USDA takes the position that the JC's role is to supply input to USDA's long-range planning process and to accomplish much of the legislative planning responsibilities of the Secretary. JC members, however, believe their key role lies in fostering coordination and that their role in planning is that of an advisor to other actual planners (GAO, 1981).

There is also debate over the composition of JC. Through early 1981, the JC was composed of 24 members, which represented the following: 9 from USDA, 5 from land-grant colleges and SAES, 2 from UAB, 2 from private industry, 1 from Office of Science and Technology policy, and 5 from extension, nonland-grant universities and other interested parties. In the view of SAES, they are not adequately represented on the JC considering that they fund and conduct a significant amount of agricultural research (OTA letter of inquiry, 1981). There is a perception that because the JC is composed of a large number of USDA employees, it is dominated by USDA.

In relation to this concern is the fact that the JC must use USDA for staff support. The JC believes it would enhance its ability to be an independent advisory committee if it had its own staff (OTA letter of inquiry, 1980).

In evaluating its own performance, the JC believes it has made some progress in its area of responsibility. But it recognizes that certain responsibilities charged to it by Congress have not been fulfilled (OTA letter of inquiry, 1980).

It is not surprising that the JC has not, in its 3 years of existence, fully satisfied all of its objectives. In fact, the JC only recently was able to develop its 21-member committee on regional and national organizational structure. Serious questions exist as to whether the JC could ever effectively carry out the functions assigned to it. Even more serious questions exist as to whether, if it could carry out those assignments, the results would be desirable.

Castle, in a recent evaluation of the food and agricultural research planning system including ARPAC, put it this way:

> This (the present) system is a vast exercise in hypocrisy. All experienced administrators know that planning and coordination exercises are not worth much if control of budget and personnel resides elsewhere. If you believe as I and many others do, that decentralization has been and is a necessary characteristic of a productive system, the only thing worse than the present planning and coordination would be to give it control over budget and/or personnel. There are worse things than irrelevance; if the present planning and coordination really became relevant to budget and personnel the situation would be worse—much much worse (p. 16).

ROLE OF THE NATIONAL AGRICULTURAL RESEARCH AND EXTENSION USERS ADVISORY BOARD

The Food and Agriculture Act of 1977 also directed the Secretary of Agriculture to appoint a National Agricultural Research and Extension Users Advisory Board (UAB). Its primary purpose is to represent the divergent opinions of users and determine their needs and priorities. UAB's members come from the food and agricultural sectors of the economy; others are consumers. They are chosen for their potential to offer opinions independent of political considerations that might inhibit Federal employees or representatives of organizations. Among UAB's mandates are the following:

- review USDA's policies, plans, and goals for research and extension;
- examine relationships between private and public programs and assess the extent of research conducted by the private sector;
- recommend policies, priorities, and strategies for research and extension; and
- assess distribution of resources and allocation of funds for research and extension.

UAB is required to submit two reports annually. One is to the Secretary recommending allocation of responsibilities and funding levels among federally supported agricultural research and extension programs, including a review and assessment of the allocation of funds for research and extension by the organizations represented on the JC. The second is a report to the President and to the Senate and House agriculture and appropriations committees which reviews the President's proposed budget for food and agricultural sciences.

UAB has focused its efforts on primarily reviewing and advising the Secretary on national long-term research priorities, policies, and strategies. In preparing the above reports it develops research priorities in a multistep procedure. First, members identify their own concerns and after discussion develop a list of priority areas. Next, UAB obtains an inventory of research and extension activity in each area. After holding field meetings and soliciting more opinions from users, the original list is modified to develop a statement of UAB opinion.

Priorities recommended by UAB are examined by the JC, and UAB in turn reviews the JC's recommendations. In the end, the two groups may agree on one set of priorities, but they are not obligated to do so.

UAB's responsibilities are more realistic and attainable than those of the JC (Knutson, Paarlberg, and McCalla, 1980). However, its impact on research priorities is unclear. UAB itself questions whether it has had any impact. USDA officials feel that UAB has been effective. However, when questioned, these officials were unable to point to specifics (GAO, 1981). Some USDA administrators indicate that they refer to UAB reports when establishing their priorities, but, because UAB priorities often parallel USDA positions, the UAB's impact is uncertain. USDA's responses to UAB reports indicate the similarity of the two groups' positions. In response to UAB's October 1979 report, USDA concurred fully or in part in 41 of UAB's 46 recommendations. In concurring, USDA often cited ongoing work as covering the recommendations (GAO, 1981).

Critics have not been as harsh with UAB as they have been with the JC. USDA believes UAB is fulfilling its intended role but has yet to deal effectively with negative or low priorities. Moreover, says USDA, UAB needs to: a) learn more about the science and education system, and b) improve its group decision processes and skills. Some critics in the private sector believe that both the JC and UAB have done a miserable job, have had little impact, and do not adequately represent the private sector (Responses to OTA letters of inquiry, 1980). These critics are for the most part organizations that are not represented on UAB.

Lack of user representation on UAB is a problem. UAB has limited membership and cannot include individuals from all interested groups. Representatives of interested groups and organizations can appear before UAB, but this procedure is less than satisfactory to most organizations. Even if UAB were to arrange for formal and periodic meetings, it is only an advisory board, and most organizations desire direct contact with those responsible for public-supported research. However, UAB members do not see themselves as representatives of organized groups. They believe their task is to interact among themselves and with researchers, not to serve as mere conduits for the opinions of others. They believe they represent the multiple interests of all users, rather than the interests of groups (Response to OTA letter of inquiry, 1980),

UAB, like the JC, must rely on USDA for its resources. It does not have operating funds or authority to appoint staff. Thus, the scope of work performed by UAB relies on the benevolence of USDA.

UAB was established as a citizens group to represent users of research. However, some represented on the present UAB are more providers or performers of research than strictly users. Examples include the Rockefeller Foundation and retired researchers. These entities should more appropriately be represented on the JC.

METHODOLOGICAL APPROACHES IN DETERMINING RESEARCH PRIORITIES[6]

The process for determining priorities for food and agricultural research in the United States invariably raises problems for those who administer the system. Moreover, these problems are exploding into complex policy issues. Unfortunately, the processes that were formerly used to determine priorities no longer seem to be functioning as smoothly as they did. New processes for improving the priority-setting system are necessary for three reasons.

First, decisions will always have to be made, but they should not be made by default. Decisions deserve to be arrived at by a responsible process.

Second, most of the expertise for making appropriate decisions is within the system itself. Some persons would prefer to shift the decision process—or at least some segments of it—outside the system. However, the record of the system is too commanding to allow its leadership to abandon its role.

Third, the evolving planning system somewhat legitimized by the Food and Agriculture Act of 1977 threatens the system. Castle characterizes the research system as a troubled and uncertain system, and the proposed system of national planning and coordination as a vast exercise in hypocrisy (Castle, 1980). This disturbing evaluation has been endorsed by others.

Those managing the system must work within it to adapt it as needed; otherwise the inevitable result is to lose the freedom which the system now enjoys. What is needed is a strategy that can discipline the system, protect its integrity, retain reasonable control of it, provide a framework for more accountability, and give more positive direction to the system.

A number of new processes for priority setting are available for research management to consider. One is the project ranking system, in which an attempt is made to place judg-

[6]The information presented in this section draws heavily from the OTA resource paper, "The Process of Setting Priorities for Food and Agricultural Research," prepared by Charles E. French.

ment on research priorities into some kind of rigorous evaluation system. Another is an approach to optimize resource allocation, such as benefit-cost analysis.

Another new process that deserves careful consideration is the one used in the World Food and Nutrition Study conducted by the National Academy of Sciences in 1977. This process included: a) a thorough analysis of the need for the study and the time required to complete it, b) an evaluation of the various constraints involved, c) a thoughtful study of the criteria for choice, and d) an accurate delineation of the parameters of the study (French, 1981).

Within the current planning system, consensus development does indeed occur, but it occurs more on a give-and-take negotiation among managers than on approaching the problem on a more systematic basis of project-ranking, benefit-cost analysis, or the methodology used in the World Food and Nutrition Study.

The most important guidance gleaned from the new processes is that they are mechanisms for developing a consensus. This avoids certain drawbacks such as indecision, internal bickering and resultant weak bargaining power, outsiders, failure to communicate clearly, and underrating society's expectations about putting parts of the research house in order. Consensus by those within the system would help on all these problems.

In setting up a priority-setting process, consensus making protects the integrity of the individual and demands rigor—i.e., being realistic about the situations in which the participants can be expected to make reasonable judgments. Another useful principle about consensus making is that it must provide for interaction. Feedback is a powerful modern concept, and it can prove itself in the priority-setting process.

A good, workable priority-setting process keeps the research system from being bogged down with other problems and gives the system a chance to stand on its own in making priority judgments. Moreover, a rigorous planning-process approach goes a long way in arguing for a fairly open, freely operating research system. There is no room for internal strife. And finally, the need for continuity in planning and evaluation within the system seems obvious. In the present planning systems, continuity is often lacking.

It should be kept in mind that these new processes are still evolving and have not yet proved themselves in some situations. They cannot surround problems that the mind cannot comprehend; they cannot create judgment. They cannot substitute for peer accountability or scientific objectivity. Priority planners should also realize that consensus making is only one part of these processes. But it is an important one. Scientists may not always want a consensus. Scientists make convincing arguments that the lifeblood of their creativity and objectivity lies in their diversity and controversy. These processes, therefore, have limits and any use made of them in priority setting should take their latent limitations into consideration.

PRINCIPAL FINDINGS

- To adequately determine research priorities there need to be explicitly stated goals for food and agriculture. There are no explicitly stated food and agricultural goals for the research community to use in determining research priorities.

- There is concern whether the functions assigned to the JC are attainable. It has had major problems in attempting to satisfy these functions and as a result has had limited impact. Its effectiveness is limited by a lack of consensus by its members on its role, perception of USDA dominance, and overorganization.

- Functions of UAB are more attainable than those of the JC. Impact of UAB on research priorities is unclear. It cannot represent all users of research, and those not represented are critical of UAB's performance. UAB, like the JC, lacks its own operating funds and is dependent on USDA for its resources. Its membership includes performers as well as users.

. There is lack of satisfactory long-term process for evaluating existing research activities, potential research opportunities, and development of a new set of research priorities. Long-term research planning which is updated every 4 years or more can be accomplished by an intensive, comprehensive study involving research administrators, scientists, and users.

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Chapter VIII

International Dimensions of Research

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Chapter VIII

International Dimensions of Research

Until the 1930's, the U.S. food and agricultural research system was concerned almost wholly with domestic problems. Immediately following World War II, however, changing world conditions caused agricultural research to be viewed in a broader international setting. There are several reasons why this viewpoint has become even more important over the past 30 years.

The United States is becoming increasingly dependent on the developing nations for a growing amount and diversity of food imports (largely noncompetitive) and raw materials. For these countries to continue to assist the United States they must have economic and political stability, and one way that the United States can assure such stability is to help them meet their own increasing food needs (caused by rapid population growth and rising incomes).

Another reason for strengthening the international research and technology base of poorer nations is to assist them in producing more of their basic food needs. This is in their own best interest, but is also of value to the United States to the extent that it enables the Nation to cut down on foreign food aid. Since the end of World War II, the United States has spent about $30 billion to alleviate starvation among these nations (Furtick, 1981). Because of rapidly rising world population, decreasing self-sufficiency, and increasing commodity prices, the annual food-aid cost is rising sharply and could become an impossible burden for the United States and other donors.

Helping the developing nations to improve their economic standing will, in turn, aid in opening up vast foreign markets for U.S.-produced goods. Now, as never before, we need added trade to offset the decline in balance of payments caused largely by burgeoning oil imports. Serious disincentives for the American private sector make expanded foreign trade difficult or unattractive.

Yet another reason for stressing expanded international involvement in agriculture is that there is much the United States could learn from agricultural research conducted in the rest of the world. Once the United States was far ahead of the rest of the world in the scope of agricultural research achievements; but in recent years, this status has declined significantly as the U.S. agricultural research system has languished and the systems of other nations have advanced. There is an increasing amount of research available, which the United States could draw on in meeting its own needs.

Finally, and perhaps foremost in the minds of many, provision of such assistance is the humanitarian thing to do, even where the United States secures no immediate benefit.

The world will not be a better place solely or simply because of agricultural research. But it plays a kingpin role in agricultural development, and agricultural development is of much greater importance to many nations than may be generally recognized in the highly urbanized U.S. society.

While there is great promise for the United States and others in a broadened international dimension in agricultural research, there is a long way to go before this potential is fully reached. Much will depend on the performance of two organizations–the U.S. Agency for International Development (AID) and the U.S. Department of Agriculture (USDA). At present, both face substantial, but differing, handicaps in carrying out this task.

This chapter traces the development of international agricultural research activities in AID and USDA, notes concurrent developments in the international agricultural research system, and presents findings on the problems of current U.S. international participation

DEVELOPMENT OF U.S. INTERNATIONAL RESEARCH ACTIVITIES[1]

Originally, neither USDA nor the land-grant colleges had any governmental charge or funding for international activities. But as the research capability of both groups grew, their scientists were increasingly called on by foreign governments and organizations. By the 1930's Americans had provided technical agricultural assistance on five continents.

All of this was done on an individual and ad hoc basis. Not until 1938 was USDA given legal authority to provide technical assistance in the Convention of Cultural Relations. In 1939, Public Law 355 established cooperative tropical experiment stations in Latin America to develop crops complementary (noncompetitive) to U.S. production. Funds were appropriated in July 1941, and the first program began with the signing of an agreement with Peru in April 1942. The onset of World War II delayed progress.

After World War II, the Marshall Plan provided the main vehicle for U.S. involvement in international agricultural matters. It is not known, however, how much assistance the plan provided directly to agricultural research in Europe. Subsequently, point IV, established in 1949, extended U.S. assistance to other areas. The early emphasis in point IV was on the transfer of American agricultural technology and establishment of extension services. In the early 1950's, the need for institutions of teaching, research, and extension was recognized, but it was still thought that technology could be directly transferred to developing countries.

By the early 1960's, it became apparent that U.S. technology simply was not immediately useful to many tropical and semitropical developing nations. Adaptation was necessary, and this required an indigenous research capacity. This realization came slowly and unevenly, and many nonagriculturalists do not comprehend it to this day.

Meanwhile, some useful related activities had been carried out. Early in the 1950's, American foreign assistance agencies contracted with a number of American agricultural colleges to help establish comparable institutions in developing nations.[2] American colleges also provided training for foreign students, resulting in development of institutions and trained staff which could later contribute to research.

One of the most significant research developments at midcentury started quite differently. In the early 1940's following a visit by Secretary of Agriculture Wallace to Mexico, the Rockefeller Foundation sent a small team of' prominent agricultural scientists to that country to see what steps might be taken to increase its agricultural production. A grain improvement program was begun in 1943 in cooperation with the Office of Special Studies of' the Ministry of Agriculture. Dr. Norman Borlaug soon joined the program, and in 1959, he became head of Rockefeller's International Wheat Improvement Project. The wheat project was merged with a comparable corn program in 1963 to form the International Center for Corn and Wheat Improvement. Work sponsored by the Mexican Government was shifted to the National Institute of Agricultural Research in 1961 (Stakman, Bradfield, and Mangelsdorf, pp. 1-93).

[1]This section draws heavily from vol. V of the Supporting Papers: World Food and Nutrition Study, pp. 91-127, and from Furtick, 1981.

[2]See Read for details on a highly successful program in India.

In looking back on the early post-World War II period in 1964, one observer stated:

> Although our government has been actively engaged in technical assistance in agriculture throughout Latin America for two decades, the sad truth is that not a single first-class agricultural research center has been developed as a consequence of these activities. Mexico has done well, but not because of any technical assistance from the U.S. Government. . , . Japan has done exceedingly well on her own. But throughout South Asia, where we have both public and private commitments to assist agriculture, with few exceptions new agricultural research has been neglected (Schultz, p. 201)

Despite the strong dependence of U.S. agriculture on a steady generation of new technology, the U.S. technical assistance programs for nearly 20 years neither developed nor used new agricultural technology in the cooperating countries with any real degree of effectiveness (Moseman, 1970).

U.S. Agency for International Development

In 1961, the various scattered international assistance activities of the United States were combined into a new AID. This agency provided the link for much of the involvement of USDA and the States in developing countries for the next 20 years. However, AID had little to do with developed nations.

Origins of Research Component

The lack of a sound research component within the U.S. foreign assistance program was recognized when AID was established. Hence a research program with special budget support was initiated in 1962. In July 1964, a conference on international rural development concluded that greater support should be given to the research component by AID, in its own programs and within its contracts with U.S. agricultural universities. Although data are fragmentary, it appears that there was a substantial expansion in expenditures on agricultural research during the 1960's.

Prior to the formation of AID, agriculturalists involved in foreign assistance were grouped in one central Office of Agriculture in the Department of State. Senior members had line responsibility and could make budget decisions involving projects and programs. With the establishment of AID, however, many of the agriculturalists were dispersed to regional bureaus, and those that remained were given staff duties. With this dispersion came a decline in responsibility, in Washington and in the field. Some efforts were made to return to the pattern of the 1950's, but the proponents were outdone by the powerful regional bureaus which preferred to retain their new status.

There were other constraints. One was a congressionally imposed lid on the amount of money that could be spent on all forms of research, which continued to the mid-1970's. The other constraint was on commodities that were considered to be in surplus, such as wheat and rice.

The tide began to change for food crops in February 1966. President Johnson, in his "War on Hunger" message of February 10, emphasized the need to help countries in balancing agricultural productivity with population growth and to eliminate the surplus concept in food aid. On March 7, 1968, AID issued a new order that liberalized the commodity focus and made it possible to provide support for a broader range of research activities.

Despite the provincialism of the regional bureaus and the substantial difficulties of the period, the AID research specialists had a global vision. At a meeting of the Development Advisory Committee in the spring of 1967, the U.S. delegation presented a proposal for strengthening international collaboration in adaptive research with special emphasis on: 1) world centers patterned after the International Rice Research Institute, 2) regional centers to be concerned with the problems of major ecological regions, and 3) national centers for attention to localized problems (Moseman, 1970, pp. 93-94).

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While this concept exceeded the realities of research in AID at the time, there was some followthrough. AID became involved in some program reviews of national agricultural research systems in several Asian nations. AID also began to provide funding to the International Maize and Wheat Improvement Center in 1969 and to three other international centers in 1970. A massive review of the new cereal varieties was held in the spring of 1969, and later that year, a Technical Assistance Bureau, which provided a needed focus on research, was established.

The Technical Assistance Bureau (to become the Development Support Bureau in 1977) and the regional bureaus sharply expanded their support for research in the 1970's. Three main avenues of support were used: bilateral, multilateral, and contracts with American institutions. The regional bureaus were involved in bilateral activities which were principally research loans supplemented by some grant funds. The Technical Assistance Bureau was involved in varying degrees with all three activities. It provided technical assistance in the bilateral loan activities and grant funding for multilateral and contract activities. The multilateral research activities involved the support of the international centers sponsored by the Consultative Group on International Agricultural Research (CGIAR) plus two other international research organizations, which are not members.

Although overall funding for research increased sharply over the period, only that portion funded by the Technical Assistance Bureau can be documented with much precision. The bilateral programs sponsored by the regional bureaus and country mission usually involved many other activities beyond research.

While the research funding levels rose in AID, research continued to have a relatively uncertain position in the organization and staffing of the agency. AID continued to be a general purpose organization run by generalists rather than by scientists. There were relatively few trained agriculturalists and even fewer experienced agricultural researchers.

To provide a more clearly defined role for research, consideration was given in the late 1970's to establishing a separate—though companion—research agency, the Institute for Scientific and Technological Cooperation (ISTC). ISTC, however, did not receive congressional approval.

AID added a science advisor and allocated some funds to the National Academy of Sciences to cosponsor modest research projects in developing nations. There is some concern among AID research specialists that these projects could be counterproductive and divert less-developed-country researchers from projects of greatest importance to their country to those of interest to a few U.S. scientists, who may have little knowledge of the developing country. An attempt is being made to avoid this problem.

Research at the Country Level

AID support of research and related programs has not been consistent. By far the largest expenditure (though small in relation to total funds for AID food and nutrition programs) has been at the country mission level in response to requests by host governments. Even so, there has often been reluctance to fund research because most AID country mission administrative personnel do not have agricultural backgrounds. They tend to think, as was common in the 1950's and early 1960's, that all the answers are available from U.S. agriculture. Projects with more rapid payoff tend to be favored in order to show concrete results during their tour of duty (Furtick, 1981). This is unfortunate because of all the donors, AID usually has: 1) the best access to information in host countries, 2) a greater chance to affect local priorities, and 3) the largest reservoir of food and agricultural expertise. AID missions can readily work with most donors informally to ensure balanced programs with realistic objectives.

Research projects at the country mission level have usually been aimed at building or strengthening the research capacity of local research institutions. Such programs have usually been carried out through contracts with universities, interagency agreements with USDA, or private contractors. Increasingly, these activities have required close coordination with other bilateral and multilateral donors that may be supporting different aspects of the same institution. The effectiveness of these projects has been hampered by lack of qualified persons in the field missions, compounded by frequent transfers. This has made it difficult for AID to effectively serve the needs of the host countries. In addition, lengthy review and contracting procedures have made timely assistance difficult.

AID support for this research has long been handicapped by inadequate or inappropriate staffing (Furtick, 1981). Use of foreign service officers as project monitors between foreign service assignments has led to rapid turnover of administrative staff, frequently with little or no research training, resulting in delays and mismanagement. Some regional bureau staff have been suspicious of research as lacking impact and relevance; this has prevented competent planning and implementation. There has also been a chronic lack of adequate project evaluations during and after the contract period.

Centrally Funded Research

Centrally funded research covers the various activities that are not country specific. Many of the funded contracts are strictly research in nature. Others have a technical assistance component to provide educational and other activities to hasten use of the research results. (Centrally funded research at the international agricultural research centers is discussed in a subsequent section.)

Because AID does not have a research staff of its own, all centrally funded research has been contracted primarily to universities, consortia of universities, USDA, other Federal agencies, or in a few cases, to private research organizations. This research has included grants that, as a result of insistence by the university community, have been contracted to universities with minimum restrictions on their use (Furtick, 1981). Their purpose was to strengthen research capability in areas where AID anticipated continuing requests for assistance and current capacity was inadequate to respond. These strengthening programs usually covered a 5-year period.

A major difficulty in use of expertise was that strengthening grants were centrally funded, and the regional bureaus were at odds with the central bureau. Further, the regional bureau management had little or no training in agriculture and did not understand or appreciate the role of science and technology in country development. In a few cases, this expertise was used by AID. However, with changing missions and regional personnel who had changing ideas and lack of expertise in agriculture, these resources were soon forgotten.

Other contracts have been aimed at solution of problems of multicountry importance such as specific pest and disease problems, biological nitrogen fixation by tropical legumes, and control of major weed problems. In some missions, these research activities have been used to backstop specific problems identified by AID country missions.

Title XII of the Foreign Assistance Act of 1975

Title XII of the Foreign Assistance Act of 1975 provided for the establishment of a Board for International Food and Agricultural Development (BIFAD). The purpose of the act was to more fully use the expertise of American land-grant colleges and universities in agricultural development programs. The congressional sponsors originally proposed to the Secretary of Agriculture that this program be made part of USDA. This suggestion was not accepted, and the program was incorporated within AID, but without separate funding. BIFAD members are appointed by the President, of which the first were appointed in late 1976. The legislation requires that a majority be from universities and the others from outside government.

This legislation was viewed among some AID staff as an attempt by the universities to take over part of the AID functions (Furtick, 1981). A long struggle between AID and BIFAD followed. AID viewed the role of BIFAD as advisory to AID; however, the legislation gave it policy and oversight authority without AID representation. After the appointment of the first BIFAD, the implementation of title XII appeared to bog down in a jurisdictional wrangle between BIFAD and AID. The legislation created much of the problem because title XII did not carry new funding or provide BIFAD authority over existing funds. Thus, all programs and projects identified as title XII had to come from ongoing food and agricultural programs of AID. Without tearing down ongoing programs, programs to be established with university participation required either: 1) a long wait for new funds or 2) accepting ongoing programs or commitments as title XII activities. BIFAD was reluctant to become identified with programs for which it had not been involved in the planning and programing. The latter solution has been used primarily (Furtick, 1981).

Eventually under the current process, a large segment of both country AID mission programs and central AID programs will have had major title XII input and will be the result of joint AID-university interaction. This process is moving more smoothly. The long and often stormy period required to implement title XII has caused congressional impatience and provided ammunition to the program's critics. It has taken nearly 5 years for the program to become functional in the ways intended, but there are still many unresolved problems.

As developed, the title XII program has two main components: the Joint Committee for Agricultural Development (JCAD) and the Joint Research Committee (JRC). JCAD deals with education and technical assistance. At the country level, JRC has given particular attention to developing collaborative research support programs (CRSPs). The concept of a CRSP is one of cooperation and collaboration in program development among the qualified scientists in the United States, national institutions in developing countries, and appropriate international agricultural research centers. Each participant must make a significant contribution of its own resources. Each program covers a specific area of research priority. The first of these projects is in effect; others are under development, and implementation will depend on availability of funds. As in the case of BIFAD, it took time to get this program under way and there were considerable problems. Initial administrative costs of such programs were substantial (Furtick, 1981).

Title XII has been promoted as providing the means for universities to commit themselves to long-term assistance in international food and agricultural development. Although many of the major universities have had multimillions of dollars annually from AID contracts for many years, contracts have usually been approached on an ad hoc basis. This has prevented the development of career tracks and promotion and tenure criteria for international activities. Moreover, it became hazardous for younger faculty members to accept assignments without jeopardizing their careers. The condition has made administrators reluctant to release senior faculty, because of the interruption in ongoing programs. This has often caused the universities to become hiring halls to fill contract obligations, rather than develop a pool of permanent faculty with international experience available for use in international programs.

BIFAD issued a major policy paper in 1980 on ways to overcome these deficiencies in the university system; it was entitled "Toward More Effective Involvement of Title XII Universities in International Agricultural Development." A companion document was adopted by the Executive Committee of the National Association of State Universities and Land-Grant Colleges (NASULGC) on February 13, 1979, and distributed to all member universities; it was entitled "Statement of Principles for Effective Participation of Colleges and Universities in International Development Activities. " These documents are excellent reviews of the problems and potential solutions.

U.S. Department of Agriculture

USDA, since its early history, interpreted the Organic Act of 1862 as limiting its role to the service of U.S. agriculture. Many dedicated employees, however, have individually contributed significantly to foreign assistance programs in recent years. USDA also has managed two international research and training programs. Some recent legislative and administrative changes have provided the basis for further involvement.

General Administrative Arrangements

Most of these individual contributions have been made through interagency personnel agreements (PASA in the case of overseas assignment; RSSA in the case of Washington assignment) to carry out AID programs.

Such assignments have distinct limitations for those involved, including jeopardy to promotion and retention of career assignments, and thus career development. Because PASA/RSSA's are not part of the regular agency budget, they have always been approached on an ad hoc basis, in spite of the relatively large size of this annual funding. Because there is no continuing agency funding base, there has never been a career track established for international research and development; thus, it has not been possible to develop a current pool of experienced international staff. Because these assignments are disruptive to regular ongoing programs, USDA administrators are reluctant to authorize qualified staff to take PASA/RSSA assignments. It is not surprising, therefore, that USDA employees are often hesitant to participate in international work under such circumstances.

To fill AID requests, USDA has sometimes turned outside the organization and hired individuals on a temporary basis—in effect acting as a hiring hall for AID. The PASA's have been popular with AID because of the rapidity of implementation in contrast to lengthy contract procedures required with universities and private contractors.

The result is that in the U.S. Government, AID has the money and USDA has the predominant agricultural expertise. USDA does not use its expertise in the planning and program development stage of AID programs, and is reluctant to release its experts for implementation. Thus, USDA has a limited pool of talent with overseas experience and no career staff for continuity.

The lack of USDA direct involvement in foreign assistance is the result of deliberate past administrative decisions by Secretaries of Agriculture. They felt this to be a conflict of interest with promoting domestic production and trade. An example was the proposal by the authors of title XII to place it under the jurisdiction of USDA. Because this did not find favor with USDA administration, it was placed in AID.

Many lower level USDA administrators have tried unsuccessfully to strengthen the USDA role in foreign assistance. Efforts have included detailed recommendations for implementing section 406 (tropical and subtropical agricultural research), involvement in title XII, and support of other international programs including the International Agricultural Research Centers (Furtick, 1981). These efforts were not favored in the USDA budget decision process until recently.

For many years, USDA had a small international program staff, but during the Carter administration, the various international programs were consolidated under a new Office of International Cooperation and Development (OICD) reporting to an Undersecretary of Agriculture. This has led to an international program advocacy group in USDA that could interact at the final budget decision level.

Special Foreign Currency Research Program (SFCRP)

One early activity was the SFCRP authorized by the Agricultural Trade Development and Assistance Act of 1954 (Public Law 480) as amended in 1958 and 1959. SFCRP did not, however, attain substantial proportions until the 1960's, It used local currencies paid to the United States for Public Law 480 sales to finance in-country research of mutual interest to the foreign nation and the United States. It was administered by the International Programs Division of the Agricultural Research Service (ARS).

Public Law 480 sales were initially made to a number of countries that are not now classified as developing nations. Thus in fiscal year 1965, out of total research expenditures of local currencies equivalent to $7.16 million, 68.4 percent was made in countries not now classified as developing nations.

During the 1970's, there was a shift in Public Law 480 repayment terms from local currencies to dollars, which sharply reduced the number of countries with excess local currencies available for the purpose. Hence, SFCRP gradually became limited to just a few countries. By fiscal year 1975, the leading countries were Pakistan, India, and Egypt.

Although a large number of research projects have been conducted under SFCRP, no formal evaluation has ever been made. Thus, it is difficult to comment on the project's value to and impact on the host country or the United States. Some observers, however, feel that the program diverted less-developed-country researchers from tasks that might have been of greater national benefit. At the same time, the benefits to the United States, except for work done in Israel, are not well-known.

Tropical and Subtropical Research and Training Program (TSRTP)

A second research program was authorized under section 406(4) of the Food for Peace Act of 1966 as amended. USDA was allowed to enter into research contracts or agreements with American institutions in the field of tropical and subtropical agriculture and to make the results available to friendly developing nations.

Authorization was provided to spend up to $33 million a year. No funding was provided under the Food for Peace Act; it was to be obtained through regular USDA channels. USDA, in turn, evidently did not give the program high priority, No funding was obtained until fiscal year 1975, when $500,000 was appropriated, partly to establish two research and training centers, in Hawaii and in Puerto Rico. Two principal objectives were set: 1) to provide tropical training and experience for USDA and land-grant college personnel by working on tropical research problems under tropical conditions, and 2) to provide foreign nationals with a place to learn techniques and methodology under tropical conditions from U.S. specialists.

As TSRTP evolved by the mid-1970's, the program centered on the University of Hawaii and the Federal Experiment Station at Mayaguez, Puerto Rico, designated as the Mayaguez Institute for Tropical Agriculture. In addition, some universities had projects financed by TSRTP funds. Coordination was provided by the International Programs Division of ARS. Funding levels were $529,000 in fiscal 1976 and $681,000 in fiscal year 1977,

Subsequently, the Hawaiian and Puerto Rican sites were renamed the Pacific Basin Center and the Caribbean Basin Center, Funding was raised to $1,8 million in fiscal year 1978, to $2.2 million in fiscal year 1979, and $2.8 million in fiscal year 1980. Funding was shifted from the supplementary budget to the regular budget in fiscal year 1981.

As of early 1981, Furtick noted that:

> Competition between universities and AR (USDA) scientists for the limited funding has at times hampered sound program development. It is currently being conducted more as a competitive grants program than as a cohesive program to establish overall tropical re-

search priorities and utilize the best scientific talents to solve critical tropical problems.

The program also appears to be domestic in orientation, This focus was brought out in a recent internal struggle for control of the program with another USDA agency (OICD): The Science and Education Administration "decided to give it a strictly domestic tropical agriculture focus and keep it" (Furtick, 1981).

Recent Legislative and Administrative Changes

During the 1970's, USDA became increasingly involved in bilateral programs and other activities that involved a research component. Many of these were with middle-income nations (not covered by AID), which paid the bills.

International scientific cooperative programs were developed under an agreement between USDA and NASULGC. The agreement was implemented through the establishment of an International Science and Education Council in 1974.

Under section 1458 of title XIV of the Food and Agriculture Act of 1977, Congress authorized USDA to: a) become involved in international research, extension and related technical programs in developing nations in collaboration with AID and land-grant universities, and b) work directly with the more developed countries that are ineligible for AID support.

As discussed earlier, to improve consolidation and administer existing and emerging international activities, OICD was established in May 1978. In early 1980, it absorbed some of the research activities formerly administered by the International Programs Office of ARS.

As of early 1981, the most relevant OICD programs were concentrated in two divisions: a) Scientific and Technical Exchange, and b) International Research. The latter division administers: a) SFCRP discussed earlier, b) research carried out under its binational program with Spain, and c) the Binational Agricultural Research and Development Fund. The last program is carried out with Israel; it became operational in November 1978 and operates off the interest from an $80 million endowment fund established by the United States and Israel, with a focus on subjects of mutual interest. In one sense, it is an outgrowth of the SFCRP, which once included Israel.

In fiscal year 1981, the International Cooperative Research Program was proposed by OICD for the International Research Division. It would have focused on problems shared with other nations, developed and developing, The proposal was not funded by Congress but was to have been resubmitted as part of the fiscal year 1982 budget (this was not done because of budget constraints). It would have called for initial funding of $2.5 million, and would have included 15 individual research projects ranging in cost from $50,000 to $400,000. One would have involved cooperation with the international agricultural research centers and another would have involved programs between U.S. agricultural universities and other nations.

USDA maintains administration of certain in-house overseas research. Some USDA research programs have found it advantageous to maintain overseas laboratories. The subjects include controlling insect and weed pests, exotic plant and animal diseases, and improvement of storage and transportation procedures in shipping international products, In 1977, there were six such laboratories.

Private Sector Activities

Although the private sector plays a major role in domestic food and agriculture, particularly in developmental research, its activity has not been as significant in the international area.

One of the most important reasons is the size, stability and corporate experience of the private sector in the U.S. market, For example, the United States consumes most of the world hybrid seed corn, nearly half of the world's pesticide production, and is the largest single consumer of fertilizer, machinery, animal health products, etc. By far the largest part of the remaining market for these products is in the other temperate zone, hard currency, industrial countries of Europe, Japan, Australia, etc. Why should the private sector devote energies to the developing world, largely in the tropics, where their current products often do not work well, where small farms predominate, where local infrastructure is inadequate, where governments are not stable, where illegal payments are a standard procedure, and where currencies are difficult to convert and repatriate? Yet, the potential of the future market is enormous; if it were ever fully developed, it would dwarf the domestic market.

European and Japanese private sectors have been much more aggressive in developing or modifying technology for the developing country market because of their relatively restricted domestic market, a history of trade as a way of life, and the variety of government incentives used for this purpose. These incentives include complete tax exemption for expatriates, aggressive marketing assistance as part of diplomatic initiatives, acceptance of the need for special payments to gain business, and allowance for these payments as deductible business expenses. They also provide export incentives and insurance against expropriations or losses from government instability.

In contrast, even the $20,000 short-term and $25,000 long-term overseas U.S. income tax exemptions were voided in recent years, but restored again beginning in 1982. * There have been limits on deductions of local tax payments and fringe benefits, ignoring the preponderance of services provided to resident U.S. citizens that are not enjoyed by those living overseas. When American firms decided to do business abroad where expatriate staff was required, they were largely turned to non-Americans to solve the tax costs that otherwise should have been added to salary. As noted, recent passage of the 1981 omnibus tax bill has alleviated some of these constraints.

Under current amendments to the Corrupt Practices Act, special payment to gain business abroad is a criminal offense. Thus, American firms have increasingly stayed in business by becoming subcontractors to non-American firms that make the illegal payments.

Less export assistance and fewer incentives are available to American firms than to their competitors. In addition, the imposition of special environmental protection restrictions on some products often makes the development of new products for overseas markets impossible.

*Effective January 1, 1982, the newly enacted tax law will free from U.S.–though not foreign–taxes income up to $75,000 a year from working expatriates. The maximum also will rise by $5,000 a year until 1986 when it reaches $95,000. Housing allowances will become largely tax exempt.

THE EMERGING INTERNATIONAL RESEARCH SYSTEM

Although growth of the U.S. agricultural research system stagnated somewhat in recent years, much has been happening in agricultural research in the rest of the world. An international agricultural research network is volving. It is perhaps not yet a system in a formal sense, but the major pieces are in place.

Structure and Growth of the System

The two main institutional components are: a) a group of international agricultural research centers and b) national agricultural research systems in developed and developing nations.

International Centers[3]

The international centers may be the best known component of the system, Most are sponsored by CGIAR. CGIAR sponsors 10 centers and three related programs (table 11), Several other centers exist outside the CGIAR system, including the International Fertilizer Development Center in the United States, the Asian Vegetable Research and Development Center in Taiwan, and the International Center for Insect Physiology and Ecology in Kenya.

Development of the international centers began in 1960 with the establishment of the International Rice Research Institute (IRRI) in the Philippines by the Ford and Rockefeller Foundations. This step was followed by establishment of three other centers later in the decade by the same groups. CGIAR was established in 1971 to secure and coordinate funding from other sources. Both the number of programs and funding grew sharply during the 1970's (tables 11 and 12). CGIAR had 31 donor members by 1980; 33 in 1981. The United States, through AID, is a charter member and provides about 25 percent of total funding (table 13).

In the relatively short period of their existence, the international centers have had an extraordinary effect on international agricultural research. While their focus is on tropical

[3]Further details on these centers are provided by the Consultative Croup.

Table 11 .—CGIAR-Sponsored International Agricultural Research Centers and Programs

	Location	Year established	Core funding, 198& (in millions)
Centers			
1. International Rice Research Institute (IRRI)	Philippines	1960	$15,032
2. International Maize and Wheat Improvement Center (CIMMYT)	Mexico	1966	16,056
3. International Institute of Tropical Agriculture (IITA)	Nigeria	1968	14,038
4. International Center for Tropical Agriculture (CIAT)	Colombia	1968	14,275
5. International Potato Center (CIP)	Peru	1972	7,100
6. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)	India	1972	10,375
7. International Laboratory for Research on Animal Diseases (ILRAD)	Kenya	1974	10,031
8. International Livestock Center for Africa (ILCA)	Ethiopia	1974	8,954
9. International Center for Agricultural Research in the Dry Areas (ICARDA)	Syria, Lebanon	1975	11,292
10. International Food Policy Research Institute (IFPRI)	United States	1975	2,305
Programs			
11. West African Rice Development Association (WARDA)	Liberia	1968	2,562
12. International Board for Plant Genetic Resources (IBPGR)	Italy	1973	2,925
13. International Service for National Agricultural Research (ISNAR)	Netherlands	1979	1,095

[a]Does not include special projects. Some contributions remained to be allocated to individual centers/programs.

SOURCE U S. Agency for International Development, 1981.

Table 12.—Total Core Expenditures on Centers and Programs Sponsored by CGIAR, 1972-80

Year	Millions of dollars
1972	$20,060
1973	24,955
1974	34,525
1975	47,545
1976	62,870
1977	77,225
1978	85,280
1979	98,535
1980	118,565
1981 (prop.)	139,200

SOURCE: CGIAR Secretariat.

Table 13.—AID Contributions to international Agricultural Research Centers (in millions of dollars)

Fiscal year	CGIAR[a]	AVRDC[b]	IFDC[c]	Total
1970	$ 1.679	$0	$0	$ 1.679
1971	2.984	0	0	2.984
1972	3.770	0.600	0	4.370
1973	5.390	0.600	0	5.990
1974	6.805	0.600	0	7.405
1975	10.755	0.600	4.100[d]	15.455
1976	14.870	0.600	5.100[d]	20.570
1977	18.140	0.600	3.445[d]	22.185
1978	21.400	0.600	3.800	25.800
1979	24.800	0.600	4.000	29.460
1980	29.000	0.600	4.000	33.600

[a]Centers and programs sponsored by the Consultative Groupon International Agricultural Research (listed in table 11).
[b]Asian Vegetable Research and Development Center, Taiwan.
[c]International Fertilizer Development Center, Alabama.
[d]Of the total of $12.6 million for the 3 years, $8,8 million was for capital construction and equipment and $3.8 million was for operations.

SOURCE: AID/DS/AGR.

and semitropical agriculture for the developing nations, they provide an international point of exchange for agricultural research in their respective fields—for developed country donors and developing country recipients. They are firmly in the mainstream of international research, and their research quickly becomes known and used in national research programs. They have also shown the need for further development of national research systems in developing nations.

The centers are excellent, productive research organizations. They have modern facilities and highly qualified staffs. Naturally they have their own difficulties and limitations. They are not, for example, designed to do basic research, which may be more effectively done in developed nations. But they have created a new appreciation of the value of applied agricultural research.

National Programs

While the international centers may have taken center stage in recent years, the national (public) research programs of other developed and developing countries have expanded significantly. This expansion is documented in financial terms in table 14. From 1959 to 1974, total global expenditures (in constant dollars) increased three times. The largest increase was in Asia (excluding Japan). The smallest increase (excluding perhaps some small developing nation) was in the United States. In 1959, public research expenditures in Western Europe were less than half of those in the United States; by 1974, Western Europe exceeded the United States. Or to view the matter differently, in 1959, U.S. expenditures represented about 27.7 percent of global agricultural research expenditures; by 1974, the U.S. proportion had dropped by 10 percent to 17.9 percent. If privately sponsored research, which is of significant importance in the United States, were included, the situation might be somewhat different, but the same might be true of other developed nations.

Table 14.—Public Expenditures on Agricultural Research, Major Regions of the World, 1959 and 1974 (in millions of constant 1971 dollars)

Region/country	Expenditures[a] 1959 (millions of dollars)	1974	Change 1959 to 1974 (percent)
Asia (excluding Japan)	$ 40.9	$210.5	414%
Japan	57.7	260.4	451
Western Europe	117.1	452.4	287
Latin America	33.9	129.4	281
Canada, Australia, and New Zealand	83.6	241.5	189
U.S.S.R.	158.6	425.0	168
Eastern Europe	83.4	216.4	159
Africa	52.5	115.4	120
United States	240.3	447.5	86
World total	$868.0	$2,498.4	188%0

[a]Does not include expenditures on international agricultural research centers.

SOURCE: Compiled from James K. Boyce and Robert E. Evenson, *National and International Agricultural Research and Extension Programs,* Agricultural Development Council, New York, 1975, pp21-31 (table 2.1) ("Constructed Time Series").

It would be useful to know what has happened since 1974; it is probable that the same general trends have continued. The increase in funding in the developing nations may have become even more pronounced as international assistance agencies, particularly the World Bank, have sharply increased the volume of lending for agricultural research (World Bank, p. 34). CGIAR, as noted in table 11, has recently established an International Service for National Agricultural Research to assist developing nations. Preliminary data gathered by Evenson indicate that a particularly sharp increase in research expenditures has taken place in Southeast Asia (Evenson, phone conversation, Jan. 28, 1981).[4] U.S. funding during this recent period appears to have increased only slightly.

International Networks

As suggested earlier, national and international agricultural research programs are increasingly being linked in scientific networks at the commodity level. One example in which the United States is particularly active is the International Winter and Spring Wheat Research Networks The United States is one of several developed-country members that provide or coordinate the transfer of germ plasm or some other needed technology. They also report on the results of multisite testing. In this way, participants can have prompt access to the results of international trials. The system is inexpensive and extraordinarily efficient.

Potential Value of the System to the United States

Few nations cannot benefit directly or indirectly from agricultural research done elsewhere. This is particularly true of nations with well-developed research systems that are able to adapt the research to their own conditions. Hence the United States, as one of the world's largest generators and users of agricultural technology, should be in a position to contribute and gain as much as any nation. Considering the need to continually improve our agriculture in order to keep domestic food costs down and to maintain our competitive ability in foreign markets, this is a significant matter,

General Nature of Benefits

Direct benefits to U.S. agriculture include new and improved technologies that could either be put directly to use or be applied with some further modifications, The United States, like other nations, has borrowed agricultural technology for centuries. Over time, foreign borrowing may have played a smaller role. When the United States dominated world research, it was perhaps felt that there was less to learn elsewhere, but with the rest of the world now surpassing the United States in research growth, there will be much more that the United States might profitably use.

Similarly, the United States might do well to study the structure of research systems in other nations in order to identify useful ideas for our system. Despite an early interest in foreign systems (see footnote 1 on p. 30 in ch. III), the United States has paid little attention to them for the past 75 years. One of the papers prepared for this study has briefly reviewed six leading foreign systems and has identified several features that might be worthy of further study (Smith, 1980).

The existence of expanded research systems in other developed and developing nations should contribute significantly to the improvement of agriculture in those nations. From the point of view of the U.S. foreign-assistance program, this means that there is a larger research base from which to draw, both in the other developed nations and in the international centers, and a greater opportunity to profitably use it in the developing nations.

Improvement of agriculture in developing nations can benefit the United States in sev-

[4]The International Food Policy Research Institute has completed a study of research funding in developing Nations. The data are not quite comparable with Evenson's, but do confirm the growth in funding. See Oram and Bindlish.

[5]For details, see Kern.

eral ways. First, as it contributes to economic development, it will improve commercial export markets for U.S. agricultural products. Second, it will reduce the need for United States confessional food aid—which is getting increasingly expensive as U.S. surpluses disappear. Third, moderation of food prices in other nations may have a moderating effect on food prices in the United States. Fourth, the United States is a major importer of agricultural products that are not grown here; improvements in this area can mean lower costs to U.S. consumers.

Specific Examples

The assistance provided by the United States to international research has already found use in U.S. agriculture. One example is rice (Dalrymple, 1980).

Semidwarf rice originated in East Asia, and most of the varieties in use trace their origins to varieties developed at IRRI. These varieties, along with semidwarf varieties developed through irradiation of domestic varieties, were used as parents in breeding programs in the United States, particularly in California.[6]

Semidwarf rice varieties adapted for U.S. conditions are fairly recent and as yet have only been used in California. Semidwarf rice varieties are under development in the Southern States and may make a contribution there. Of the semidwarf area in California, half or more was recently planted with a variety (M9) of IRRI parentage (60 percent in 1979 and 50 percent in 1980). It in turn represented about 30 percent of the California rice area in 1979 and 37.5 percent in 1980.

California specialists estimate that the semidwarf varieties have increased yields 10 to 15 percent. California yields were at a record level in 1979 (6,520 lb/acre) and next-to-record level in 1980 (6,440 lb/acre). The 1979 yield was 11.1 percent above the previous high. California yields in turn were 41.8 and 46.3 percent above the U.S. average in 1979 and 1980.

[6]For details, see Rutger and Brandon.

A related example is semidwarf wheat varieties, which occupied over 30 percent of the U.S. wheat area in 1979 (Dalrymple, 1980). The United States has also benefited in irrigation technology from bilateral research with Israel: drip irrigation and the use of water containing higher salt concentration are two such areas.

The future will offer many further opportunities for the United States to benefit from research done elsewhere. The major constraint at present is the rather limited U.S. connection with the emerging international research system

Status of U.S.-International Linkages

The degree of U.S. involvement with the international research system varies somewhat with the direction of linkage and the groups involved. It is probably stronger on the giving than the receiving end, and AID probably has stronger connections than USDA.

The reasons are fairly simple: AID has a charge and funding to support this sort of activity; USDA as yet does not have a direct charge or funding to link into the system. The latter group has some AID-funded programs with certain aspects of the international system, but these are more in the nature of providing assistance; any return flow is a side benefit. A question might be raised as to how well AID does in terms of making use of American agricultural research knowledge overseas, but there can be little question that the United States is poorly organized to stimulate a return flow from the international system.

Much of what has been drawn from the international system to date has been a result of individual initiative and contacts of American scientists. They have generally received little encouragement or financial support from their administrators. Travel budgets are nearly always restricted when budgets are tight, and high-cost international travel is prone to be at the head of the list. Yet, only so much can be done at the international level by mail; ultimately the scientists must travel.

Other arrangements may have to be made, which present troublesome administrative problems or suggest less than complete fidelity to some immediate domestic problems. Thus, what has been accomplished in some cases may be in spite of the system rather than because of it.

Furtick has outlined the specific charge in the following terms (1981):

> The need now is for the United States to link its scientific capacity into this major national and international research network to both contribute and gain from the new knowledge that they are generating.

With reference to the international research centers themselves, he states:

> In spite of their importance, the United States to date has made only limited government effort to link its scientific community to these centers or build major linkages that will insure that new technology discovered by these centers which is useful to the United States will be rapidly transferred from these centers to the mainstream of U.S. science.

Finally:

> The question is, how can we develop a sound partnership between our science and that of the rest of the world for mutual benefit? We are no longer going to be only a donor in the future, We will also become a recipient.

CONSTRAINTS ON INTERNATIONAL PARTICIPATION

It is not very difficult to list the many constraints on more effective participation in the international agricultural research system. It is much more difficult to provide realistic suggestions as to what might be done about it. Because of current economic constraints, additional resources in funding and staffing will be hard to obtain. In any case, the U.S. international research effort has not organized in a manner to make optimum use of available resources.

AID: Lower Income Nations

Although the United States may not have the commanding lead in agricultural research that it once had, it still harbors one of the largest agricultural research systems in the world. It also has a very large and perhaps better funded system of research on more basic but related scientific matters; however, little attention has been given to using this resource.

AID is the main outlet for assistance to lower income nations, but many legitimate questions have been raised about AID's ability to perform this task efficiently and effectively,

The Bask Problems

One of the major AID limitations in addressing international research is an inadequate number of appropriately trained professional staff. Records of the past 10 years show a dramatic increase in funding levels in the AID agricultural sector ($270 million in 1971 to $720 million in 1980) (Furtick, 1981). The relative share of the agricultural sector in AID-appropriated funds has gone from 19 to 50 percent since 1970, In addition, congressional and other mandates have proliferated the type of special issues that AID is expected to address in the agricultural sector.

AID's total employment level peaked in 1968. Since that time, the numbers in certain professional categories have been substantially reduced, particularly in agriculture. Between 1968 and 1976, the total number of AID's U.S. employees was reduced by 55 percent; however, during the same period, agriculturists were reduced 78 percent. It appears that the reduction in professional staff has been somewhat inversely proportional to funding increases.

As of **1980,** with 50 percent of the resources, the agricultural officers composed only 5 percent of the agencies' total personnel. There were 256 agricultural positions and more than 20 percent were vacant, Almost 80 percent of the agricultural officers are assigned overseas; and most of them act as program generalists/administrators. Many are older, and although about 75 percent have advanced degrees, mostly M, S., very few have had recent specialized technical experience. Very few have been released for in-service professional improvement in agriculture during their careers.

The lack of an agricultural career ladder and professional identification has made recruitment and retention of qualified personnel difficult. Recently, the pressure for recruitment has become more critical due to the large number of staff reaching retirement age. Understaffing and vacancies make adequate in-service orientation and training nearly impossible (TPCA, 1980).

The personnel system is inadequately designed to attract or retain agricultural scientists. There are two categories of professional staff: Foreign Service and General Service (GS). Foreign Service personnel are, as a result of recent congressional initiatives, clearly favored over GS personnel in top-level staffing and promotion. Most of AID's few trained scientists, however, are GS employees who can expect little or nothing in the way of promotion. As a result, about one-third of the staff of the Office of Agriculture in the Development Support Bureau is composed of agriculturalists on short-term loan from other Government agencies (particularly USDA) and universities. Most are not enhancing their careers by working for AID; AID, moreover, shows little gratitude.

The other key problem is organization of agricultural and research staff. Through early 1981, no one person or office was in charge of agriculture or agricultural research. Nor were any agriculturalists to be found at high administrative levels.* Those on the staff are scattered throughout the agency, almost invariably serving in a staff capacity. They have no line authority and are not in a position to make budget decisions, Most are found in regional bureaus, where they are a distinct minority and hardly have time to focus on research. The situation is even worse in country or field missions, where there are usually only one or two agriculturalists, and sometimes none. Even in the central Office of Agriculture in the Development Support Bureau (DSB), research is only one of many activities and often seems to play a subordinate role. * DSB is considered a service organization by the regional bureaus, which often have quite different concepts of research,

Some improvements could be made in staffing and organization, but this will not be easy. The Foreign Service problem transcends AID; it permeates the whole State Department structure. The organization problem transcends agriculture and involves the whole AID structure. There are vested interests in both groups which would mitigate against change, Yet unless something is done about these fundamental points, other efforts to improve the scientific component of AID will be frustrated. It may be easier to modify the organizational structure than the personnel system.

Many observers think that AID needs to pull all its technical staff members together into one or more central bureaus with line authority and responsibility equivalent to those of the regional bureaus. Agriculture would be a major component of such a consolidation, Each of the major functional divisions, including agriculture, might have a research division. * *

Another alternative is to abolish the regional bureaus and establish technical operating bureaus around the major thrusts of

*This situation changed later in 1981 with the appointment of Dr. Nyle Brady, a prominent soil scientist and former Director General of IRRI, as Senior Assistant Administrator of the Agency for Science and Technology.

*DSB has subsequently been designated the Bureau of Science and Technology (S&T).

**A partial shift has recently been made in this direction with the designation of four technical directorates within S&T. Food and Nutrition is one of the four. Technical staff members from the regional bureaus will be allowed to become associate members of S&T, Agency-wide sector councils are being established. But in most other respects, the regional bureau structure remains the same.

AID programs as defined in legislation—i.e., food and nutrition, population and health, and natural resources and energy. These technical bureaus would be headed by technical career professionals. They would have responsibility for country as well as control programs of technical assistance, research, training, and institution building. The necessary continuing functions of the eliminated regional bureaus would be assigned to regional office positions under the Bureau of Program and Policy Coordination (PPC) or an assistant administrator with limited role and powers necessary for liaison with State and collation of normal desk functions.

Title XII

As previously discussed, title XII originated as an effort by the university community to set a framework within which university participation would be more compatible with university capabilities. The law created high expectations in the university community for substantial funds to build an international dimension in all interested universities. They expected to receive enough funds to institutionalize their hopes (Furtick, **1981).**

The law provided everything needed except for new appropriations or authority over old appropriations. This condition has led to disenchantment for many in the university community, AID, and Congress. For those that have received significant funding at the country program level as a result of JCAD planning, it would probably have come to them anyway without the tortuous process involved (Furtick, **1981).** However, “strengthening grants, ” averaging $100,000 a year, have been given to some universities over which they can exercise major discretion in order to strengthen their basic international programs.

Those few universities that have been funded under CRSP, have received funds that would normally have been available under AID centrally funded research, but with fewer strings attached and not eroded by the high administrative costs levied by the title XII process. They also would not have the high administrative and matching fund requirements that are built into CRSP implementation system (Furtick, 1981).

USDA: Middle- and High-Income Nations

USDA has inherited responsibility for dealing with AID-graduate or middle-income countries and presumably is to deal with high-income nations on matters relating to agricultural research. For a long time, USDA was not authorized funds to carry out this task.

Countries wanting our help had to pay for it. Since it was difficult to set up such programs without planning, which took considerable time on USDA’s part and for which it had no funding, the situation sometimes got rather awkward. Some Federal money has recently become available for those initial expenses, but it is still a tight situation.

Essentially no funds are available for providing more general assistance. As noted earlier, a new International Cooperative Research Program has been proposed by OICD that would make it possible to initiate and expand activities in this area. The proposal is stalled for lack of funding.

TSRTP operated by USDA was also, as noted earlier, established in part as a vehicle to provide assistance to other nations. It does not appear to have been used for this purpose, and now has almost entirely a domestic orientation. Attention should be given to reviving the international aspects of the program.

The Role of States

Much of the agricultural expertise used by AID, and to a lesser extent by USDA, is provided by land-grant universities. Although often called on for assistance, the States for a long period had little voice in the process. They also had, with a few exceptions, no steady funds. With the establishment of BIFAD in AID, they gained a voice, and with the establishment of strengthening grants under BIFAD's auspices, they gained limited funding.

A BIFAD staff member has prepared a project proposal that would facilitate cooperative research activities between U.S. research institutions and the international agricultural research centers (Nielson, 1981). As of the fall of 1981, the proposal was undergoing review. It is quite promising but has a long way to go in the administrative process before it becomes a reality. *

The International Research Network

As suggested, the United States might well do more to facilitate the acquisition and use of knowledge generated by the world agricultural research community. This matter has been given virtually no governmental attention. USDA is the logical agency to lead this activity. Such a program could well be carried out in USDA in OICD, in cooperation with ARS. OICD, in fact, sponsors a few activities that might be said to be of this nature, but they are limited to just a few countries. OICD's proposed International Cooperative Research Program would make it possible to establish a significant and broad-based program. Until such an effort is funded, the United States will continue to miss out on many of the benefits of the international agricultural research network.

Engaging the Private Sector

It is probably safe to assume that any overseas research conducted by American private firms will be used by them, as appropriate, in their domestic activities. The trick is to stimulate their overseas research; this may not be easy.

*There is some precedent for such activity. In mid-1981, Australia established a center for International Agricultural Research to fund research undertaken by Australian institutions to benefit developing countries (Australian ..., 1981).

The pattern, as previously noted, is for American firms to do some research in other developed nations, but very little in less developed nations because of the relatively limited market. Incomes are low and agriculture is generally not highly advanced. Until the potential market improves, American firms are not likely to invest much in research.

A more subtle problem is that private firms are more likely to do research on mechanical rather than on biological technology because of its patentability. It may not fit as well as biological technology, however, with developing country needs.

Finally, some recent changes in U.S. Government actions pertaining to payments to gain business and environmental regulations may further dissuade American business. This administration appears to be reconsidering these matters.

Private industry could play a greater role but the role may be more limited and selective than desired.

Coordination

If greater emphasis is ultimately forthcoming to strengthen U.S. participation in the international agricultural research system, there may well be need for a coordinating process. There is so little formal activity at present that this is hardly an issue.

AID has the additional problem that through early 1981 it did not have one person or office in charge of its agricultural research activities; hence it would have difficulty in designating a representative who could speak for more than part of the organization, This situation has recently started to change.

If AID, the prime Federal agency for assistance to developing countries, is restructured to strengthen its technical capability and accountability, it will be in a position to make a significant contribution to coordinating its efforts with others.

PRINCIPAL FINDINGS

- Benefits are derived in the United States as well as globally from U.S. assistance to developing countries in solving technical problems and helping overcome socioeconomic constraints to ensure adequate food production and consumption.
- AID and USDA are involved in international agricultural research and technical assistance, but from the developing country standpoint, AID is the prime Federal agency.
- Research and technical assistance to assist developing countries require an inhouse capability in the technical disciplines and issues to be effective. Organizational structure, responsibilities, accountabilities, and procedures must reflect this fact.
- Through early 1981, AID was not organized or staffed to be effective in carrying out its responsibilities. Technical leadership was lacking in the decisionmaking positions. With 50 percent of the total budget in food and agricultural activities, technical personnel trained in these areas account for 5 percent of the total personnel, Few, if any, were in decisionmaking positions.
- The United States has much to gain as well as to give in the international research network, At present, no Federal agency has the specific responsibility for taking the lead in coordination and cooperation on methods, procedures, and actions necessary to accomplish maximum U.S. benefits.

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Chapter IX

Implications for Research Funding

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Chapter IX

Implications for Research Funding

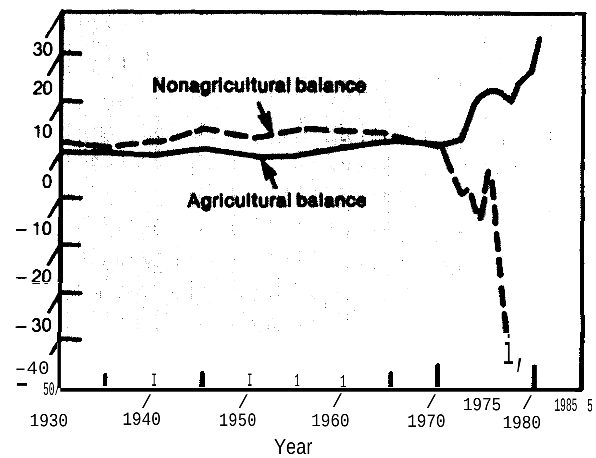
Information on the various aspects of funding U.S. agricultural research appears in several chapters of this report. This chapter brings together the more significant aspects of funding and identifies the pertinent issues as they apply to the overall assessment of research.

PRESENT SITUATION

In approaching this topic, it is well to keep in mind not only that the food and agricultural industry is the largest of all U.S. industries, but also that the application of science to agriculture has played a major role in bringing the United States to the center of world power and leadership,

One of the major ways in which agriculture has contributed to this status is the phenomenal increase in agricultural exports. The value of these exports rose from $2.9 billion in 1950 to $7.2 billion in 1970, and then increased sharply in 1975 to $21.9 billion and to $41.2 billion in 1980. This growth had the effect of increasing the agricultural balance of exports over imports from a deficit of $1,1 billion in 1950 to a positive balance of $23.8 billion in 1980. In contrast, the United States had a negative trade balance for all other commodities of $48.6 billion in 1980. Similar data for the period 1930-80 appear in figure 25.

Figure 25.—Agricultural and Nonagricultural Trade Balance—1930-80 (in billions of dollars)



SOURCE: USDA/ESS.

The fact that the rate of increase in yields of some commodities seems to be leveling off—together with the fact that the level of constant Federal dollars for some commodity research through U.S. Department of Agriculture (USDA) has been declining—raises concern as to whether the high level of agricultural exports can be maintained. Concern is also being expressed as to whether this disparity might lead to markedly higher food prices at home.

As discussed in chapter IV, most evaluations of food and agricultural public research indicate an internal rate of return that is quite favorable. For aggregate investment, rate-of-return estimates are predominantly in the range of 30 to 40 percent. The estimates range from a low of 23.5 percent to as high as 100 percent. However, these high rates of return are evidence of a problem of inefficiency. Economic efficiency calls for investment funds to be allocated in such a manner that the marginal returns in all categories are the same. The high rate of return on agricultural research indicates underinvestment by the public sector. The present funding situation reflects this fact.

Among the major Federal agencies conducting research, USDA ranks the lowest in dollar expenditures for research. In 1978, total Federal expenditures for research and development were $26.2 billion. USDA's expenditures were $381 million, or about 1.5 percent of the total. This compared to Department of Defense—45 percent; Department of Energy—16 percent; and Department of Health, Education, and Welfare—12 percent. USDA's status among Federal agencies represents a continuing decline in the Federal research and development budget—from a high of 39 percent in 1940 to 1.5 percent in 1978.

In addition to the low level of funding, the cost of conducting research has increased substantially. Research today requires more sophisticated and expensive equipment and support staff than was required 10 years ago. For example, new research horizons, such as genetic engineering and systems approaches to agriculture, are much more expensive than past traditional research.

Researchers are having great difficulty in replacing wornout or obsolete equipment and acquiring newly developed ones. Total capital expenditures per scientist doubled from 1975 to 1979 (Berlowitz, et al., 1981). In a recent study of five important physiochemical subdiscipline, it was shown that the cost of scientific instruments priced above $5,000 rose at an annual rate of 20 percent from 1970 through 1978, far exceeding the average rate of inflation (Berger and Cooper, 1979).

At many public institutions, operation and maintenance costs for scientific equipment could be supported by other budgets in the past, but now the costs exceed the capacity of institutional funds to meet them (Berlowitz, et al., 1981). When institutions cannot meet operation and maintenance costs, scientific equipment is improperly maintained, shortening the useful life thereof; support personnel are decreased and support activities accumulate; and faculty and graduate students function as technicians, with a consequent loss of time for research and training. These consequences greatly hinder a research program.

In addition to traditional research areas such as production efficiency, resource conservation, and crops and livestock, there are many new areas that require research such as environmental concerns, community services, community living standards, and human nutrition. Thus, many traditional research areas actually are receiving less funding today, because the total research funds are being spread among a wider range of research areas, some of which require considerable support.

With reduced budgets, much of the basic and long-term research efforts dwindle. Even worse, new opportunities, such as genetic engineering in plant or animal breeding (the new biology), do not receive attention due to the pressure to keep current projects active. For example, there is pressure to develop an insect-resistant sorghum during the next 3 years, rather than develop a whole new breeding system for sorghum.

It appears that the primary responsibility for this decline and low level of Federal research funding for agriculture has been USDA's. USDA leadership has not had much appreciation for the value of research and has not given it high priority (this is particularly likely to happen during a period of surpluses). To be sure, the Office of Management and Budget puts limits and pressure on all departments to stay within monetary budget levels, but departments have discretion within these limits to make priority adjustments within their departments. Up to 1980, the executive budgets have not shown the needed increases in agricultural research. As a general rule, Congress has appropriated the full requested budget level for agricultural research and in some cases has increased the level of USDA funding.

Although Federal funding of agricultural research has remained nearly static in constant dollars since 1965 and research on agricultural production has decreased, many other countries have had major increases in expenditures for agricultural research (see table 14, p. 162). Even as late as 1959, U.S. public expenditures for agricultural research were significantly greater than any of the countries or regions listed. This is not true today.

To view the data in the right perspective, one should keep in mind that most of the other countries probably badly needed an increased emphasis on agricultural research during the period surveyed, At the same time, the United States was still reaping broad benefits from a past era when research had received greater emphasis,

Since the productivity of agriculture and most industries relies heavily on research and new technologies, it is evident that if the United States is to remain the world leader in agriculture, a major change will be needed in the trend of expenditures in U.S. agricultural research.

What should be the extent of public investment in U.S. agricultural research? This question cannot be answered precisely. Evidence indicates, however, that it should be much higher than it is. The trend to relatively slight increases in agricultural research has resulted in actual decreases in most old-line agricultural research efforts. (The term "old-line research" refers to areas such as ways to increase productivity of animals or crops. Newer kinds of research that compete for the research dollar would include studies in areas such as environmental quality, energy from nonfossil fuel sources, etc.)

FUTURE SOURCE AND DISTRIBUTION OF FUNDS

From what source or sources should the funding for public-supported research come? There is little doubt that many States will continue to increase their investments in agricultural research, but the rate of increase will probably be less than needed. Some will fall behind; a few are already experiencing difficulties. There is ample evidence, based on beneficiaries and spillover effects of research, that from an equity standpoint the major source of funding should be the Federal Government.

The question also arises as to how agricultural research dollars funded by the Federal Government should be distributed. Again, there are no quantitative data to give precise answers. There are, however, past records and logic that can give some guidance. In the first place, USDA has the responsibility as the lead agency for the program and for working cooperatively with the State agricultural experiment stations (SAES) and other institutions. Since 1916, the relative amount of federally appropriated funds has averaged about 78 percent for USDA in-house research and 22 percent for the States in the form of formula and special grant funds. Since that system has served the United States well in the past, there appears to be no overriding rationale for a major change in this ratio.

Formula (Hatch) funds were first made available to the SAES on the basis that it was in the national interest to have a SAES in each State working on State and local problems. This need still exists, and now that we have a better knowledge of the beneficiaries and the spillover effects of research, the rationale for Federal funding is even greater today. Unlike research in many other fields, much agricultural research is site specific, simply because it is so closely related to the problems of a specific area. Hence there must be facilities and professional staff available for such research, none of which can be created or dissipated on short notice. Biological research must be long term and continuous to be effective. SAES are best equipped to manage the solution of local and State problems. Formula funding, therefore, which has been a continuing and secure source of funds, has been a mainstay in developing strong SAES. The need continues and will continue in the forseeable future.

Competitive grant funds are useful in providing flexibility in funding research areas that have high priority because of changing economic or other conditions or where new research indicates a greater effort has a high probability of being successful. These grant funds thus are concerned primarily with relatively short-term projects—i.e., 2 to 6 years (even though these may be on long-term problems). Another use of grant funds is to obtain expertise in certain research areas where it either is unavailable from the in-house staff or would not be desirable or efficient for in-house staff to conduct such research. All research institutions are eligible to compete for these grants, and the desirable level of funding for such grant research is probably best determined through experience. Unless some specific amount is set aside for grant funding, there may well be a tendency to contract for a less desirable level of research.

The SAES and the U.S. universities represent a tremendous resource—in physical facilities and in qualified personnel—for agricultural research and education. It is in the U.S. interest to use these resources in carrying out the national research effort wherever capability and mutual interest exist on specific objectives and programs.

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Chapter X

Issues and Options

NOTE: This chapter was largely completed in early 1981 and refers to the food and agricultural system as of that date. Draft copies were made available at that time for congressional committee staff and executive agencies. Some of the report's policy options have already been enacted. The chapter has not **been revised to reflect these changes, but the options enacted or in the process of being enacted are mentioned in footnotes.**

Contents

Issues and Options

This assessment of U.S. food and agricultural research addresses the structure of the research system as it relates to meeting the national and international research needs: a] to define local, regional, and national problems on a scientific or other basis in order to assign research responsibilities, b) to identify research roles of participating agencies, c) to evaluate present methods of priority determination, and d) to assess the quality of research management, the adequacy of funding systems, and methods of fund allocation.

Six main issues were identified and investigated. The study resulted in a number of pertinent findings for each issue. Those findings that require action by the executive branch, but that also may be of interest through oversight to Congress, are discussed in more detail in appendix A. Others led to a number of options which Congress might consider in actions it chooses to take in strengthening and improving the U.S. food and agricultural research system. The relative merits and disadvantages of the options also are presented to give guidance in choosing the most suitable options and their possible courses of action.

ISSUE: ARE CURRENT ROLES OF THE PARTICIPANTS IN THE FOOD AND AGRICULTURAL RESEARCH SYSTEM WELL-DEFINED AND APPROPRIATE?

FINDINGS

There is a role for a strong national U.S. Department of Agriculture (USDA) research program. This role has been carried out in the past by USDA in-house research and Federal funding to State agricultural experiment stations (SAES). Historically, the USDA role was associated with broad regional, national, and international activities. The role of SAES, insofar as Federal funds are concerned, has been primarily for local, State, and regional problems. These roles are becoming less distinct.

Grant funds are provided for newly identified high-priority research needs. SAES, nonland-grant universities, and others compete for these funds on the basis of their interest and ability to do Federal research. This is a desirable aspect of the total research effort.

The Committee on Food and Renewable Resources has not yet satisfactorily fulfilled its role. This is because it is a relatively new feature in a well-entrenched bureaucracy; it needs more specific, highly defined objectives; and it does not have the authority of individual agencies that might be addressing the same problems from more authoritative positions.

Under the 1977 Food and Agriculture Act, the **1890** land-grant institutions and Tuskegee Institute participate in research and receive most of their funds from Federal resources. Their academic role and functions are consistent with those of the 1862 land-grant institutions, They have pressing needs—one of the more important being improved facilities. Coordination with the rest of the system is less than adequate.

The private sector tends to view its role primarily from a profit potential. It conducts research in areas of company interest and in areas that may give it proprietary advantages. There are significant research areas of interest to the public that are not receiving nor will receive adequate research attention if left to the private sector.

OPTION 1

Maintain present roles with clarification. This option would imply continuation of most procedures in effect.

USDA would continue in its role as lead agency in the Federal Government, including coordination of all agricultural research, extension, and teaching activities conducted or financed by Federal funds. Roles would be more clearly defined as follows.

Federal funds allocated to USDA would be primarily for problems of regional or national importance, where: a) the nature or magnitude of the problem is such that a single State or States cannot provide the resources for its solution, b) there is regional or national concern for the problems, or c) from an industrial standpoint, the risk is too high or too demanding for a single industry. USDA also would remain responsible for servicing the research needs of action agencies within USDA. USDA would remain responsible and accountable to the executive and legislative branches of Government for the administration and national coordination of such programs. USDA would leave to the States those local, State, and site-specific problems that can be handled by the SAES.

SAES, insofar as formula funds are concerned, would have primary responsibilities for State and local problems. SAES also would deal with problems of a regional, national, and international nature that are an extension of their State and local problems. But, where USDA has active regional and national programs, such programs would be developed cooperatively. SAES and other institutions (e.g., nonland-grant universities) would compete for grant funds on the basis of their ability to effectively perform needed tasks.

The 1890 land-grant institutions would continue to receive Federal funds and carry out their present role. However, coordination with the rest of the system would be improved.

The private sector would continue without special incentives or pressures to conduct the research that best fits its interests.

Pros

This option provides Congress and the executive branch with one Federal agency, USDA, to hold responsible and accountable for the coordination of all Federal agricultural research funds, and within USDA, Agricultural Research (AR), which is responsible and accountable for broad regional, national, and international research programs. It provides a mechanism (when properly managed and organized) to carry out programs of immediate concern to Congress and the executive branch and to respond quickly to their mandates. It also provides a mechanism whereby Federal funds can go directly (through formula funding) to the SAES and the 1890 land-grant institutions. This helps maintain their research base and makes available the extensive resources of these institutions for problems of national concern—for direct use through grant funding and through cooperative efforts with AR. Further, through grant and contract funding, other interested research institutions can contribute to the national goals and needs of U.S. agricultural research.

The private sector is encouraged to continue its research efforts in those areas of most importance to the specific firms in accordance with the competitive and free enterprise system of this country,

Cons

This option continues to perpetuate the concern on the part of SAES of too much direction and coordination of research conducted with Federal funds. Non-USDA research institutions may feel that USDA is attempting to dictate their research programs to them. It also continues to foster greater difficulties in coordination of regional research funded through Federal sources than might otherwise occur if earmarking of formula funds by Congress for high-priority areas of research were implemented. It perpetuates the problem of lack of strict accountability to Congress or USDA regarding the types of research problems which are to be funded. In addition, it perpetuates the lack of objectivity or clear rationale reflected by the Office of Management and Budget (OMB), the Office of Science and Technology Policy (OSTP), and others as a basis for choosing the research areas for funding. The decisionmaking process for agricultural research would remain unclear to the outside critics concerned with agricultural research.

OPTION 2

Eliminate the in-house USDA role. Provide increased funding to SAES to conduct most publicly supported research.

Pros

The SAES have large and capable research facilities and staff. They are well-acquainted with local and State problems and can effectively conduct research on these problems. Most regional and national problems are made up of local and State problems and if these are solved at the State level, eventually all such regional and national problems will be solved. Federal funds to the States provide more freedom to the individual researchers, and research can best be carried out in an atmosphere free of constraints.

This decentralization reduces the problem of bottlenecks in the articulation of local and State research needs and the flow of communication from the clientele to the researcher by not having to pass through high levels of administration in Washington, then back down to the researchers themselves.

Cons

This option provides no mechanism for an agency or individual to be responsible for the identification of specific national or regional research needs, methods of attack, and assurance that given programs could be carried out. It provides for no agency with direct accountability. It provides no mechanism for immediate and quick response to issues, problems, and programs of immediate concern to Congress. It provides no direct support linkage to the research needs of USDA and other Federal action agencies.

When funds are in short supply, priorities must be set and funds allocated to the high-priority items. Researchers have to direct their interests and efforts to the high-priority items and the availability of funds. The important national research issues are not solved by a large number of researchers working "on" a problem, but by a few concentrating their efforts on the more important aspects of the problem and by coordinating and using in a planned approach all interested efforts relating to the specific problem in question. It is doubtful that an individual State or group of States is capable of supporting and conducting research of major national interest problems involving, for example, marketing, transportation, watersheds, and Federal regulations.

OPTION 3

Eliminate the in-house USDA research role. Use present in-house funds, special grants, and competitive grant funds for contract research to carry out important USDA research programs.

All in-house USDA research funds and USDA contract and grant funds except formula funds would be placed in one agency to be used for contracting important USDA research programs, a system similar to that used by the U.S. Agency for International Development (AID). USDA laboratories and field locations, including Beltsville, could be organized into centers for contract purposes. Federal positions, except those required for contracting purposes, at such locations would be eliminated. A fairly large overall USDA management and contracting staff with training in appropriate technical aspects of agriculture would be required. Ownership of field and laboratory facilities could be retained by the Government.

Pros

This would eliminate many Federal positions in USDA and would ease the personnel ceiling problem considerably, Coordination might be improved in cases where SAES or State universities received contracts to carry out USDA programs. It might make the closing of some low-priority Federal facilities easier. USDA's ability to shift program emphasis when desired might be improved, It could provide special funds for additional short-term contracts on high-priority areas. Land-grant university research programs and those of the SAES receiving research contracts probably would be strengthened by the influx of new research funds.

Cons

This would eliminate the largest agricultural research organization in the United States under one management system. AID, which did and does operate in this manner, has never been able to attract sufficient competent technical staff. Thus, USDA would probably find it difficult to maintain a highly competent staff capable of planning broad regional and national programs, Since conduct of agricultural research on these programs is the principal purpose of the Federal in-house program, this function would be mostly lost. Costs of conducting such research programs probably would increase, because contractors, whether from State agencies or the private sector, would require a certain level of profit. It would be disruptive to all affected Federal research scientists, because they would have to become research contract managers to stay in USDA, or lose their Federal retirement and other benefits if they became contractors themselves or if they resigned. Many, if not most, scientists probably would seek employment elsewhere, and it probably would be difficult to hire competent staff. It would be very disruptive to the present research programs, and it would make planning and coordination with SAES more difficult, except where the SAES or State university was the contractor.

OPTION 4

Reduce the role of SAES in regional, national, and international research from the Federal standpoint by eliminating all formula funds, leaving grants as their source of Federal funds.

Pros

This would help eliminate the criticism that formula funds are given to SAES without sufficient accountability and Federal management, It might help to remove some of the competition between SAES and USDA over budgets. It would increase the probability that Federal funds going to SAES and other institutions would go to those most capable of performing good research, if done on a competitive basis. It would make it easier to be sure the funds were spent on problems deemed by the Federal granting agency to be of high priority at the time of the grant.

Cons

This would tend to eliminate or drastically reduce the partnership between USDA and SAES and have some negative effect on coordination and cooperation. Many SAES could not maintain their research base without the present formula funding.

Unlike research in many other fields, much agricultural research is site specific, simply because it is so closely related to the problems of a specific area. There must be facilities and professional staff available for such research, none of which can be assembled or dissipated on short notice. Biological research must be long term and continuous to be effective. SAES are best equipped to manage this research, and formula funding provides a continuous and secure source of funds for this activity. In addition, overhead costs on grant funds are high; there are no overhead charges on formula funds. Therefore, from the Federal standpoint, less money is actually spent on research under grant funds than under formula funds.

It would draw resources (scientists) to one institution (receiving the funds) from other institutions. It would intensify competition for an available pool of scientists and the total social product could be decreased, It would also weaken the positive interrelation between fundamental knowledge creation and applied technologies or processes that exist in SAES. In addition, it could weaken the synergistic relationship among research, extension, and teaching. This would also decrease the capacity and initiative of some land-grant universities to develop young agricultural scientists who have regional and national orientation.

OPTION 5

Increase the role of the private sector through incentives to conduct more research of concern to the public.

Pros

The private sector now conducts research for the agricultural industry on the basis of business investment. It has the capability to conduct more research and probably would if it were profitable to do so. By providing direct grants, tax deductions, or other incentives, the private sector might be induced to increase its efforts in agricultural research. Since most businesses are profit oriented, the research would be directed more to practical business needs and hence might be of more immediate economic value than some long-term basic research efforts.

Cons

The very nature of the private sector requires it to be concerned with self-interest and self-preservation. While increased incentives might be helpful in some areas, it would be a mistake to assume any amount of incentives would assure adequate research on all issues of public concern and priority needs. Many public research needs in agriculture, if solved, would be counterproductive to some agribusiness firms—probably those that would be the most capable of working on such problems. Industry is not interested in conducting research on nonproprietary products. Research conducted by USDA and SAES maintains competition and is in the public interest. Research in the private sector, while frequently having many public benefits, can help to decrease competition among firms comprising the food and agricultural sector and can have adverse effects on the public in the absence of adequate public research.

There is danger of research inquiry focused on narrowly defined issues that are of proprietary interest to the business firms conducting the research. Most of the benefits would tend to be focused on business-related activities of the firm and affiliated firms, with much less attention directed to benefits to consumers and the general public.

ISSUE: ARE CHANGES NEEDED IN THE INTERNAL ORGANIZATIONAL STRUCTURE OF USDA TO EFFECTIVELY CONDUCT RESEARCH?

FINDINGS

Through early 1981, the Director of the Science and Education Administration (SEA) did not give adequate attention to policy and coordinating functions. Operational details of SEA interfere with effective management at the administrator's level.

The national program staff (NPS) has insufficient authority and responsibility to provide effective leadership to regional and national research programs. A change in responsibility would be conducive to improved staff capability.

Rationale for establishing AR regions along the same boundaries as SAES regions is managerial and has been beneficial for this purpose. This rationale does not conform to types of farming or to regional or national issues, and as AR is organized, is detrimental to the development of broad regional and national programs.

There is little evidence of the need for area director positions in AR.

Cooperative Research (CR) conducts Hatch-supported project reviews. These are less than in-depth examinations. As a part of the process, onsite reviews are held, but at no specific intervals and with no required follow-up except as would be done locally.

CR lacks authority in dealing with the States. It operates as though it were under the supervision of SAES directors rather than the administrator of SEA.

CR administers the competitive research grants programs. Its major clientele, SAES, compete for these grants. There is criticism of this arrangement.

Human Nutrition (HN) has not accomplished the intent of the Food and Agriculture Act of 1977 with respect to human nutrition research. USDA established human nutrition research as a mission, but it did not establish human nutrition as a separate budget item. Nor has it properly funded and staffed the six research institutes to conduct meaningful research.

Through early 1981, in the Economics and Statistics Service (ESS), concern existed that the combination of the statistical unit with the economics research unit had caused confusion for the public between the statistical unit's information and the projections and forecasts of the economics research unit. A small proportion of the economic research budget is allocated to research and there is very little cooperative effort with AR.

SEA Organizational Structure

OPTION 1

Operate as a policy and coordinating office. *

SEA would no longer have an operating function. The administrators of the respective agencies would be responsible for the operating functions of their agencies. For example, budgets and other management functions would be prepared within each of the agencies and coordinated at the SEA level.

Pros

The administrators of AR, CR, HN, and Extension could operate more efficiently if SEA were strictly a policy and coordinating office rather than an operating office, thus delaying decisions that can easily and more effectively be made by the administrators, and often second-guessing them. The director of SEA would have more time to carry out the policy and coordinating responsibilities of the office. These are not given enough attention and this may be one of the reasons research has not done well financially in recent years. This option would be helpful in removing the criticism of the administrators and SAES of the time involved and limited results produced from the SEA budget process. It would reduce staff requirements of SEA and shorten decisionmaking time for the administrators.

Cons

Removing the operating responsibilities of SEA and placing full operating responsibilities with the administrators would strengthen each of the respective administrators, but might make coordination and planning at the SEA level more difficult.

OPTION 2

Establish an Assistant Secretary for Research, Extension, and Higher Education with a Deputy Assistant Secretary who would coordinate agencies comprising SEA. The position of Director of SEA would not be retained.**

In recent years, research has become increasingly less important in USDA as evidenced in the budget and structure of the Secretary's office. Most studies of U.S. agricultural research have recommended that the present functions of SEA be headed by an assistant secretary.

*USDA has begun putting this option into effect.

**The presently drafted Agriculture and Food Act of 1981 authorizes a USDA Assistant Secretary for Research, Extension, and Higher Education.

Pros

This option would give research increased prominence in USDA and in the eyes of OMB and Congress. The office would have a larger role in forming overall policy and would give agricultural research a higher level of recognition. Further, it would have additional advantages as discussed in option 1. The role of knowledge creation and application in contributing to overall national policy and welfare would be strengthened within USDA.

The cost, both in terms of funds and social product or welfare forgone, always goes up as the number of individuals involved in coordination, planning, etc., is increased. Creating an assistant secretary could reduce somewhat the marginal social costs relative to current operations.

Cons

USDA has a limited number of assistant secretary positions. Since USDA in the recent past has not rated research and the other functions of SEA at a high level, it would not like to see one of the present authorized assistant secretary positions mandated for these functions. This option would require the removal of an assistant secretary position from another function unless Congress authorized an additional one.

Agricultural Research

OPTION 1

Within AR, transfer line authority including the responsibility and accountability for planning and coordination of research, and resource allocation for regional and national research, from regional administrators to NPS staff. (Discussed in app. A.)

OPTION 2

Same as above, but consider a change in the number and/or location of regions to provide more efficient management and eliminate the offices of area directors. (Discussed in app. A.)

Cooperative Research

OPTION 1

Strengthen authority in managing Federal funds to the States.

The authority of CR would need to be increased to enable it to administer Federal funds more effectively. CR would exercise more rigorous authority in approval and disapproval of proposed projects under formula funding and for reviews of such projects to be continued, reduced, or discontinued than it does today,

Pros

With increased authority, CR could represent the SAES in a more meaningful way within USDA concerning budgets, research priorities, formula v. grant funds, etc. It would increase their effectiveness in the review of research projects funded by Hatch or grant funds, as well as in their periodic reviews at the individual SAES. Such reviews would tend to increase the contributions of these projects and programs to agricultural research in general. This plan would help to eliminate criticism by OMB and others that these funds are not well-managed.

Cons

The original Hatch Act makes the directors of the SAES responsible and accountable for the Hatch funds they receive. It is doubtful that all SAES directors would agree to a stronger CR without legislation changing the agency's organic act. An effort to do this without the support of the SAES would be disruptive to the research effort.

OPTION 2

Establish formula funds as block grants and eliminate the CR office; establish a secretariat for handling block grants.

The directors of the SAES have the responsibility and accountability for the Hatch funds they receive. At best, CR is a general coordinating office with little or no real

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authority. This option would eliminate CR and set ‘up a secretariat to perform the task necessary to transmit the formula funds as block grants.

Pros

This option would save time, funds, and personnel positions of SAES and USDA, since the present reports, reviews, and planning with CR would not be required. It would have little or no adverse effect on research programs.

Cons

This option would tend to increase the criticisms that formula funds receive little or no meaningful review by USDA. The present reviews are desired and thought to be helpful by a number of SAES, but this benefit would be lost. CR staff provides services to the States other than project reviews, such as training for SAES directors, that would be eliminated.

OPTION 3

For options 1 and 2 above, remove administration of all competitive grants from CR or secretariat staff and establish an office for this function that would report directly to the Assistant Secretary of Research, or Director of Science and Education.

Pros

The competitive grants would be administered by an agency or office that would have no vested interest in who receives the grants. Any office that has a vested interest and administers such grants is subject to criticism, whether warranted or not. This option would give more objectivity to the competitive grants program. While this would mean an extra office reporting to the Assistant Secretary or Director of SEA, there would be a comparable reduction in authority and workload in CR.

Cons

It would require establishing an additional office.

Human Nutrition

Interagency Options

The OTA report *Nutrition Research Alternatives* discussed earlier dealt with interagency issues in nutrition research. The options on interagency cooperation stated in that report are still pertinent. The following option is added:

OPTION

Adopt a uniform accounting system for nutrition research expenditures for Federal agencies engaged in nutrition research.

This system would differentiate between those projects whose primary goal was human nutrition and those in which human nutrition was of secondary interest. A standard definition of human nutrition research would be followed.

Pros

This system would give Congress a mechanism whereby it could reasonably compare nutrition research efforts at USDA and the Department of Health and Human Services (DHHS). At present, this cannot be done because of the retrospective approach to the nutrition-research budget taken by DHHS and the large number of research projects done by the National Institutes of Health (NIH) in which nutrition is of secondary interest.

This system would eliminate double reporting of research funds which frequently occurs in an area such as nutrition because of the interdisciplinary nature of the field and its interactions with diseases, as well as growth and aging.

This system would differentiate between research actually carried out in humans and that which merely may have applicability to humans.

Cons

Unless Congress can articulate a satisfactory accounting method that will clarify the research efforts of USDA and DHHS, it will be left to the individual agencies to determine.

Intra-Agency Options

OPTION 1

Maintain present management structure within USDA with clarifications in budget and staffing. [Discussed in app. A.)

OPTION 2

Remove HN from SEA and place it under the Assistant Secretary for Consumer Affairs. (Discussed in app. A.)

OPTION 3

Dispense with the HN center as an administrative and planning entity, and disperse human-nutrition research within AR, with each of the centers under the authorit y of the director for that region. (Discussed in app. A.)

OPTION 4

Dispense with HN as an administrative and planning entity, disperse the clinical and laboratory components within AR under the authority of the regional directors, and place the survey and statistical research information services under the Assistant Secretary for Food and Consumer Services.* (Discussed in app. A.)

OPTION 5

For options 1 and 2 above, determine if all regional HN research centers are needed, and if not, which ones best serve the public interest. Available funds for HN would be allocated to the needed centers. (Discussed in app. A.)

Economics and Statistics Service (ESS)

OPTION 1

Reinstate each ESS component to separate agency status reporting to the Assistant Secretary or Director for Economics. (Discussed in app. A.)**

OPTION 2

Reinstate each ESS component to separate agency status with the Statistical Reporting Service (SRS) reporting to the Assistant Secretary or Director for Economics and the Economics Research Service (ERS) reporting to SEA. (Discussed in app. A.)

* USDA has put this option into effect.
* *USDA has put this option into effect.

ISSUE: IS THE PRIORITY-SETTING SYSTEM FOR FOOD AND AGRICULTURAL RESEARCH WORKING?

FINDINGS

To adequately determine research priorities, explicitly stated goals for food and agriculture are required. There are no well-defined food and agricultural goals for the research community to use in determining priorities.

There is concern whether the functions assigned to the Joint Council on Food and Agricultural Science (JC) are attainable. It has had major problems in attempting to satisfy these functions and as a result has had limited impact. Its effectiveness is limited by a lack of consensus among its members on its role, perception of USDA dominance, and overorganization.

Functions assigned to the National Agricultural Research and Extension Users Advisory Board (UAB) are more attainable than those for the JC. Impact of UAB on research priorities is unclear. It cannot represent all users of research, and those not represented are critical of UAB's performance. UAB, like the JC, lacks its own operating funds and is dependent on USDA for its resources. Its membership includes research performers as well as users.

There is lack of a satisfactory long-term process for evaluating existing research activities, potential research opportunities, and development of a new set of research priorities. Long-term research planning covering a period of 4 years or more can be accomplished by an intensive, comprehensive study involving research administrators, scientists, and users.

Food and Agricultural Goals

OPTION 1
Maintain present system of no goals.

Pros

Establishing goals for food and agriculture is complex and time consuming. Not setting goals saves much time and expense of elected officials. Congressional action frequently represents the thinking of the most articulate groups. This may or may not represent the best action for a given sector.

Cons

With no goals set by society, the research community must assume some goals in order to prepare a research agenda. The research community cannot agree on what these goals should be, and this results in continuing confusion over the research agenda. The research community will continue to be criticized for its lack of direction. Further, since Congress provides the funds for research, it should set the broad long-term goals and expect the research community to respond to them.

OPTION 2
Congress and/or the executive branch set goals for food and agriculture.

Pros

This would give clear direction to the research community on what the research agenda should be. Public funds would be spent on research needed to meet goals established by society through its elected officials. Congress and the executive branch must deal with conflicting goals all the time, consequently they are in the best position to do this. Since Congress provides the funds for research, it should set the broad goals and expect the research community to respond to them.

Cons

Setting goals in food and agriculture is complex and time consuming.

Research Agenda

OPTION 1
Prepare a national research agenda at specific intervals using scientists, administrators, users, and consumers under the auspices of USDA. *

Such a study would: a) evaluate what is being done, existing priorities, and needed research opportunities, and b) develop a new set of research priorities and recommendations.

The study would use methodologies pioneered by the National Academy of Sciences' World Food and Nutrition Study and the OTA studies on nutrition research alternatives and emerging food marketing technologies for priority determination.

It would be conducted every 4 years with a final report delivery date of December 1 of the year of each Presidential election. The timing would coincide with both the installment of an administration and the enactment of the farm bill.

"The presently drafted Agriculture and Food Act of 1981 mandates USDA to conduct a long-range planning study for food and agricultural research.

Such a planning system would not be institutionalized in terms of the individuals involved. A cross section of scientists, research administrators, users, and consumers would be included. The staff conducting the study would be very small, consisting of a director, deputy director and a few assistants. The bulk of the work would be conducted through the various work groups of participants. This ad hoc feature is viewed as being critical to success in long-range infusion of new ideas.

Short-range planning would be done regularly by each research entity in conjunction with budget preparation. To bridge the gap between priorities and budget, research units would give special attention to how the proposed budget fits into the achievement of the goals established by the priorities identified in the long-range plan. Flexibility would exist for individual research units to emphasize those designated priorities that fit most closely their agricultural situation. This system is not meant to be a national priority setting for SAES, since they are primarily responsible for State and local issues. But it is a system for national priority setting for broad regional and national issues.

Using the concept of long-term priority establishment and short-term budget planning, the JC and UAB would modify their responsibilities to place emphasis on: 1) supervising the planning process, z) providing a forum for communication, and 3) providing interim evaluation of planning goals. Specifically, they would assist in identifying and recruiting scientists, administrators, users, and consumers to be part of the long-range planning process. They would be the focal point in monitoring and evaluating the extent to which the research system is meeting the objectives specified in the long-range plan. They would also provide an interim evaluation of priorities in light of conditions in agriculture.

The whole process would be conducted on a continuous rolling basis that generates reports of past accomplishments, support for budget hearings, and periodic reports on longer term priority needs of budget planning and authorization.

Pros

Priorities established in the long-range study would serve as the basis for authorization and budget hearings with Congress and give a sense of direction to the total research effort. Hearings would reflect accomplishments and changes in the orientation that result from the planning process.

The modifications of responsibilities for the JC and UAB would permit a more simplified structure, particularly for the JC, than is currently anticipated. Also, the number of meetings required would be substantially reduced.

Coordinating the study under the auspices of USDA would be in keeping with the lead agency responsibilities for food and agricultural research given to USDA by Congress.

Cons

Because the study is coordinated under the auspices of USDA, other participants in the research system may feel it is a USDA study.

OPTION 2

Prepare a national research agenda at specific intervals using scientists, administrators, users, and consumers under the auspices of NAS.

This would be the same concept as discussed in the previous option. The only change is that it would be coordinated under the auspices of NAS rather than USDA.

Pros

NAS would be considered an unbiased and thus more objective party than USDA by some of the participants in the research system.

Cons

Historically, NAS has resisted the use of lesser known scientists, nonscientists, users of research, and the public in conducting such studies. The success of this effort depends to a large extent on the participation of these groups. NAS expertise is more oriented to basic rather than mission-oriented research. Also, having NAS responsible for such a study would weaken USDA's leadership role in research, which is contrary to recent legislation.

ISSUE: HOW SHOULD FEDERAL FUNDS BE ALLOCATED FOR IN-HOUSE USE AND FORMULA DISTRIBUTION?

FINDINGS

Formula funds are necessary for maintaining a strong SAES in the pluralistic food and agricultural research system.

Distribution of Federal funds for in-house funds, formula funds, and special grants has remained relatively constant over the last 65 years.

OPTION 1

Maintain present method for distribution of in-house and formula funds.

The distribution of Federal funds to SAES and USDA would continue to be determined by negotiation between the two parties and the relevant appropriations subcommittees.

Pros

Since historically the distribution of Federal funds for in-house and formula funds has remained relatively constant and has seemed to work well, there is little need for change.

Cons

Much time and energy are spent by many individuals and organizations in vying for these funds. Their efforts could be better spent in conducting research.

The friction created by this process unnecessarily interferes with the needed close relationship between SAES and USDA.

OPTION 2

Set Federal funds for formula funding and special grants at a fixed percentage based on historical precedents.

SAES would receive a specific percentage of the total Federal funds for research. The percentage to be derived is not meant to be a minimum or maximum. It would be a fixed amount that is determined by Congress based on performance and historical precedent. This would be based on the total of formula funds, special grants, and AR in-house funds. The base would not include competitive research grants and capital investments.

Pros

A fixed percentage would end the vying for funds by SAES and USDA at the expense of each other and would reduce the time and effort involved. It would allow these two major research institutions to work more closely together toward their common goals and present to Congress a more unified approach to solving our important food and agricultural problems. It would eliminate the most important cause of friction between USDA and SAES, which at times adversely affects the whole system.

Cons

In the budget process, individual budgets should be authorized on their merit and not as a percentage. Budgets set as a percentage of total funds introduce the likelihood of a lack of rigor in responsibility and accountability of expenditures.

ISSUE: WHAT SHOULD THE SOURCE OF FUNDING BE FOR U.S. AGRICULTURAL RESEARCH, AND ARE PRESENT LEVELS ADEQUATE?

FINDINGS

USDA expenditures for research are the lowest among major Federal agencies that conduct research. In 1978, USDA's share of Federal expenditures for research was 1.5 percent of total expenditures.

Constant dollar agricultural research expenditures of USDA in-house research increased only 1 percent between 1966 and 1979, while those in SAES increased 40 percent.

State appropriations are the major source of research funding at the SAES, and in constant dollars increased 57 percent from 1966 to 1979. Federal Hatch funds account for 20 percent of SAES funding, and in constant terms have increased on the average only 1.5 percent a year from 1966 to 1979, or 20 percent for this time period.

The justification of public funding of food and agricultural research is based on benefits well in excess of costs. Issues of equity, because of the interstate flow of food and related commodities and the spillover effect of research from one geographic region to another, are also cited. Producers benefit from expanding demand and from reduced costs. The distribution of consuming population among States, however, is related to the distribution of agricultural production only to a very limited degree. From the equity consideration of the geographic distribution of costs associated with research and the benefits flowing from this research, substantial Federal funding of food and agricultural research is considered the most equitable. Paradoxically, Federal research funding, relative to State funding, has decreased as the interstate flow of commodities has increased. Therefore, taxpayers in food-surplus States are subsidizing consumers in food-deficit States, and the degree of subsidization is increasing steadily.

OPTION 1

Maintain present Federal funding levels.

Pros

From a management standpoint, limited funding, up to a point, tends to increase the efficiency in the use of funds. It focuses the use of funds on the highest priority areas. Even though funds are not adequate, in times of austerity it may be all that can be afforded.

Cons

There is a certain level of funds needed just to maintain the research establishment. This does not allow research institutions to keep pace with higher research costs and does not allow research into new problem areas without reducing significant levels of effort in important traditional research areas. Nor does it allow the United States to maintain the strength and responsiveness necessary in meeting growing U.S. and worldwide needs and demands for food and other agricultural products. From an equity consideration, the ratio of Federal funding relative to State funding for research would not improve, causing taxpayers in food-surplus States to continue subsidizing consumers in food-deficit States.

OPTION 2

Significantly increase present Federal funding levels for food and agricultural research.

Pros

Significantly increasing the Federal level of funding will: 1) allow the research institutions to better keep pace with the high cost of conducting research, 2) allow the pluralistic research system to embark into new areas of research while maintaining significant levels of effort in important traditional research areas, and 3) allow the United States to maintain the strength and responsiveness necessary in meeting growing U.S. and worldwide needs and demands for food and other agricultural products. From an equity standpoint Federal funding relative to State funding for research would increase, which in turn would decrease, if not eliminate, the subsidization by taxpayers in food-surplus States to consumers in food-deficit States.

Cons

From a strict management standpoint an increase in funding may tend to decrease the efficiency in the use of funds.

ISSUE: DOES THE INTERNATIONAL RESEARCH PROGRAM SERVE NATIONAL AND INTERNATIONAL INTERESTS?

FINDINGS

AID and USDA are involved in international agricultural research and technical assistance, but from the developing country standpoint, AID is the prime Federal agency.

Research and technical assistance to assist developing countries requires an in-house capability in the technical disciplines and issues to be effective. Organizational structure, responsibilities, accountabilities, and procedures must reflect this fact.

Through early 1981, AID was not organized to be effective in carrying out its responsibilities. Technical leadership was lacking in the decisionmaking positions. With 50 percent of the total budget in food and agricultural activities, technical personnel trained in these areas accounted for 5 percent of the total. Few, if any, were in decisionmaking positions.

The United States has much to gain as well as give in the international research network, At present no Federal agency has the specific responsibility for taking the lead in coordination and cooperation on methods, procedures, and actions necessary to accomplish maximum U.S. benefits.

OPTION 1

Centralize technical staff in one bureau in AID. USDA would maintain its present level of activity. * (Discussed in app. A.)

OPTION 2

Establish within AID technical operating bureaus around the major thrusts of the AID program as defined in legislation—i.e., food and nutrition, population and health, and natural resources and energy (technical bureaus would be headed by technical career professionals). USDA would maintain its present level of activity. (Discussed in app. A.)

OPTION 3

Increase USDA involvement in the international agricultural research network with major emphasis on maximizing U.S. benefits. This applies to both options 1 and 2 above. (Discussed in app. A.)

*AID has moved in the direction of this option, but still retains the regional bureau structure,

Appendixes

Options That Relate Primarily to Action by the Executive Branch but in Which Congress May Wish To Be Involved Through Oversight

Science and Education Administration-Agricultural Research (SEA-AR) (see p. 185)

OPTION 1

Within AR, transfer line authority including responsibility and accountability for planning and coordination of research, and resource allocation for regional and national research, from regional administrators to the national program staff (NPS).

The reorganization of 1972 removed scientific leadership from the former national technical leaders (now NPS) and placed it in the hands of regional deputy administrators and area officers, NPS is divided into five units, headed by a chief, as follows: livestock and veterinary science; soil, water, and air; crop science (production and protection); post-harvest technology; and human nutrition. Since most U.S. Department of Agriculture (USDA) laboratories or field locations are organized around mission-oriented research, only two or three of the chiefs are usually involved at any location.

This move has resulted in a lack of national leadership for national programs and, in effect, substituted a series of programs more oriented to local, State, or several State areas. NPS has no authority in research allocation. Instead, it offers strictly staff recommendations which may or may not be accepted.

Pros

This option would reduce wasted manpower and eliminate many of the unnecessary and unproductive debates in developing regional and national programs. It would greatly facilitate the development of national research leaders, strengthen the scientific aspects of the programs, help to focus the programs on the important regional and national issues, and improve cooperation with State agricultural experiment station (SAES) scientists and other scientists. This provides an opportunity for close contact between research scientists and their immediate NPS specialists and the assurance of coordination of various disciplines at the chief level. Scientists and administrators can choose the appropriate NPS specialists, chief, deputy administrator, or administrator to contact according to their needs.

Cons

Resource allocation decisions would be made by scientists interested in broad regional and national concerns. This would make it more difficult for local interested groups to divert the efforts of the local AR scientists and budgets to local and State problems.

OPTION 2

Same as above, but consider a change in the number and/or location of regions to provide more efficient management and eliminate the offices of area directors.

The geographical area covered by each regional deputy administrator was chosen to coincide with the SAES regional areas and has little significance with truly regional research problems. Such problems do not follow State lines, nor does any group of regional problems fall within the same cluster of States. Consideration should be given to whether there is a need for four such regional administrators and their best geographic locations, including the D.C. area. It is beyond the scope of this assessment to study the specific number needed and their most effective location. However, the findings of this assessment raise questions concerning the need for and efficiency of the present number and their location.

Pros

This option or option 1 would eliminate the need for the area director positions. All technical planning would be carried out by NPS and technical staff, and with the reduced workload, the regional administrators could easily handle the administrative functions without the need for area directors. This would aid in eliminating in-house opposition to the closing of unneeded AR field locations. The area directors could find employment in the local and regional research stations or laboratories, where they could use their talents to the advantage of both. Locating the regional administrators in the D.C. area would facilitate focusing on broad regional and national issues.

Cons

Locating the regional administrators in the field and having their duties correspond to SAES regions assists in frequent contacts between the regional administrators and the SAES directors of his regions and probably helps in coordination at the management level.

HN Intra-Agency Options (see p. 187)

OPTION 1

Maintain present management structure within USDA with clarifications in budget and staffing.

Human Nutrition (HN) would remain within SEA but with its own budget. The administrator of HN would be given budgetary authority similar to the AR administrator. The administrative relationship of the HN administrator to the center directors who are not employed by USDA would be delineated.

Pros

This option would clarify HN's status within USDA. At present, administrative and budgetary authority are split, in contrast to good management principles. It would obviate possible conflicts of interest between AR research interests and HN research interests, This option would remove one layer of bureaucracy between the administrator of HN and the Secretary. It also would carry out the mandate of Congress.

Cons

The HN budget is not large enough to warrant a separate system,

OPTION 2

Remove HN from SEA and place it under the Assistant Secretary for Food and Consumer Services.

Pros

This option would place all nutrition activity of USDA within the purview of a single assistant secretary concerned with nutrition, and would give the administrator of HN direct access to the assistant secretary.

Cons

This option would separate nutrition research from all other research in USDA. Use could not be made of the peer review mechanisms within SEA.

Placement of HN within an action arm of USDA would cause research results to be less respected than if they were produced by an independent research arm, It would cause research to be directed toward the needs of that arm and thus hamper long-term research projects. It would politicize nutrition research so that research directions might change with each change in administration,

Placing HN in a nonresearch division will place it under administrators unfamiliar with research administration and inexperienced in solving the unique problems associated with human nutrition research,

Situated as it is in SEA, HN is not tied to any one constituency within USDA. By placing it in the same division as the Food and Nutrition Service (FNS), HN would be under tremendous pressure to focus primarily on FNS's research needs. While FNS represents a large fraction of USDA's budget, the clientele served represent only a small fraction of the U.S. public. The human nutrition research needs of producers, processors, and a large segment of the consuming public might be neglected.

OPTION 3

Dispense with HN as an administrative and planning entity and disperse HN within AR, with each of the centers under the authority of the director for the region in which it is situated.

Pros

Any positive aspects of such a move would be political rather than managerial. It would reassert that USDA holds producers' interests to have greater priority than consumers' interests.

Cons

Segmentation of human-nutrition research would destroy the ability of USDA to develop a coordinated research effort in human nutrition. Human nutrition is one aspect of USDA's research effort whose parameters are not "site specific." Dispersal of HN component parts to the regional directors would make coordination of the human nutrition research effort nearly impossible.

Dispersal of HN would also place the centers in the position of competing for funds with other research in its particular region. Since most regional directors are agricultural-production oriented, the HN centers' budgets would not be expected to fare well.

The regional directors have little experience in administering human nutrition.

Research at the HN centers would lose its national character and could become focused on the agricultural products of a region, rather than on basic human conditions and their nutritional needs, e.g., infancy, parturition, lactation, aging.

The coordination of all Federal HN research as called for in the 1977 farm bill and the development of the nutritional surveillance network would become difficult, if not impossible, when the lead agency (USDA) for human nutrition research has no in-house administrative, budgetary, or coordinating mechanism for the direction and/or use of human-nutrition research. For example, the mechanism for the coordination of the nutrient data bank and food consumption survey in the Consumer Nutrition Center and Beltsville's nutrient composition laboratory with the Department of Health and Human Services' Health and Nutrition Examination Survey would be nonexistent.

The development of information and educational material relating to human nutrition—a nationwide concern—would be under regional authority.

OPTION 4

Dispense with HN as an administrative and planning entity, disperse the clinical and laboratory components within AR under the authority of the regional directors, and place the survey and statistical research and information services under the Assistant Secretary for Food and Consumer Services. *

Pros

FNS would have closer coordination with the developers of nutrition information and educational material and with researchers who survey and analyze food consumption patterns in the United States.

Cons

All the cons of options 2 and 3 apply. In addition, there is the problem of separating the development of educational and informative materials from the research on which they are based. Not only would the possibility of misinterpretation arise, but it would be the necessary to hire additional staff to do the interpretive work, because the scientists who developed it would be in a different division of USDA.

The clinical and laboratory research segments of HN would presumably still use USDA's information bureau for the dispersal of information. With coordinating mechanisms absent, the information released could contradict that being released by FNS.

The informative and educational materials released by FNS would be seen by many to be politically tainted, since they are released by an action arm of USDA, rather than by a research group.

Separation of either the nutrient-composition labs or the nutrient data bank from the food-consumption survey would be cumbersome and inefficient. The development and transfer of usable information would be severely hampered, making use of the data bank extremely expensive and time consuming.

OPTION 5

For all options above, determine if all regional HN research centers are needed, and if not, which ones best serve the public interest. Available funds for HN would be allocated to the needed centers.

Pros

This will assure that funds allocated to HN are used for high-priority needs. It would assist in

*USDA has put this option into effect.

funding centers at a level commensurate with U.S. national interests.

Cons

National laboratories for the six centers have been built for or assigned to the objectives of the centers. At the time it was authorized by Congress, there was a need for this research. Even though the centers are inadequately funded, there is continuing interest in these activities. Also, because of the deluge of nutrition misinformation and its increasing impact, as evidenced by the growing health food and health care industry, it would be in the best interest of U.S. producers and consumers to maintain regional HN research centers that address areas of public concern in nutrition and can distribute to the public scientifically based information on food and nutrition as it relates to health.

Economics and Statistics Service (ESS) (see p. 187)

OPTION 1

Reinstate each ESS component to separate agency status reporting to the Assistant Secretary or Director for Economics. *

The two components of ESS, the Economics Research Service (ERS) and the Statistical Reporting Service (SRS), would become distinct operating agencies, each headed by an administrator. This option would eliminate positions in the present administrator's office.

Pros

This option would help eliminate confusion between the statistical unit's information and the projections and forecasts of the economics research unit.

It would also reduce the administrative layering that exists by eliminating the present questionable bureaucratic procedures and paperwork.

Cons

It would create two entities where the appearance of one existed before.

OPTION 2

Reinstate each ESS component to separate agency status with SRS reporting to the Assistant Secretary or Director for Economics and the ERS reporting to SEA.

ERS would join the other research agencies —i. e., AR and HN in SEA. For the economic policy analysis that needs to be conducted, an analytical and policy staff would be assigned directly to the Assistant Secretary or Director for Economics.

Pros

Having the main research agencies reporting to SEA at either the director or assistant secretary level has the following advantages: 1) coordination among research agencies is much easier, 2) it facilitates the integration of economics research with biological and physical science research, 3) much biological and physical science research would become more relevant and productive with leadership and participation by production and marketing research economists, and 4) by working more closely with the biological and physical scientists, it may be easier for economics research to obtain increased funding.

Cons

The disadvantages include: 1) not all economics research lends itself to integration with biological and physical science research, 2) the Assistant Secretary for Economics would have only one reporting agency which does not warrant position at the level of assistant secretary or director, and 3) the economics unit maybe regarded as a service unit to biological and physical research,

International Food and Agricultural Research (see p. 192)

OPTION 1

Centralize technical staff in one bureau in the Agency for International Development (AID). USDA would maintain its present level of activity. *

The technical staff from the regional bureaus and missions would be combined with the present central staff of the Development Support Bureau (DSB) to form an overall operating technical bureau. The technical bureaus would have responsibility for country and central programs of technical assistance, research, training, and institution building and would be headed by out-

*USDA has put this option into effect,

*AID has moved in the direction of this option, but still retains the regional bureau structure.

standing professionals in their relevant fields. The functions of the regional bureaus would be reduced essentially to those necessary for liaison with State and collation of normal desk functions. Presidential appointees would not be required for these positions. More study would be needed on the details of structuring the agency within such a reorganization.

Pros

This would permit but not assure much better and more coherent patterns of relationships between AID and sources of needed U.S. technical expertise such as universities, other Federal agencies, voluntary agencies, and private firms, It should permit improvement in developing strategies for various functional programs such as agricultural development, population, etc. It might result in more emphasis on research as an instrument in development.

Cons

In the absence of major organizational and policy changes, centralization of technical staff would result in confused line of authority, particularly to field staff.

Country program decisions are made "in-line" —i.e., missions to regional bureaus to Program and Policy Coordination (PPC) to administrator, DSB's central staff is involved only by regional bureau sufferance and on a very limited basis. In cases of differences, the regional bureau view prevails except on rare occasions where an administrator may override. DSB influence is largely via professional relationships with regional bureau specialists, who have some influence, albeit usually marginal, in mission/regional bureau decisions. The influence is usually on technical details—not program strategy, program composition, or intercountry allocations. Unless buttressed by actions sharply reallocating decision-making responsibility, centralization of technical staff would probably reduce even further technical staff participation in major decisions regarding country programs and "regional strategies. "

This option could well sever the line of communication between technical personnel in field missions and their counterparts in Washington. This communication, in the formal sense of collaboration on program and project design and implementation, is currently nebulous and varies greatly, Centralization of technical staff might reduce it still further.

It would cause further program imbalance toward capital transfer (in some suitable disguise) as this would reduce the need for intrusion of central staffs in regional bureau decision making,

OPTION 2

Within AID establish technical operating bureaus around the major thrusts of AID programs as defined in legislation—i.e., food and nutrition, population and health, and natural resources and energy (technical bureaus would be headed by technical career professionals). USDA would maintain its present level of activity.

The technical bureaus would have responsibility for country as well as central programs of technical assistance, research, training, and institution building and would be headed by outstanding professionals in their relevant fields. The regional bureaus would be eliminated and regional office positions set up in the PPC or under an assistant administrator with limited role and power necessary for liaison with State and collation of normal desk functions. Presidential appointees would not be required for these positions. This would reduce the cost and amount of manpower to perform these functions. More study would be needed on the details of structuring the agency within such a reorganization.

Pros

This option would make desired organizational changes and enlarge the role of technical to nontechnical personnel. With the technical operating bureaus organized around the major thrusts as defined in legislation, the program would focus more clearly on U.S. interests. With it organized around technical issues, it would strengthen tremendously the ability of AID efforts to identify the important technical issues constraining development of the various countries, to recruit and manage technical resources, and to work with the departments or instruments of government of the developing countries in solving their own problems. This would reduce both the cost and amount of manpower to perform these functions.

Cons

This option would require a major change in the types of personnel hired by AID. The number of technical people would increase considerably with a greater decrease in nontechnical people. It would require either a reduction in force or a long time in attrition. It would require special care in choosing the administrators for the technical bureaus. They would have to be competent in their professional areas, international experience, and administration.

OPTION 3

Increase USDA involvement in the international agricultural research network, with major emphasis on maximizing U.S. benefits. This applies to both options 1 and 2 above.

The United States has much to gain, as well as give, in international agricultural research. USDA would be given specific responsibility for taking the lead in programs to maximize U.S. benefits from agricultural research conducted in other countries and the international centers. This would be closely coordinated with AID agricultural activities.

Pros

One Federal agency would have the responsibility to assure maximum U.S. benefit from agricultural research conducted abroad. It would increase cooperation with other nations and research institutions. It would increase our ability to obtain knowledge quickly of breakthroughs and current research. It would also expand opportunities for U.S. scientists.

Cons

A program to promote benefits to the United States from research of the international centers and developing countries could cause other donors to accuse the United States of trying to be a beneficiary as well as a donor to the international effort to assist Third World countries through research in agriculture.

Statistics on Research Funding

Table B-1 .—Role of Research in Total USDA Budget, 1915-54

Fiscal year	(1) Funds for research[a] (thousands)	(2) Total USDA budget (millions)	(3) Research as proportion of USDA budget (percent)
1915	$ 7,440	$ 29.9	24.9%
1916	6,640	29.1	22.8
1917	7,240	37.4	19.4
1918	7,740	73.4	10.5
1919	8,340	117.3	7.1
1920	9,140	149.4	6.1
1921	9,240	151.7	6.1
1922	9,640	134.5	7.2
1923	9,940	87.5	11.4
1924	9,840	89.9	10.9
1925	10,740	79.8	13.4
1926	12,600	168.5	7.5
1927	13,380	155.0	8.6
1928	15,060	151.0	10.0
1929	17,640	166.8	10.6
1930	19,835	213.4	9.3
1931	21,040	371.6	5.7
1932	20,426	288.6	7.1
1953	17,437	425.4	4.1
1934	15,500	626.6	2.5
1935	15,828	1,060.7	1.5
1936	19,386	710.5	2.7
1937	22,041	789.4	2.8
1938	24,187	931.7	2.6
1939	29,882	1,529.2	2.0
1940	28,992	1,656.0	1.8
1941	28,274	1,548.0	1.8
1942	28,925	1,610.0	1.8
1943	28,736	1,131.0	2.5
1944	29,030	1,185.0	2.5
1945	29,922	1,169.0	2.6
1946	34,807	1,258.0	2.8
1947	40,426	1,292.0	3.1
1948	47,739	1,241.0	3.8
1949	57,285	1,198.0	4.8
1950	60,043	1,507.0	4.0
1951	58,691	1,311.0	4.5
1952	58,182	1,365.0	4.3
1953	57,948	1,318.0	4.4
1954	59,828	1,504.0	4.0

[a]Includes both Federal research and funds passed On to States.

SOURCES: Col. 1. Table B-2, col 1.
Col. 2. "USDA Appropriations," USDA Office of Budget and Finance, B&FR 67-H-245, January 25,1966.

Table B-2.–Appropriations for Research in USDA Budget, 1915-73

Year	(1) Total research funds in USDA budget (thousands)	(2) Funds allocated to States (thousands)	(3) Funds for USDA Federal research (thousands)	(4) Proportion of funds used for USDA research (percent)
1915	$ 7,440	$ 1,440	$ 6,000	80.6%
1916	6,640	1,440	5,200	78.3
1917	7,240	1,440	5,800	80.1
1918	7,740	1,440	6,300	81.4
1919	8,340	1,440	6,900	82.7
1920	9,140	1,440	7,700	84.2
1921	9,240	1,440	7,800	84.4
1922	9,640	1,440	8,200	85.1
1923	9,940	1,440	8,500	85.5
1924.	9,840	1,440	8,400	85.4
1925.	10,740	1,440	9,300	86.6
1926.	12,600	2,400	10,200	81.0
1927.	13,380	2,880	10,500	78.5
1928.	15,060	3,360	11,700	77.7
1929.	17,640	3,840	13,800	78.2
1930.	19,835	4,335	15,500	78.1
1931 ..,....	21,040	4,340	16,700	79.4
1932.	20,426	4,357	16,069	78.7
1933.	17,437	4,359	13,078	75.0
1934.	15,500	4,361	11,139	71.9
1935.	15,828	4,38a	11,440	72.3
1936.	19,388	4,995	14,393	74.2
1937.	22,041	5,620	16,421	74.5
1938.	24,187	6,232	17,955	74.2
1939.	29,882	6,541	23,341	78.1
1940.	28,992	6,849	22,143	76.4
1941	28,274	6,862	21,412	75.7
1942.	28,925	6,926	21,999	76.0
1943.	28,736	6,926	21,810	76.1
1944.	29,030	7,001	22,029	76.0
1945.	29,922	7,001	22,921	76.6
1946.	34,807	7,206	27,601	79.3
1947.	40,426	7,206	33,220	82.2
1946.	47,739	9,572	36,167	79.9
1949.	57,285	11,295	45,990	80.3

SOURCES: Col. 1. Cols. 2 and 3.

Col. 2. 1915-62. Robert George Latimer, "Some Economic Aspects of Agricultural Research and Education in the United States," Purdue University, Department of Agricultural Economics, Ph.D. Dissertation, January 1964, p. 171.

1963-73. *Funds for Research at State Agricultural Experiment Stations,* USDA/CSRS, annual issues.

Col. 3. 1915-62. Latimer, pp. 65-66. (The same statistics, unrounded form, are reported byW.L. PetersonandJ. C. Fitzharris in "Operation and Productivity of the Federal-State Research System in the United States," in *Resource Allocation and Productivity in National and International Agricultural Research* (T. M. Arndt, D. G. Dalrymple, and V. W. Ruttan, eds.), University of Minnesota Press, 1977, p. 63).

1963-73. Peterson and Fitzharris, pp. 63, 64.

Table B-2.—Appropriations for Research in USDA Budget, 1915-73—Continued

Year	(1) Total research funds in USDA budget (thousands)	(2) Funds allocated to States (thousands)	(3) Funds for USDA Federal research (thousands)	(4) Proportion of funds used for USDA research (percent)
1950	**$60,043**	$ 13,219	*$46,824*	78.0%
1951	**58,691**	13,585	*45,106*	76.9
1952	**8,182**	13,230	*54,952*	77.3
1953	**57,948**	12,587	*45,361*	78.3
1954	**59,828**	13,564	*46,264*	77.3
1955	**72,561**	19,118	*53,443*	73.7
1956	**83,943**	24,304	*59,639*	71.0
1957.	**115,543**	28,890	*86,653*	75.0
1958.	**113,426**	29,702	*83,724*	73.8
1959.	**129,877**	30,863	*99,014*	76.2
1960.	**136,039**	30,853	*105,186*	77.3
1961 ..,....	**160,747**	31,825	*128,922*	80.2
1962. .,....	**161,480**	34,728	*126,752*	78.5
1963.	**172,800**	36,700	*136,100*	78.8
1964.	**190,000**	40,200	*149,800*	78.8
1965.	**239,400**	46,900	*192,500*	80.4
1966. ...,..	**264,700**	52,000	*212,700*	80.4
1967.	**274,800**	56,300	*218,500*	79.5
1968.	**278,000**	58,500	*219,500*	79.0
1969.	**272,600**	59,400	*213,200*	78.2
1970.	**300,100**	61,400	*238,700*	79.5
1971	**331,200**	68,100	*263,100*	79.4
1972.	**382,200**	88,200	*294,000*	76.9
1973.	**407,900**	104,000	*303,900*	74.5
Average. 1915-73				78.4%

SOURCES: Coil. Cols. 2 and 3.

Col. 2. 1915-62. Robert George Latimer, "Some Economic Aspects of Agricultural Research and Education in the United States," Purdue University, Department of Agricultural Economics, Ph.D. Dissertation, January 1964, p. 171.

1963-73. *Funds for Research at State Agricultural Experiment Stations,* USDA/CSRS, annual Issues.

Col. 3. 1915-62. Latimer, pp. *65-66.* (The same statistics, In rounded form, are reported byW. L. Peterson and J. C. Fitzharris In "Operation and Productivity of the Federal. State Research System in the United States," in *Resource Allocation and Productivity in National and International Agricultural Research* (T. M. Arndt, D. G. Dalrymple, and V. W. Ruttan, eds.), University of Minnesota Press, 1977, p. 63).

1963-73. Peterson and Fitzharris, pp. 63, 64.

Table B-3.—Research and Development Expenditures by Government Agencies (DOD, HEW, USDA, DOE, NASA, NSF, Other Selected Agencies and Total) at SAES and USDA—1966-78 (in thousands of current and constant dollars)

	DOE		NASA		NSF		Other agencies	
Year	Current	Constant	Current	Constant	Current	Constant	Current	Constant
1966	$1,212	$1,271.77	$5,050	$5,299.06	$244	$256.034	$ 541	$567.68
1967	1,257	1,257.00	4,867	4,867.00	262	262.000	694	694.00
1968	1,369	1,296.40	4,429	4,194.13	284	268.939	625	591.86
1969	1,406	1,260.99	3,963	3,554.26	274	245.740	744	667.26
1970	1,346	1,117.01	3,800	3,153.53	289	239.834	1,043	865.56
1971	1,303	1,009.30	3,258	2,523.63	337	261.038	1,357	1,051.12
1972	1,298	942.63	3,157	2,292.67	455	330.428	1,169	848.95
1973	1,363	925.95	3,061	2,079.48	480	326.087	1,288	875.00
1974	1,489	912.94	3,002	1,840.59	556	340.895	1,278	783.57
1975	2,047	1,153.24	3,064	1,726.20	595	335.211	1,486	837.18
1976	2,464	1,308.55	3,447	1,830.59	609	323.420	1,541	818.37
1977	3,536	1,761.83	3,703	1,845.04	697	347.285	1,695	844.54
1978	4,196	1,930.97	3,876	1,783.71	754	346.986	2,005	922.69

	DOD		HEW		USDA		Total	
Year	Current	Constant	Current	Constant	Current	Constant	Current	Constant
1966	$7,024	$7,370.41	$1,014	$1,064.01	$153	$160.546	$15,247	$15,999.0
1967	8,049	8,049.00	1,147	1,147.00	165	165.000	16,441	16,441.0
1968	7,709	7,300.19	1,252	1,185.61	159	150.568	15,827	14,987.7
1969	7,696	6,902.24	1,297	1,163.23	163	146.188	15,543	13,939.9
1970	7,360	6,107.88	1,221	1,013.28	177	146.888	15,236	12,644.0
1971	7,509	5,816.42	1,476	1,143.30	197	152.595	15,437	11,957.4
1972	8,318	6,040.67	1,751	1,271.60	224	162.672	16,377	11,893.2
1973	8,404	5,709.24	1,838	1,248.64	236	160.326	16,670	11,324.7
1974	8,420	5,162.48	2,290	1,404.05	240	147.149	17,275	10,591.7
1975	9,012	5,077.18	2,363	1,331.27	265	149.296	18,832	10,609.6
1976	9,655	5,127.46	2,546	1,352.10	303	160.913	20,565	10,921.4
1977	10,963	5,462.38	2,787	1,388.64	344	171.400	23,725	11,821.1
1978	11,825	5,441.79	3,132	1,441.33	381	175.334	26,169	12,042.8

SOURCE: NSF, Science Indicators 1979, "Table 4-2 Research and Development Expenditures by U.S. Government Departments, 1986 -1978."

Table B-4.—Total Research Expenditures at SAES, USDA, and Combined SAES and USDA—1966-79 (in thousands of current and constant dollars)

	SAES		USDA		Combined SAES + USDA	
Year	Current	Constant	Current	Constant	Current	Constant
1966	$205,215	$215,336	$153,084	$160,634	$ 358,299	$375,970
1967 ...., .	207,675	207,675	165,424	165,424	373,099	373,099
1968	242,687	229,817	159,150	150,710	401,837	380,527
1969	259,292	232,549	163,865	146,964	423,157	379,513
1970	282,101	234,109	176,896	146,802	458,997	380,911
1971	300,224	232,552	197,084	152,660	497,308	385,212
1972	346,942	251,955	224,308	162,896	571,250	414,851
1973	378,658	257,240	236,291	160,524	614,949	417,764
1974	430,609	264,015	240,183	147,261	670,792	411,276
1975	490,054	276,087	265,604	149,636	755,658	425,723
1976. , ...	527,120	279,936	302,531	160,664	829,651	440,601
1977	605,455	301,672	343,859	171,330	949,314	473,001
1978, ...	662,533	304,893	380,556	175,129	1,043,089	480,022
1979 .....,	708,932	301,288	381,242	162,024	1,090,172	463,312

SOURCE: Compiled from USDA, Inventory of Agricultural Research FY1966-79, vol. 11, Science and Education Administration.

Table B-5.—USDA, SAES, and Combined USDA and SAES Scientist Years, 1966-79

Year	USDA	SAES	Combined
1966	3,660.40	6,146.00	*9,806.4*
1967	3,817.80	6,179.00	*9,996.8*
1968	3,515.96	5,752.50	*9,268.5*
1969	3,511.67	5,955.90	*9,467.7*
1970	3,544.30	6,031.10	*9,575.4*
1971	3,541.43	5,841.10	*9,382.5*
1972	3,682.61	5,914.30	*9,597.0*
1973.	3,610.91	5,953.50	*9,564.3*
1974.	3,489.61	6,034.20	*9,523.8*
1975.	3,436.86	6,133.40	*9,570.1*
1976.	3,439.38	6,281.30	*9,720.5*
1977.	3,540.23	6,556.70	*10,096.7*
1978.	3,595.10	6,514.02	*10,114.5*
1979.	3,451.40	6,520.47	*9,971.8*

SOURCE. Compiled from USDA, Inventory of Agricultural Research FY1966-79, vol. II, Science and Education Administration.

Table B-6.—Total Research Expenditures by USDA Research Agencies (ARS, ESS, and CR)–1966-79 (in current and constant dollars)

Year	ARS		CR[a]		ESS	
	Current	Constant	Current	Constant	Current	Constant
1966	$136,761	$143,506	$ 0.0	$ 0.0	$16,323.0	$17,128.0
1967	145,716	145,716	1,997.0	1,997.0	17,711.0	17,711.0
1968	142,405	134,853	1,969.9	1,865.4	14,774.9	13,991.3
1969	146,801	131,660	1,999.6	1,793.4	15,064.3	13,510.6
1970	161,113	133,704	1,694.4	1,406.1	14,089.1	11,692.2
1971	176,076	136,387	2,647.2	2,050.5	18,361.0	14,222.3
1972	192,617	139,882	12,500.0	9,077.7	19,190.8	13,936.6
1973	200,322	136,088	15,400.0	10,462.0	20,569.2	13,973.6
1974	206,995	126,913	11,583.0	7,101.8	21,604.9	13,246.4
1975	224,096	126,251	16,471.6	9,279.8	25,036.1	14,104.9
1976	252,514	134,102	21,973.8	11,669.6	28,043.0	14,892.7
1977	292,956	145,967	21,903.0	10,913.3	28,999.8	14,449.3
1978	323,146	148,710	23,707.0	10,909.8	33,703.0	15,509.9
1979	327,168	139,043	16,933.0	7,196.3	37,141.0	15,784.5

[a]These expenditures Include only the funds used within USDA for administering research funds in the States and obligations of CR administered special grants They are not double-counted in anyof the SAES expenditures from Federal sources

SOURCE: Compiled from USDA, inventory of Agricultural Research FY1966-79, vol. IL Science and Education Administration

Table B-7.—Total Research Expenditures at SAES by Source of Funding (Federal Formula Funds, Cooperative Grants and Cooperative Agreements (CGCA), Other Federal Funds, State Appropriations, and Private Grants)-–1966-79
(in thousands of current and constant dollars)

	Federal formula funds		CGCA		Other Federal funds	
Year	Current	Constant	Current	Constant	Current	Constant
1966	$ 48,017	$50,385.1	$6,008	$6,304.30	$24,522	$25,731.4
1987	48,694	48,694.0	6,260	6,260.00	23,566	23,566.0
1988	52,449	49,667.6	9,594	9,085.23	28,602	27,085.2
1989	53,912	48,351.6	7,784	6,981.17	27,834	24,963.2
1970	56,439	46,837.3	6,837	5,673.86	26,440	21,941.9
1971	62,743	48,600.3	6,320	4,895.43	25,957	20,106.1
1972	70,587	51,261.4	6,850	4,974.58	27,299	19,825.0
1973	77,220	52,459.2	7,476	5,078.80	28,748	19,529.9
1974	82,127	50,353.8	8,631	5,291.85	31,205	19,132.4
1975	90,302	50,874.4	10,773	6,089.30	34,236	19,287.9
1976	102,505	54,437.1	9,882	5,248.01	37,772	20,059.5
1977	116,761	58,176.9	11,758	5,858.50	51,759	25,789.2
1978, . . .	132,179	60,827.9	14,783	6,803.04	53,590	24,661.8
1979	142,735	60,660.9	17,827	7,576.29	56,165	23,869.5

	State appropriations		Private	
Year	Current	Constant	Current	Constant
1966	$117,942	$123,759	*$8,726*	$9,156.3
1967	120,610	120,610	*8,545*	8,545.0
1968 , ... ,	142,276	134,731	*9,788*	9,248.1
1989	157,526	141,279	*12,238*	10,974.0
1970	178,666	148,271	*13,719*	11,385.1
1971	190,892	147,864	*14,312*	11,086.0
1972	226,185	164,259	*16,021*	11,634.7
1973	247,691	188,268	17,523	11,904.2
1974	288,022	176,592	20,624	12,645.0
1975	331,270	186,631	23,473	13,224.2
1976	349,502	185,609	27,459	14,582.6
1977	393,358	195,993	31,819	15,854.0
1978	428,489	197,187	33,587	15,456.5
1979	457,104	194,264	35,101	14,917.6

SOURCE: Compiled from USDA, Inventory of Agricultural Research FY1966-79, vol. II, Science and Education Administration.

Table B-8.—Private Industry Funds for Applied Research and Development for Agricultural Products—1963-75
(in millions of current and constant dollars)

	Food and kindred		Farm machinery		Agricultural chemicals		Total private agricultural research	
Year	Current	Constant	Current	Constant	Current	Constant	Current	Constant
1963	$102	$125.5	$76	$93.5	$45	$ 55.4	$223	$274.3
1984	118	139.0	79	93.1	48	56.5	245	288.6
1965	131	147.0	96	107.7	64	71.8	291	326.6
1966	130	137.9	100	106.0	77	81.7	307	325.6
1967	134	134.0	102	102.0	92	92.0	328	328.0
1968	165	154.3	96	89.8	99	92.6	360	336.0
1969	179	156.7	99	87.8	104	92.2	362	339.3
1970	204	170.1	89	74.2	126	105.1	419	349.5
1971	207	165.2	90	71.8	130	103.8	427	340.8
1972	222	168.9	92	70.0	108	82.2	422	321.2
1973	234	170.8	117	85.4	114	83.2	465	339.4
1974	269	181.8	127	85.8	137	92.6	533	360.1
1975	292	184.8	145	91.8	165	104.4	602	381.0

SOURCE: NSF, "Table B-51 Research and Development in Industry 1975," Surveys of Science Resources series, p. 72, NSF77-324.

Commissioned Papers, Acknowledgments, and Food and Renewable Resources Program Advisory Committee

Commissioned Papers

The findings and options presented in this report are in large part based on the papers commissioned by OTA for this assessment. These papers were reviewed and critiqued by the workgroups, advisory panel, and outside reviewers. The papers are available in a separate volume through the National Technical Information Service. * The papers included are:

Evenson, Robert E., and Bryan D. Wright, "An Evaluation of Methods for Examining the Quality of Agricultural Research."

Flatt, William P., Hugo 0. Graumann, and Arthur W. Cooper, "Agricultural Research Classification for Management Purposes,"

French, Charles E., "The Process of Setting Priorities for Food and Agricultural Research."

Furtick, William R., "The Role of U.S. Food and Agricultural Research in International Agricultural Development."

Havlicek, Joseph, Jr., and Daniel Otto, "An Historical Analysis of Investment in Food and Agricultural Research."

Huston, Keith, "Priority Setting Processes in the State Agricultural Experiment Stations."

Irving, George W., Frederic R. Senti, William T. Pentzer, and Joseph C. Purcell, "The Role of the Public Sector in Agricultural Post-Harvest Technology Research."

Knutson, Ronald D., Don Paarlberg, and Alex F. McCalla, "Forces Affecting Food and Agricultural Research Decisions."

Lewontin, Richard C., "Agricultural Research in Private Universities."

Lovvorn, Roy L., "Effect of Organization, Policy, and Procedures on Research Management."

Mahlstede, John P., "The Role of the Joint Council on Food and Agricultural Sciences and the National Agricultural Research and Extension Users Advisory Board in Coordinating Research and Determining Research Priorities."

Moseman, A. H., J. S. Robins, and Harold Wilcke, "The Role of the Federal Government, State Agricultural Experiment Stations, and the Private Sector in Research."

Ronningen, Thomas S., and Hugo O. Graumann, "Incentives and Disincentives Important to Research Management and Administration."

Smallwood, Charles M., "The Role of Public State Universities in Food and Agricultural Research."

Smith, Grahame J. C., "A Comparative Analysis of Selected Non-U.S. Agricultural Research Establishments With the U. S."

White, Fred C., B. R. Eddleman, and Joseph C. Purcell, "Nature and Flow of Benefits From Food and Agricultural Research."

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* Requests for "An Assessment of the U.S. Food and Agricultural Research System, Volume II—Commissioned Papers" should be directed to: National Technical Information Service, U.S. Department of Commerce, Springfield, Va. 22151.

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Department of Energy
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Association of Research Directors of 1980 Schools and Tuskegee Institute
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Thomas Sporleder
Texas A&M University
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National Farmers Union
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Robert Wildman
National Oceanic and Atmospheric Administration
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Department of Defense
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U.S. Department of Agriculture

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Michigan State University

Glossary, Acronyms, and Abbreviations

Glossary

Biological nitrogen fixation—A term used for processes by which organisms such as bacteria or fungi take nitrogen out of the air and change it into a form that plants can use. Nitrogen is one of the most important plant nutrients, as it is the basis of all protein compounds. Although abundant in air, plants cannot use nitrogen directly from the air.

Block grant—Given primarily to general purpose governmental units in accordance with a statutory formula and can be used for a variety of activities within a broad functional area.

Constant dollars—Current dollars adjusted for inflation,

Consumer surplus—The excess of the amount consumers are prepared to pay for a product (rather than go without it) over the amount actually paid for it.

Demand—A schedule of the quantities of a product or service consumers are willing and able to buy at various prices.

Donors–Countries or organizations that make major contributions directly or through group action to support international development activities.

Economic surplus—The sum of consumer and producer surplus.

Food and agricultural science-The biological, social, economic, and political considerations of: a) agriculture, including soil and water conservation and use, use of organic waste materials, plant and animal protection, and plant and animal health; b) processing, distributing, marketing, and using food and agricultural products; c) aquiculture; d) home economics, human nutrition, and family life; and e) rural and community development. For purposes of this assessment it does not include forestry and forestry products.

Formula funds—Expenditure for agricultural research from the Federal Government to the States, based on size of rural population and number of farms.

Hatch Act—An 1887 Act of Congress establishing experiment stations in all States,

Income elasticity–The responsiveness of the quantity demanded of a product to a change in income of consumers.

Integrated pest management—Optimization of pest control in an economically and ecologically sound manner, accomplished by the coordinated use of multiple tactics to assure stable crop production and to maintain pest damage below the economic injury level while minimizing hazards to humans, animals, plants, and the environment.

International network—A multicountry cooperative program with common objectives in which there is joint planning, assignment of areas for primary responsibility, coordination of activities, reporting on results and decisions on follow-up activities. These networks may be partly or wholly funded from one source or entirely by the individual collaborators.

Land-grant university—An agricultural institution established by the Merrill Act in 1862,

Marginal product—The additional output from the last input employed,

Marginal rate of return—The net value of the last dollar invested.

Marketing margin—The difference between farm price and retail price; includes processing and transportation costs, etc.

Mission-oriented research—Research aimed at the solution of a well-defined problem of economic importance such as the control of a specific insect problem, curing an animal disease, etc.

Multilateral aid—The aid programs that represent contributions from numerous donors but act in the same manner as would a single donor. UN agencies are good examples.

Multiplier effects—A measure of the effect on total national income arising from a unit change in one of its components.

Nonland-grant university—A private university or public State university.

Post-harvest technology research–Physical and biological study of the functions involved in the assembling, processing, fabricating, preserving, packaging, storing, distributing, and transporting of agricultural commodities and food products.

Price elasticity of demand—The degree of responsiveness of the quantity demanded of a product to changes in its price.

Price elasticity of supply—The responsiveness of the quantity of a product supplied to a change in its price.

Research management—Systematic allocation and distribution of funds, scientists, support personnel, and other resources to be used to seek solutions to problems related to science.

Scientist-year—One scientist working full time for a period of 1 year.

Spillover benefits—Research conducted in a geographic area, such as a State, that impacts another geographic area.

Sustainability of farming system—A farming system that uses renewable resources in such a way that farming can be continued in perpetuity.

Value of marginal product—The additional revenue generated from the last unit of an input.

Acronyms and Abbreviations

AID — Agency for International Development
AMS —Agricultural Marketing Service, USDA
AR –Agricultural Research, SEA, USDA (1977-81)
ARA —Agricultural Research Administration (1941-53), USDA
ARPAC —Agricultural Research Policy Advisory Committee
ARS —Agricultural Research Service (1953-77), (1981-), USDA
AVRDC —Asian Vegetable Research and Development Center
BAI — Bureau of Animal Industry, USDA
BDI – Bureau of Dairy Industry, USDA
BEPQ — Bureau of Entomology and Plant Quarantine, USDA
BHNHE — Bureau of Human Nutrition and Home Economics, USDA
BIFAD — Board for International Food and Agricultural Development, USAID
BPISAE — Bureau of Plant Industry, Soils, and Agricultural Engineering, USDA
CAS —Committee on Agricultural Science (1963-69)
CDC —Center for Disease Control
CGIAR — Consultative Group on International Agricultural Research
CFRR —Committee on Food and Renewable Resources
CNRU —Clinical Nutrition Research Unit
CR –Cooperative Research, SEA, USDA (1977-81)
CRIS —Current Research Information System
CRSP — Collaborative Research Support Program
CSESS —Cooperative State Experiment Station Service, USDA (1962)
CSRS —Cooperative State Research Service, USDA (1962-77) (1981-
DAC — Development Advisory Committee
DHHS — Department of Health and Human Services
DOC — Department of Commerce
DOD — Department of Defense
DOE — Department of Energy
DSB — Development Support Board
EPA — Environmental Protection Agency
ERS — Economics Research Service, USDA (1961-77) (1981-)
ES – Extension Service, USDA
ESCOP — Experiment Station Committee on Organization and Policy
ESCS — Economics, Statistics, and Cooperatives Service, USDA (1977-80)
ESS — Economics and Statistics Service, USDA (1980-81)
FCCSET — Federal Coordinating Council on Science, Engineering, and Technology
FDA — Food and Drug Administration
FS –Forest Service, USDA
GAO –General Accounting Office
GNP — gross national product
HEW – Department of Health, Education, and Welfare
HN – Human Nutrition, SEA, USDA (1977-81)
ICARDA — International Center for Agricultural Research in the Dry Areas
ICRISAT — International Crops Research Institute for the Semi-Arid Tropics

IDCA-AID — International Development Cooperative Administration
IITA — International Institute for Tropical Agriculture
ILCA — International Livestock Center for Africa
ILRAD — International Laboratory for Research in Animal Diseases
IPA — Intergovernmental Personnel Act
IRRI — International Rice Research Institute
ISNAR — International Service for National Agricultural Research
ISTC — Institute for Scientific and Technological Cooperation
JC –Joint Council on Food and Agricultural Sciences
JCAD – Joint Committee for Agricultural Development
JPE –Joint Planning and Evaluation Staff, USDA
JRC –Joint Research Committee
LAIR — Letterman Army Institute for Research
MAPS — Management and Planning System
NAS — National Academy of Sciences
NASA — National Aeronautics and Space Administration
NASCD — National Association of Soil Conservation Districts
NASULGC — National Association of State Universities and Land-Grant Colleges
NCHS — National Center for Health Statistics
NCI — National Cancer Institute
NCI-DNCP — NCI-Diet, Nutrition, and Cancer Program
NHLBI – National Heart, Lung, and Blood Institute
NIAMDD — National Institute of Arthritis, Metabolism, and Digestive Diseases
NIH — National Institutes of Health
NIH-NCC — NIH-Nutrition Coordinating Committee
NOAA-DOC — National Ocean and Atmospheric Administration
NPS –National Program Staff, USDA
NSF — National Science Foundation
OES — Office of Experiment Stations, USDA
OICD —Office of International Cooperation and Development, USDA
OMB —Office of Management and Budget
OSTP — Office of Science and Technology Policy
OTA –Office of Technology Assessment, U.S. Congress
PAC — Program Analysis and Coordination, USDA
P.L. — Public Law
PPC — Bureau of Program and Policy Coordination
PPS– Program Planning Staff, USDA
PSAC — President's Science Advisory Committee
RANN — Research Applied to National Needs
R&D — research and development
RMA — Research and Marketing Act of 1946
RPs — Research Programs
RPAs — Research Program Areas
RPGs — Research Program Groups
SAES — State Agricultural Experiment Stations
SCS — Soil Conservation Service
SEA — Science and Education Administration (1977-81)
SFCRP — Special Foreign Currency Research Program
SRS — Statistical Reporting Service
TSRTP — Tropical and Subtropical Research and Training Program
UAB — National Agricultural Research and Extension Users Advisory Board
UN — United Nations
USDA — United States Department of Agriculture
VA — Veterans Administration