STUDY BY THE STAFF OF THE U.S. GENERAL ACCOUNTING OFFICE

Agricultural Research- - Its Organization And Management

Department of Agriculture

The information contained herein identifies

--the acts which provide for Federal support of agricultural research,

--the organizations involved in that research,

--the diversity of the research conducted, and

--the sources of funds supporting agricultural research.

The study describes the principal techniques employed by the U.S. Department of Agriculture and State institutions to plan and coordinate their research programs. It also discusses some of the most important management techniques employed by the Agricultural Research Service, Cooperative State Research Service, Forest Service, and Economic Research Service in carrying out their responsibilities for agricultural research.

RED-76-92

APRIL 9, 1976

PREFACE

This study was prepared in response to a request from the Joint Economic Committee. Its purpose is to provide a general overview of the organization, scope, and management of publicly supported agricultural research. It was developed as a source of information and no attempt was made to evaluate the effectiveness, efficiency, or economy of the research program.

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The Federal-State agricultural research system is a large, complex, and dynamic system with many independent decisionmakers. It involves 6 Department of Agriculture agencies, 55 State agricultural experiment stations, 15 schools of forestry, 16 land-grant colleges of 1890, and Tuskegee Institute. During fiscal year 1974, the latest year for which the Department had information available, these agencies spent over $700 million and over 10,000 scientific man-years on agricultural research.

At June 30, 1974, they were working on over 21,000 highly diversified research projects. The research involved gaining and applying knowledge to (1) biological, physical and economic phases of producing, processing, and distributing farm and forest products, (2) consumer health and nutrition, and (3) social and economic aspects of rural living.

Plans for agricultural research are generally based on inputs from managers and scientists from within the Federal-State research organizations and from such outside sources as the Congress, the Office of Management and Budget, producers, research users, other Department of Agriculture agencies, and other Federal agencies. It is usually the scientists, however, who formulate the ideas and initiate the research work to be carried out.

Most of the information for this study was provided by the Department at our request. We did not verify or attempt to evaluate this information. Department representatives reviewed a draft of this study and their suggestions were considered in its final preparation.

Henry Eschwege

Henry Eschwege, Director
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ABBREVIATIONS

ARPAC	Agricultural Research Policy Advisory Committee
ARS	Agricultural Research Service
CRIS	Current Research Information System
CSRS	Cooperative State Research Service
ERS	Economic Research Service
RWU	research work unit
USDA	U.S. Department of Agriculture

CHAPTER 1

THE FEDERAL-STATE AGRICULTURAL RESEARCH SYSTEM

The Federal-State agricultural research system has a history of over 100 years. It is made up of 6 agencies in the U.S. Department of Agriculture (USDA), 55 State agricultural experiment stations (53 are under the management of land-grant colleges of 1862), 15 schools of forestry, 16 land-grant colleges of 1890 (colleges originally established for black students), and Tuskegee Institute. (See app. I for a detailed listing.) These organizations conduct about 95 percent of all publicly supported agricultural research.

Federal support of agricultural research began with the Organic Act of 1862 (7 U.S.C. 2201 and 301-308). Additional legislation includes the Organic Act of 1890 (7 U.S.C. 323); the Hatch Act of 1887, as amended (7 U.S.C. 361a); the McSweeney-McNary Forestry Research Act of 1928, as amended (16 U.S.C. 581); the McIntire-Stennis Act of 1962 (16 U.S.C. 582a); and the act of August 4, 1965 (7 U.S.C. 450i). These and other acts authorizing Federal funds for agricultural research are discussed below.

The Organic Act of 1862 established USDA and charged the Commissioner (now Secretary) of Agriculture to acquire and preserve all information concerning agriculture which he could obtain by means of books and correspondence, and by practical and scientific experiments. The act also authorized the donation of public lands to the States and territories to endow, support, and maintain at least one college for the benefit of agriculture and mechanic arts.

The Organic Act of 1890 authorized a portion of funds from the sale of public lands to be used to support colleges for agriculture and mechanic arts. It provided that no money be paid to any State for supporting and maintaining a college where a distinction of race or color was made in admitting students. It also provided that establishing and maintaining such colleges separately for white and black students complied with the provisions of the act if the funds were equitably divided.

Agricultural research at the Federal level, as provided for by the Organic Act of 1862 and several subsequent acts, including the Research and Marketing Act of 1946, as amended (7 U.S.C. 427-427i and 1621-1627), is carried out primarily by USDA's Agricultural Research Service (ARS) and Economic Research Service (ERS). USDA's Statistical Reporting

Service and Farmer Cooperative Service perform a small amount of agricultural research in carrying out their programs.

ARS was established by the Secretary on November 2, 1953, under authority of Reorganization Plan No. 2 of 1953 and other authorities. It conducts basic, applied, and developmental research in the fields of livestock; crops; pest control; soil, water, and air resources; environmental quality; domestic and export marketing; use of agricultural products; food and nutrition; consumer services; rural and international development; and agriculturally related health hazards, including food safety.

ERS was established by Secretary's Memorandum No. 1446, Supplement No. 1, dated April 3, 1961, under Reorganization Plan No. 2 of 1953 and other authorities. ERS develops and carries out a program of economic research designed to provide economic intelligence for USDA, other Federal decision-makers, farmers and related industries, and the general public. Research findings are made available to farmers and other users through research reports and through economic outlook and situation reports on major commodities, the national economy, and the international economy.

The McSweeney-McNary Act of 1928 authorized USDA to conduct such experiments as deemed necessary to determine, demonstrate, and promulgate the best methods for:

--Reforesting and growing, managing, and utilizing timber, forage, and other forest products.

--Maintaining favorable conditions for water flow and for preventing erosion.

--Protecting timber and other forest growth from fire, insects, diseases, or other harmful agents.

--Obtaining the fullest and most effective use of forest lands.

The act also authorized investigations to determine and make known the economic considerations which should underlie the establishment of sound policies for managing forest lands and utilizing forest products. The Forest Service carries out the research authorized under the act.

The Cooperative State Research Service (CSRS) was established by the Secretary on July 19, 1961, under authority of Reorganization Plan No. 2 of 1953, to administer legislation that authorizes Federal appropriations for agricultural research carried on by the State agricultural experiment stations,

schools of forestry, land-grant colleges of 1890 and Tuskegee Institute, and nonprofit organizations. These acts are the Hatch Act of 1887, as amended; the McIntire-Stennis Act of 1962; the act of August 4, 1965; and the Rural Development Act of 1972 (7 U.S.C. 2661 (supp. II)). The Hatch Act provides that 3 percent and the Rural Development Act provides that 4 percent of the research funds appropriated pursuant to those acts be set aside for Federal administration. In addition, CSRS receives a direct appropriation for administering research.

The following table shows the Federal funds appropriated to USDA's major research agencies for fiscal years 1973-76.

	Amount appropriated						
	ARS						
Fiscal year	Regular	Scientific activities overseas	Total	ERS	Forest Service	CSRS (note a)	Total
	(000 omitted)						
1973	$205,882	$10,000	$215,882	$18,625	$61,140	$2,326	$297,973
1974	203,254	5,000	208,254	19,661	64,785	2,637	295,337
1975	223,450	5,000	228,450	22,542	77,612	3,051	331,655
1976	262,304	7,500	269,804	25,782	80,355	3,383	379,324

a Total amount appropriated to CSRS for administration.

The Hatch Act of 1887, as amended, established State agricultural experiment stations to conduct original and other research, investigations, and experiments bearing directly on and contributing to establishing and maintaining a permanent and effective agricultural industry. It authorized research basic to the problems of agriculture in its broadest aspects, including investigations to (1) develop and improve the rural home and rural life and (2) maximize agriculture's contributions to the welfare of the consumer. This act is the primary authority for the States to conduct agricultural research in connection with and supported by the Federal Government.

The McIntire-Stennis Act of 1962 authorized the Secretary to encourage and assist States in carrying out a program of forestry research at land-grant colleges or State agricultural experiment stations and other State-supported colleges and universities offering graduate training in the sciences basic to forestry and having a forestry school.

The act of August 4, 1965, authorized the Secretary to make grants to State agricultural experiment stations, other

colleges and universities, other research institutions and organizations, Federal and private organizations, and individuals for research to further USDA programs. A large part of the funds appropriated under this act in recent years have been earmarked for the land-grant colleges of 1890 and Tuskegee Institute.

The Rural Development Act of 1972 authorized the Secretary to conduct, in cooperation and in coordination with colleges and universities, research, investigations, and basic feasibility studies in any field or discipline which may develop principles, facts, scientific and technical knowledge, new technology, and other information to achieve increased rural development. It also authorized research and development programs in management, agricultural production techniques, farm machinery technology, new products, cooperative marketing, and distribution suitable to the economic development of small-farm operations.

The following table shows the Federal funds appropriated to support research at the State institutions for fiscal years 1973-76.

Fiscal year	Amount appropriated				
	Hatch Act	McIntire-Stennis Act	Act of August 4, 1965 (note a)	Rural Development Act	Total
	(000 omitted)				
1973	$67,268	$6,444	$15,400	-	$ 89,112
1974	68,242	6,203	11,583	$1,440	87,468
1975	74,964	7,070	15,224	1,440	98,698
1976	82,630	7,462	19,546	1,440	111,078

a Amounts earmarked for the land-grant colleges of 1890 and Tuskegee Institute were $10,883,000 in fiscal year 1973, $10,883,000 in fiscal year 1974, $11,824,000 in fiscal year 1975, and $12,706,000 in fiscal year 1976.

RESEARCH ACTIVITIES

The research conducted by the Federal-State research organizations is highly diversified. It involves gaining and applying knowledge to (1) biological, physical, and economic phases of producing, processing, and distributing farm and forest products, (2) consumer health and nutrition, and (3) social and economic aspects of rural living. The following table, based on the latest information available from USDA, shows (1) the number of

active research projects at June 30, 1974, and (2) the scientific man-years expended on research in fiscal year 1974, categorized by organizational unit and by the goals that have been established for classifying publicly supported agricultural research. (See app. II for a more detailed classification.)

	Number of projects at June 30, 1974	Scientific man-years expended in fiscal year 1974							
		USDA		State experiment stations		Other State institutions		Total all organizations	
		Man-years	Percent	Man-years	Percent	Man-years	Percent	Man-years	Percent
Goal I --Insure a stable and productive agriculture for the future through wise management of natural resources	2,313	686.6	15.8	529.1	8.8	33.7	15.6	1,249.4	11.6
Goal II --Protect forest, crops, and livestock from insects, diseases, and other hazards	4,164	931.4	21.3	1,187.0	19.7	23.6	10.9	2,142.0	20.2
Goal III --Produce an adequate supply of farm and forest products at decreasing real production costs	6,867	640.5	14.7	2,343.8	38.8	35.1	16.3	3,019.4	28.4
Goal IV --Expand the demand for farm and forest products by developing new and improved products and processes and enhancing product quality	2,254	802.6	18.4	529.6	8.8	32.0	14.8	1,364.1	12.8
Goal V --Improve efficiency in the marketing system	957	324.0	7.4	200.3	3.3	4.4	2.0	528.7	5.0
Goal VI --Expand export markets and assist developing nations	141	118.1	2.7	35.6	.6	.5	.2	154.2	1.6
Goal VII --Protect consumer health and improve nutrition and well-being of the American people	1,175	333.4	7.6	294.2	4.9	28.8	13.3	656.4	6.2
Goal VIII--Assist rural Americans to improve their level of living	723	109.4	2.5	159.2	2.6	17.5	8.1	286.1	2.7
Goal IX --Promote community improvement including development of beauty, recreation, environment, economic opportunity, and public services	2,659	383.7	8.8	753.7	12.5	36.6	17.0	1,174.0	11.1
Administrative	144	-	-	-	-	-	-	-	-
Unclassified	42	32.9	.8	1.7	-	3.8	1.8	38.4	.3
Total	21,439	4,362.7	100.0	6,034.2	100.0	215.8	100.0	10,612.7	100.0

Note: Due to rounding, totals may not foot and crossfoot.

Source: USDA's inventory of agricultural research.

The research conducted under the first three goals is to insure an adequate supply of farm and forest products for immediate and future needs and to reduce costs of production so as to expand markets, increase returns to producers, and lower costs to consumers. The research conducted under goals IV and V is to insure the consumer better products and to minimize the cost of processing and distributing agricultural products. Research to expand export markets for agricultural products and to assist developing nations to raise agricultural productivity is classified in goal VI and research to protect consumer health and to improve the economic and social well-being of Americans who live on farms and in rural communities is classified in goals VII, VIII, and IX.

SOURCES OF FUNDS

In addition to Federal appropriations previously discussed, the research organizations within the Federal-State research system receive funds from other Federal agencies, State governments, private industries, and other sources. The following table shows the source of dollars spent for agricultural research in fiscal year 1974 by the research organizations.

Organization	Research dollars expended in fiscal year 1974 by source						
	Federal Government						
	USDA (note a)	Other Federal agencies	Total	State Government	Industry	Other sources (note b)	Total
	(000 omitted)						
USDA agencies:							
Agricultural Research Service	$198,025	$ 4,226	$202,251	-	-	$ 507	$202,758
Economic Research Service	19,660	534	20,194	-	-	5	20,200
Forest Service	64,712	3,197	67,909	-	-	-	67,909
Statistical Reporting Service	510	56	566	-	-	-	566
Farmer Cooperative Service	819	-	819	-	-	-	819
Total USDA agencies	$283,727	$ 8,013	$291,740	-	-	$ 513	$292,252
State agencies:							
State agricultural experiment stations	$ 84,096	$31,170	$115,266	$243,709	$20,624	$44,286	$423,885
Forestry schools	1,269	762	2,031	3,737	334	256	6,358
Land-grant colleges of 1890 and Tuskegee Institute	6,662	35	6,697	-	-	27	6,724
Total State agencies	$ 92,027	$31,967	$123,994	$247,446	$20,958	$44,569	$436,967
Total--All agencies	$375,754	$39,980	$415,734	$247,446	$20,958	$45,082	$729,219

[a]Funds expended by CSRS for research administration not included.

[b]Product sales, local governments, professional societies, individuals, and other sources.

Note: Due to rounding, totals may not foot and crossfoot.

Source: USDA's inventory of agricultural research.

Particularly important is the support of agricultural research by the States. Originally conceived in large measure by the Congress and stimulated by the Hatch Act of 1887, the agricultural experiment stations are a vital and integral part of the Federal-State agricultural research system. As shown in the above table, their research supported with State dollars was more than two times that supported with Federal dollars.

CHAPTER 2

AGRICULTURAL RESEARCH POLICY

ADVISORY COMMITTEE

The central focus and oversight for the total Federal-State agricultural research programs are provided through the Agricultural Research Policy Advisory Committee (ARPAC) established by the Secretary of Agriculture in 1969. ARPAC is co-chaired by the Assistant Secretary of Agriculture for Conservation, Research, and Education and by the designee of the Division of Agriculture, National Association of State Universities and Land-Grant Colleges. Other members are:

USDA agencies	National Association of State Universities and Land-Grant Colleges
Administrator, ARS	Division of Agriculture Member, Execttive Committee
Administrator, ERS	Chairman, Experiment Station Committee on Organization and Policy
Administrator, CSRS	Representative, Association of State College and University Forestry Research Organizations
Deputy Chief for Research, Forest Service	Directors from four Agricultural Experiment Stations
Administrator, Farmer Cooperative Service	Representative, Colleges of 1890 and Tuskegee Institute
Administrator, Statistical Reporting Service	Representative, Extension Committee on Organization and Policy
Administrator, Animal and Plant Health Inspection Service	
Administrator, Extension Service	

A representative of the Agricultural Research Institute 1/ is also a member of ARPAC.

1/ A nonprofit organization that brings together agricultural research managers from the Federal Government, universities, and industry to discuss the Nation's agricultural research programs and needs.

ARPAC's objectives are (1) to develop policy recommendations for planning, evaluating, coordinating, and supporting unified long-range agricultural research programs and for delineating the appropriate areas of responsibility of Federal and State agencies in carrying out these programs and (2) to develop further the bases for Federal-State cooperation in planning and implementing Federal, regional, and interstate agricultural research programs.

ARPAC is authorized to undertake and/or sponsor those activities it considers appropriate or necessary:

--To solve local, regional, and national problems affecting agriculture, forestry, other renewable natural resources, and rural life.

--To provide scientific expertise to local, State, and Federal government agencies, private organizations, and individuals.

--To provide scientific competence for teaching and to make available increased research opportunities for graduate students.

--To provide scientific expertise and research in support of programs that relate to foreign nations.

To assist in carrying out its objectives, ARPAC (1) established a regional and national agricultural research planning system; (2) sponsored several research coordinating committees and task forces, at the national level, to identify specific research needs; and (3) sponsored a national conference to identify research issues related to the capacity of the Nation to meet its domestic and international food needs.

REGIONAL AND NATIONAL AGRICULTURAL RESEARCH PLANNING SYSTEM

ARPAC established this system in 1971. It provides for gathering and consolidating inputs from scientists and administrators from the Federal and State research organizations and others on such matters as research needs, priorities, gaps in knowledge, and financial needs.

Scientists are considered a major key to the planning process because of (1) their technical expertise to make important judgments about research possibilities and potential research successes and (2) their knowledge, gained through frequent contacts with research users, on which to make judgments about research needs, gaps in knowledge, and research priorities. Managers also play key roles in the planning

process because of their experience gained through interaction with a broad array of public individuals and groups, including legislators, research users, scientists, and other administrators.

Organization and responsibility

At the national level there is a national planning committee co-chaired by the co-chairmen of ARPAC. Other members are:

--Administrator, ARS

--Administrator, ERS

--Administrator, CSRS

--Deputy Chief for Research, Forest Service

--Regional Director, North Central Agricultural Experiment Station Directors

--Director-at-Large, Southern Association of State Experiment Station Directors

--Northeast Regional Coordinator, State Agricultural Experiment Stations

--Director-at-Large, Western Agricultural Experiment Station Directors

--Representative, Association of State College and University Forestry Research Organizations

The national planning committee is responsible for establishing guidelines for national and regional planning operations, reviewing planning projections from the regional planning units, and developing reports on national and regional research programs and program adjustments for successive 5-year cycles. The committee may charter special subcommittees to plan research needs which are national or multiregional in nature.

At each of the four regions--Northeastern, North Central, Southern, and Western--there is a regional planning committee composed of designated representatives from (1) USDA's principal research agencies, (2) the State agricultural experiment stations and other participating universities, and (3) private industry.

The regional committees have a great degree of flexibility in carrying out their planning functions. They may charter up to 7 research program groups, each dealing with a general research subject area, and as many as 47 research program task forces or combination thereof, to assist in carrying out planning functions. A listing of the research program groups and research programs follows.

Natural resources:

- Soil and land use
- Water and watersheds
- Recreation
- Environmental quality
- Weather modification
- Fish and wildlife
- Remote sensing

Forest resources:

- Inventory
- Timber management
- Forest protection
- Harvesting, processing, marketing
- Watersheds and pollution
- Range, fish, and wildlife
- Alternative uses of land
- Technical assistance
- Recreation

Crops:

- Corn
- Grain sorghum
- Wheat
- Small grain
- Rice
- Soybeans
- Peanuts
- Sugar
- Forage, range, pasture
- Cotton
- Tobacco
- New crops
- Fruit
- Vegetable crops
- Plant enhancement, environment
- Bees

Animals:

- Beef
- Dairy
- Poultry
- Sheep
- Swine
- Other animals
- Aquatic foods

People, communities:

- Food and nutrition
- Food safety
- Rural development
- Insects--man

Competition and trade:

- Farm price income
- Foreign agriculture
- Marketing and competition

General resources:

- General resource technology

The research program groups and task forces may be composed of research administrators and/or scientists from the Federal and State research organizations and,in some instances, representatives from private industry.

In addition, the research administrators of the organizations in the Federal-State research system are required each

year to estimate the number of scientific man-years that would be allocated to the 47 research programs in 5 years under the assumptions that (1) resources would be the same as the current year and (2) resources would be increased 10 percent over the current year.

Output

In March 1975, ARPAC issued a consolidated report on the results of the 1973-78 planning cycle. The report summarized the research administrators' projected changes in the research programs under the two assumptions discussed above, and ranked the research priorities developed by the regional committees. Appendix III shows the results of the administrators' projections and appendix IV shows the ranking of the research priorities.

In addition to the consolidated report, the research program groups and task forces chartered by the regional committees to assist in research planning have, since July 1, 1973, issued 31 reports on research needs. See appendix V for more information on the research program groups and task forces.

NATIONAL COMMITTEES AND TASK FORCES

To assist in the overall planning for agricultural research, ARPAC, since its inception in 1969, has sponsored committees or task forces to:

- --Identify high-priority research needs for cotton.
- --Coordinate soybean research financed by Federal, State, and private sources.
- --Identify research needed to improve transportation for agriculture and rural America.
- --Provide a framework of proposed actions and policies within which the agricultural science community can move to meet its responsibilities to minimize genetic vulnerability of major crops.
- --Report on the dairy-forage research programs and facilities in the United States.
- --Examine and appraise land-use issues determined to be important during the next 10 years and identify--in priority order--social, economic, physical, and biological research and data needed to facilitate public and private decisions related to the identified issues.

--Identify range and forage research needs for red meat production.

Although the size and makeup of the memberships of the committees and task forces varied, they included representatives from the USDA's research organizations; the State research organizations; and others, such as private industry, private foundations, other USDA agencies, other Federal agencies, and national organizations and councils. For example, the following organizations were represented on the task force to identify actions and policies for minimizing the genetic vulnerability of major crops.

USDA

Office of the Assistant Secretary for Conservation, Research, and Education
ARS
CSRS
Animal and Plant Health Inspection Service

State

University of Wisconsin
University of Illinois
Cornell University
Oklahoma State University
Purdue University
North Carolina State University

Other

Pioneer Hi-Bred International, Inc.
Amstar Corporation
Campbell Soup Company
Rockefeller Foundation

The following reports have been issued which, among other things, identify needed research for the areas studied.

--The 1973 National Cotton Research Task Force Report

--National Soybean Research Needs (undated)

--Research Needed to Improve Transportation for Agriculture and Rural America, March 1973

--Recommended Actions and Policies for Minimizing the Genetic Vulnerability of Our Major Crops, November 1973

--Dairy-Forage Research and Research Facilities: A National Review, the Current Situation, and Recommendations for the Future, February 1975

NATIONAL PLANNING CONFERENCE

ARPAC sponsored a national planning conference in July 1975, to assist in identifying the most important problems requiring research in the next 10 to 15 years that affect the capacity of the United States to increase and improve domestic and world food supplies. Delegates representing producers and processors of agricultural products, marketing firms, national farm organizations, farm labor groups, nutrition specialists, and Government agencies were invited to the conference.

The conference findings related to three broad categories: human needs for food, organization of resources to provide food, and management of resources to provide food. Some of the identified priority areas related to nutrient requirements, composition, and education; food technology; food safety; social institutions; international development; production systems; marketing systems; energy; soybean production; water; and basic plant research.

ARPAC appointed two committees to develop follow-up plans for the conference. One is responsible for apprising the Federal-State research organizations of the conference results and insuring that they will (1) systematically consider the products of the conference in terms of applicability to and implications for current and future research programs and (2) continue dialogue with conference delegates and other public participants. The other committee is responsible for establishing an acceptable data base on ongoing research related to the identified priority areas.

More detailed information on the conference is in appendix VI.

CHAPTER 3

CURRENT RESEARCH INFORMATION SYSTEM

The Current Research Information System (CRIS), operated by USDA and the State agricultural experiment stations, is an automated system which accumulates in one place essential information on all research being conducted by the organizations in the Federal-State system. It is a tool which can be used for planning, coordinating, and reviewing agricultural research. The cost to operate CRIS in fiscal year 1975 was about $442,000.

CRIS was designed to do two things:

--Improve communication among agricultural research scientists, especially on current research work.

--Provide research managers with up-to-date and coordinated information on the agricultural research programs of all participating organizations.

The system provides for accumulating both management and scientific information on each of some 21,000 research projects. The management information includes the amount of funds allocated by source; manpower allocated by types--scientists, professional support, and other support; title of the research unit; name of the principal investigator(s); name of the performing organization(s); and names of cooperators. The scientific information includes a brief description of the research project, including its title, objectives, plan of work, current progress, and the more important publications issued.

The system provides for classifying each project by the purpose or kind of research being conducted, the commodity or resource involved, and the field of science involved.

The annual inventory of agricultural research is an output of CRIS. The inventory provides updated statistical information on all research conducted by the participating organizations. The information reported includes national, regional, and organizational summaries of

--scientific man-years and amounts of funds expended by designated research problem areas and by designated commodity areas or resources not associated with commodities,

--scientific man-years expended by designated research programs and research program groups, and

--funds expended by source.

In addition, CRIS provides information on special requests by scientists and administrators in the participating organizations and others. The following shows the number of requests for information received in fiscal year 1975.

Agency	Number of requests
ARS	508
CSRS	345
ERS	39
Farmer Cooperative Service	4
Forest Service	76
State agricultural experiment stations	1,249
Other organizations	174
Total	2,395

CHAPTER 4

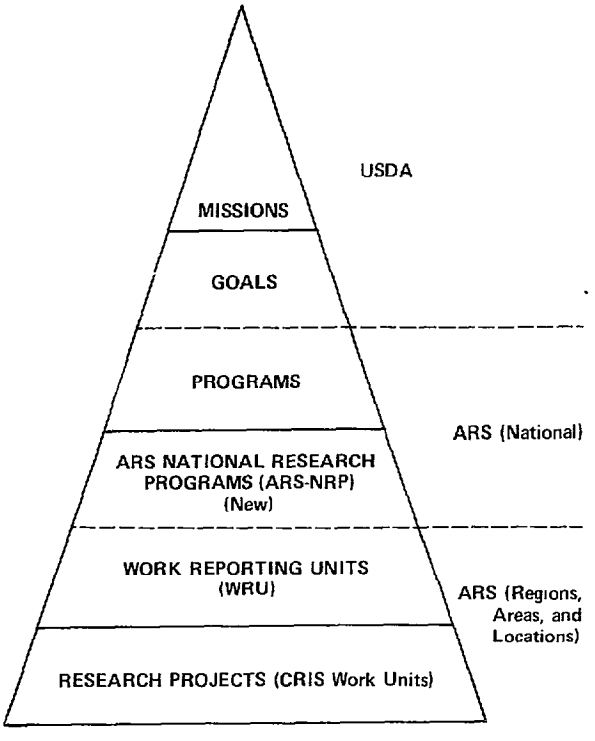
AGRICULTURAL RESEARCH SERVICE

MISSION AND ORGANIZATION

ARS is a mission-oriented agency concerned with basic, applied, and developmental research in agricultural and related fields. (See p. 2.) ARS, headed by an administrator, is geographically decentralized into 4 regions, each headed by a deputy administrator, and 27 areas and centers, each headed by a director. During fiscal year 1975, ARS employed about 9,300 people, including about 3,000 scientists, to carry out its research programs at about 145 locations. The scientists are located in every physiographic region of the Nation. This permits them to be in frequent and direct contact with users of research information and problems where they occur.

PROGRAM STRUCTURE FOR PLANNING AND MANAGING RESEARCH

ARS's program structure for planning and managing its research, as illustrated below, is tied into USDA's program structure and provides a unified framework by which specific research needs can be identified and research programs can be organized and managed.



Source Agriculture Research Service

As of January 26, 1976, ARS was finalizing 67 national research programs and 8 special research programs to assist in accomplishing 8 missions and goals. (See app. VII.) When finalized, these will replace about 300 research activities under which ARS is now operating. The research programs have been subdivided into about 1,000 work reporting units (specified research work by locations) and about 3,100 individual research projects, known as CRIS work units.

According to ARS, this program structure was based on the premise that its research must be planned, evaluated, and managed as a whole and be directed toward national needs and priorities instead of being managed as fragmented undertakings subordinate to other organizational activities. It provides the structural basis for planning, monitoring, and evaluating research; establishing priorities; budgeting and accounting; and coordinating programs with other USDA agencies and other institutions.

An outline of the system's major functions is included as appendix VIII.

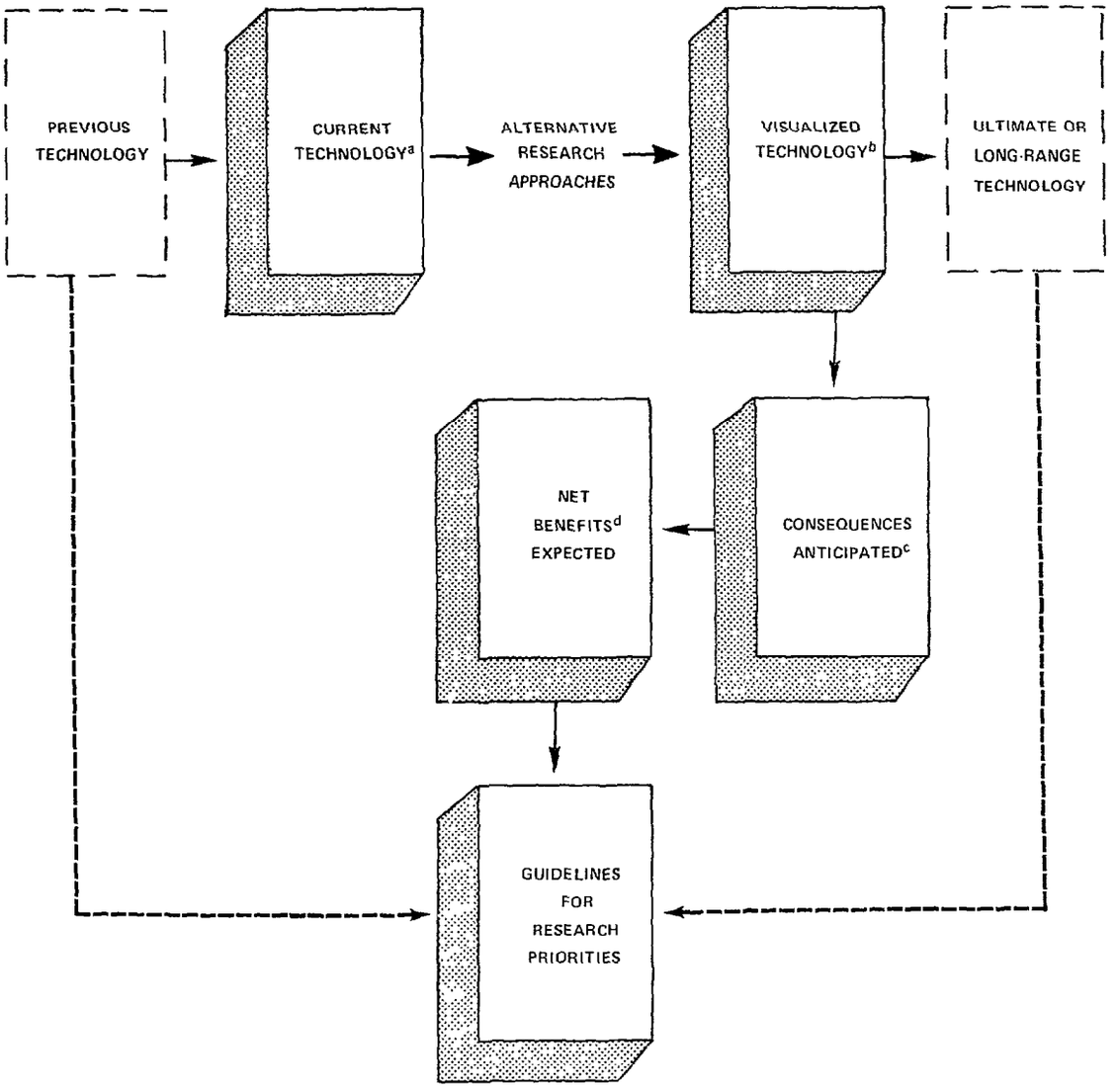
RESEARCH PLANNING

The formal long-range plans for research conducted within and supported by ARS are based on inputs from ARS scientists, administrators, and staff and from ARPAC, other advisory groups, producers, agribusinesses, other USDA agencies, other Federal agencies, the Office of Management and Budget, and the Congress.

The consolidated plans identify needed technologies for areas covered by ARS and the approaches that can contribute to technologies and point out the consequences, both with and without the research planned.

The plan for each area contains one or more technological objectives describing the most advanced technologies suitable for commercial or general use that could reasonably be developed in 10 years or less within the current level of research effort. The schematic diagram on page 19 shows the planning and evaluation process using a technological objective to focus on specific approaches to new technology and to describe anticipated consequences and benefits of altering current technology.

The lead responsibility for developing and updating, about every 5 years, the research plans has been assigned primarily to four assistant administrators who head up ARS's National Program Staff. They are assisted by about 50 staff scientists and about 250 other ARS scientists, known as



[a] The techniques now available to commercial agricultural production, marketing, or consumption.

[b] A specific technological goal which can be achieved using knowledge produced by one or more research approaches in a period of 10 years or less.

[c] The beneficial or detrimental aspects of achieving a Technological Objective that would be identified and evaluated in a formal technological assessment.

[d] The net savings in costs or net value of products generated by achievement of a Technological Objective.

Source: Agriculture Research Service

technical advisors, who are responsible for promoting and fostering scientific excellence and technical communication within ARS. The National Program Staff works with program analysts and line officers in the agency.

The research plans are required to be reviewed and concurred in by the Administrator's Program Analysis and Coordination Staff and approved by the Associate Administrator.

Under the current system the plan is divided into about 300 research activities but, beginning in fiscal year 1977, they will be consolidated into the 67 national research programs and 8 special research programs described in appendix VI. (See app. IX for an example of the plans being developed for one of the national research programs.)

According to ARS officials, copies of the plans for a program area (and for closely related areas, if requested) are sent to ARS scientists and managers who are responsible for conducting research in that area, thus permitting them to know how their work fits into and contributes to ARS's overall mission, goals, and objectives. The managers and scientists in the regions and areas are to use the plans to formulate their respective work plans. It is here that research leaders, area directors, regional deputy administrators, and their staffs make inputs into the planning process.

After decisions are made on funding levels for the fiscal year, area directors and research leaders, working with the regional office, are required to develop work reporting units and financial plans and determine how to allocate available resources among the work reporting units. Individual research projects are developed as needed.

CRITERIA USED IN DEVELOPING NATIONAL RESEARCH PROGRAMS

According to ARS officials, the subject matter areas and commodities covered by the national research programs were structured in various ways, representing compromises among many competing needs because of the complexity of the disciplines, commodities, resources, activities, and problems to be solved. They said that the following criteria were used in developing the national research programs.

--Logical subdivisions of programs and reasonable aggregations of technological objectives which link work at locations to USDA-ARS programs and to which scientists, managers, and staff can easily relate.

--A total number of elements that provide a reasonable linkage between its major programs and research projects.

--Relatively enduring research needs and objectives for solving identifiable and important problems.

--Collectively, a complete array of program elements and technological objectives that are mutually exclusive to the fullest extent possible.

--Elements that will be significant national programs in and of themselves, or otherwise will provide building blocks which can be recombined easily to develop significant national programs.

--Elements that delineate programs for individual National Program Staff scientists who have overall responsibility for national coordination and leadership.

--Relevant and useful aggregations of scientific disciplines and fields of science for use in planning, evaluating, and executing agricultural research at the national, area, and local levels.

--The basis for analyzing and evaluating research by ARS, USDA, the Office of Management and Budget, and the Congress.

--Collectively, a system that will provide the basis for setting priorities and guidelines for budgeting and reallocating resources within ARS.

--A structure that will crosswalk easily to or from CRIS and to other classification systems, such as the research program groups used in ARPAC's regional and national planning system.

APPROVAL PROCESS FOR RESEARCH PROJECTS CONDUCTED IN HOUSE

Research proposals are generated throughout the year as ARS scientists become aware of new problems and have new ideas for performing research on the problems. Some proposals are approved by the research leaders when they can be financed by redirecting ongoing work and associated resources at their disposal.

The proposals that cannot be funded are forwarded to the area directors for review and approval. The area directors approve the proposals they can fund by redirecting research and associated resources at their disposal. In some cases, however, the area directors must seek additional funding from the region.

The regional deputy administrators receive a virtually continuous flow of proposals for alternative uses of funds. This requires continual application of the research evaluative process and results in many redirections during the course of a year. Some proposals are implemented by the regional deputy administrators by utilizing resources at their disposal. Others, representing more significant actions, require the approval of the Administrator. Some must remain unfunded.

All of the above activities are budget-related and continue throughout the year. In addition, the budget development process offers an opportunity annually to request new funding for those important research pieces that the various levels of ARS management have been unable to fund. The formalized part of the budget development process takes place during the general period of January to July. It is a procedure for drawing the loosely linked developmental and evaluative budget activities that have been occurring throughout the year at various ARS operational levels together into a coherent evaluative process for determining those proposals of greatest merit and developing them into programs and packages of documented high priority before presenting the budget to the Congress.

In December and early January of each year, the Administrator and his staffs develop priority guidelines which ARS officials stated were based on information from economic and other projections, Office of Management and Budget directives, the President's budget, departmental goals, the needs and plans of action agencies, industry, and the Congress for agency-wide guidance in developing the budget. These guidelines are sent to the regions which are requested to submit proposals for new research that ARS could or should undertake. The regions in turn request inputs from scientists and their research leaders through the area directors.

Since there are more proposals than can be funded under any realistic expectation, they must be evaluated

so that only the most worthwhile are retained. Those that the regions regard as being of highest priority are forwarded to ARS headquarters for further evaluation by the National Program Staff and the Program Analysis and Coordination Staff. The criteria used by all evaluators are broken down into four areas of consideration:

--The problem itself--its importance and urgency, its relevance to agency and departmental responsibilities, and the extent of similar work elsewhere.

--The scientific merit of the research approach.

--The direct practical applicability and the scientific usefulness of the research results.

--The efficiency of resource utilization--whether ARS has or can obtain suitable needed resources and whether resources unique to ARS are being fully utilized.

Appendix X shows the scoring model ARS used for rating the proposals for fiscal year 1978.

During the evaluating process, the Administrator's staffs can amend proposals to better accomplish their research purposes or to more efficiently utilize resources. In addition, they can submit proposals in those areas of research that are needed but in which no proposals have been received. The new submissions and amended proposals are evaluated by the same panels using the same criteria discussed above. A final ranking of proposals is obtained from the scores assigned by the region and the two headquarter staffs.

As a preliminary step to developing coherent packages of important research that ARS should undertake, the evaluated proposals are collected under appropriate generalized topics identified with the established high-priority areas for research and presented to the Administrator's Staff Conference for a decision on the number of packages, titles, and total dollar amount of the budget request. After this step, the packages are to be reviewed to make sure that the proposed research is of high priority, important to this country, relevant to ARS's missions, and capable of being achieved.

ARS officials stated that, during all of this, they maintain contact with USDA's action agencies to insure that

their needs are met and with USDA's other research agencies to insure that research efforts are not being duplicated.

ARS estimates that it approves from 15 to 25 percent of the proposed projects, but the percentage approved by USDA and by the Office of Management and Budget and included in ARS's budget request to the Congress is smaller.

APPROVAL PROCESS FOR RESEARCH PROJECTS CONDUCTED BY OTHERS

ARS funds extramural research to support its missions and to supplement its capabilities. The extramural research program is primarily designed to fill gaps and supplement the intramural research program in the high-priority areas and to meet small scale emergency program needs.

Both solicited and unsolicited proposals for extramural research are reviewed by the regional deputy administrator, the National Program Staff, and the Program Analysis and Coordination Staff. Each review group assigns a priority rating to the research proposals. A listing of all research proposals, together with the priority ratings assigned, are forwarded to the Administrator for approval. The Administrator is to approve those proposals which received the highest priority ratings and can be funded with available resources.

ARS officials told us that the following criteria are used for evaluating the priority of extramural research proposals.

--Extent to which research relates to national, departmental, and ARS goals of high priority, including the ARS priorities for extramural research.

--Relevance to filling gaps and extending the objectives of in-house research.

--Adequacy of objectives.

--Adequacy of plan of work to achieve objectives.

--Originality and soundness of approach.

--Relevance of estimated cost to objectives, plan of work, and duration of project.

--Documented qualifications of the principal investigator(s) and supporting scientists.

--Time and attention the principal investigator(s) will devote to the project

--Adequacy of available facilities and equipment.

The size of ARS's extramural research program is small in relation to its in-house research program. The percent of appropriated funds used for extramural research in recent years ranged from 4.2 percent in fiscal year 1971 to 1.8 percent in fiscal year 1975.

PROCEDURES FOR REVIEWING ONGOING RESEARCH

Annually, the progress and future plans for research conducted by ARS are summarized and reported in a report for each of the 1,000 work reporting units.

Each report, prepared by the scientists conducting the research, is to identify

--the national research program objectives to which the research is directed,

--other ARS locations where research is being conducted which complements or supplements the same national program objectives,

--specific objectives of the work reporting unit for the next fiscal year,

--plan of work to be followed to accomplish the specified objectives,

--the names, grades, and titles of the scientists assigned to the work reporting unit and the amount of time spent in the current fiscal year and the estimated amount of time to be spent in the next fiscal year,

--the research projects (CRIS work units) contributing to the work reporting unit,

--the amount and source of funds expended in the current fiscal year and estimated to be spent in the next fiscal year,

--the planned duration of the work reporting unit,

--the progress made in the current fiscal year toward achieving the research objectives, and

--the need for and planned use of additional funds.

The reports are reviewed and evaluated by managers and staffs at the area, regional, and national levels.

The reports are reviewed and evaluated by managers and staffs at the area, regional, and national levels.

In addition, ARS conducts program reviews of selected research programs and subjects of national importance. ARS defines program reviews as in-depth, multidisciplinary reviews of research on a given commodity, function, or resource. They may cover all or part of a research program at a given location; all or part of a research program of a particular facility at a location; or all similar research being considered in a production area, regional area, or nationwide. Each program review team is to include representatives from the National Program Staff, the Program Analysis and Coordination Staff, and the Office of the Regional Deputy Administrator. They may also include representatives from other USDA research and action agencies, State agricultural experiment stations, and industry.

Recommendations stemming from a program review can have impacts ranging from minor to major changes in program direction, allocation of resources, and operation of facilities. The procedures require the review leader, with assistance from other team members, to prepare a follow-up report in 1 year after the review report to advise the Associate Administrator on the extent of implementation actions, the results achieved, and whether nonactivated recommendations are still germane.

Workshops are another way research is reviewed within ARS. ARS defines workshops as problem-solving or research-planning meetings or seminar-type sessions covering a specific subject matter area which may be function- or commodity-oriented in nature and national, regional, or local in scope. The objectives of workshops are to review and clarify the "state of the art" in a field or discipline, to identify problem areas, to coordinate research plans, and to provide opportunities for scientist-to-scientist interchange. They are planned, conducted, and attended by scientists with expertise in the field or discipline under review with inputs as needed from ARS line managers and staff. During fiscal years 1974 and 1975, ARS conducted 33 program reviews and workshops.

CRITERIA FOR RESEARCH EVALUATION

ARS officials said that evaluating agricultural research programs is difficult and challenging and that there were no set, proven, or agreed upon best methods or criteria

criteria most frequently used to evaluate completed research include

--number of publications,

--quality of publications and research results,

--economic and/or social impact of research findings, and

--potential value of new knowledge or technology.

The officials said that ARS places great emphasis on program evaluations, and, in fiscal year 1975, six pilot studies were initiated to explore methodologies, criteria, and cost requirements for evaluating ARS's research programs. The report on one of the six studies, "An Evaluation of Research on Lymphoid Leukosis and Marek's Disease," was dated June 1975. The results of the other studies were not available as of March 1976.

CHAPTER 5

COOPERATIVE STATE RESEARCH SERVICE

MISSION AND ORGANIZATION

CSRS's primary function is to administer Federal funds for State agricultural and forestry research authorized by the (1) Hatch Act of 1887, as amended, (2) the McIntire-Stennis Act of 1962, (3) the act of August 4, 1965, and (4) the Rural Development Act of 1972. This research is carried on by the State institutions--State agricultural experiment stations, approved schools of forestry, land-grant colleges of 1890, and Tuskegee Institute. CSRS reviews and approves in advance each research project proposed to be funded in whole or in part with these Federal funds and reviews and evaluates the State institutions' research programs and expenditures administered under the acts. CSRS also encourages and assists in establishing and maintaining cooperation within and between the States and participates in planning and coordinating research programs between the States and USDA.

CSRS functions are carried out by an administrator and a staff of about 80 employees, including about 35 scientific specialists, located in Washington, D.C.

APPROVAL PROCESS FOR RESEARCH PROPOSALS

The State institutions are responsible for developing their research programs and for initiating, reviewing, and approving research proposals to be supported with Federal dollars other than those appropriated under the act of August 4, 1965, for competitive grants. CSRS approves those proposals that are to be financed in whole or in part with Federal funds. The land-grant colleges of 1890 and Tuskegee Institute are required to submit their research programs to CSRS for approval before they can submit proposals in support of the program objectives.

The procedures for approving research projects proposed by State institutions and to be supported with Federal funds (except the portions earmarked for regional research under the Hatch Act of 1887 and for competitive grants under the act of August 4, 1965) are generally as follows.

--The project leader initiates a proposal and sends it to the department head for review and approval. The proposal includes:

1. A brief, clear, specific designation of the subject of the research.

2. The problem's importance to the agricultural and rural life of the State or region.

3. The reasons for doing the work.

4. The ways in which public welfare or scientific knowledge will be advanced.

5. A brief summary of pertinent previous research on the problem, the status of current research, and the additional information needed.

6. A clear, complete, and logically arranged statement of the project's specific objectives.

7. A statement of the essential working plans and methods to be used in attaining each stated objective.

8. The scientists and other technical workers assigned.

10. Other institutional units involved, including any advisory, coordinating, or directing committees.

11. A statement as to the cooperation with USDA or other reesearch institutions.

--The department head asks other scientists, including extension specialists, at the institution for their comments on the proposal.

--After the department head approves the proposal, it is forwarded to the institution's chief administrative officer for research.

--The chief administrative officer sends the proposal to a standing or an ad hoc project review committee for review and comment. In some cases, this step is carried out by the department head.

--After the chief administrative officer formally approves the proposal, it is sent to CSRS for review and approval.

The Hatch Act provides that not more than 25 percent of the appropriated funds be allotted to the States for cooperative research in which two or more State agricultural experiment

stations are cooperating to solve problems that concern the agriculture of more than one State. Following are the steps for approving a regional research proposal.

--The scientists or administrators of one or more State agricultural experiment stations initiate a proposal. It is forwarded to the directors of the State stations involved for approval.

--If approved, the proposal is sent to the Regional Association of Experiment Station Directors.

--A committee of three directors reviews the proposal. If approved, the proposal is voted upon by all directors in the region.

--The approved proposal is sent to the Committee of Nine--a USDA statutory committee elected by and representing the directors of State agricultural experiment stations--for review and approval.

--If approved by the Committee of Nine, the proposal is sent to CSRS for its approval.

At each review level, including CSRS, the following criteria are to be used in determining if a proposal is acceptable for regional research.

--The problem concerns two or more States.

--The problem requires more scientific manpower, equipment, and facilities than are generally available at one State station.

--The approach is adaptable and particularly suitable for cooperation with other States and the Federal Government.

--The project, if initiated, will attract additional research support which is not likely to occur through existing research program plans and mechanisms.

--The project can be made specific enough to promise significant accomplishment in 5 years or less.

--The project can provide the solution to a problem of fundamental importance or fill an important gap in knowledge from the standpoint of the present and future agriculture of the region.

--The project can be effectively organized and conducted on a regional level.

The research proposals when submitted to CSRS are first reviewed by the appropriate subject-matter specialists and, if approved, are sent to the appropriate deputy administrator for final approval. CSRS officials said that, typically, they approve about 94 percent of the regular research proposals and about 76 percent of the regional research proposals submitted for Hatch Act funding; about 94 percent of the proposals submitted for McIntire-Stennis Act funding; and about 90 percent of the proposals submitted by the land-grant colleges of 1890 and Tuskegee Institute for funding under the act of August 4, 1965.

Following are the steps involved in approving research proposals submitted by authorized institutions under the authority of the act of August 4, 1965, for competitive grants.

--Proposals initiated by scientists are sent to their institutions' chief administrative officers for review and approval.

--After approval, the proposals are sent to CSRS.

--CSRS has the specialists most knowledgeable in the specific areas coordinate the review process in the categories for which funds were supplied.

--Each proposal is reviewed by a peer group which generally includes representatives from the State institutions, ARS, and CSRS. The peer group is to rate the proposal on the basis of:

1. Research competence of principal investigators.

2. Amount of time and attention principal investigators will devote to the project.

3. Adequacy of facilities and equipment.

4. Quality of research at the institution in the program area of the proposal.

5. Feasibility of attaining objectives during length of time proposed.

6. Relevance of the proposed research to published literature and to ongoing research.

7. Identification of direct users of research results and of research beneficiaries.

--Proposals identified by the peer groups as outstanding are sent to the Office of the Administrator.

--The Administrator, after consulting appropriate staff members, approves proposals for funding.

CSRS officials told us that, in fiscal year 1974, about 90 percent of the proposals received by CSRS for competitive research grants received peer group approval, but only about 10 percent could be funded.

Following are the categories and funds allocated for competitive research grants in fiscal years 1975-76.

Category	Funds allocated 1975	1976
Environmental quality	$600,000	$ 625,000
Food and nutrition	750,000	893,750
Beef and pork production	750,000	1,781,250
Soybeans	500,000	625,000
Pest management	500,000	625,000
Rural development	300,000	-
Transportation	-	625,000
Forage, pasture, and range	-	1,000,000
Genetic vulnerability	-	625,000

REVIEW AND EVALUATION

CSRS procedures are to review research programs at each participating State institution about every 4 or 5 years. The CSRS reviews are of two types--special reviews and subject-matter reviews.

Special reviews--the preferred type--are initiated at the request of State institutions and are based on the premise that research workers want to examine their own research from time to time with colleagues in their areas of work who have different viewpoints and experiences. The format and process for a special review is developed mutually by CSRS and the State institution under review and is tailored as much as possible to the institution's needs and desires for program improvements. The special review panels may include scientists from industry, other State institutions, CSRS, and other USDA research agencies.

During fiscal year 1975, CSRS conducted 59 special reviews. These were directed primarily toward future plans for research program improvement. About 100 scientists, most of whom were from outside USDA, assisted CSRS in the reviews.

CSRS specialists conduct the subject-matter reviews. Their emphasis is on the ongoing research programs and accomplishments rather than future research planning. During fiscal year 1975, CSRS conducted 34 subject-matter reviews.

For each type of review, CSRS procedures require the review team to prepare a written report summarizing its observations, conclusions, and recommendations for use by the State institution in improving its research programs.

CSRS officials said that the criteria CSRS uses to measure the quality of the research includes its usefulness, probability of adoption, urgency or timeliness of the problem addressed, effectiveness of the research process in reaching the desired results, publication of research results in scientific journals, peer group evaluation and acceptance, and relevance of research to high-priority needs.

CHAPTER 6

FOREST SERVICE

MISSION AND ORGANIZATION

Under authority of the McSweeney-McNary Forestry Research Act, the Forest Service carries out a research program to help solve the forestry problems confronting the Nation. The program supports forestry activities on National Forests and other publicly administered lands and on privately owned forest lands, including small woodland properties.

The research is oriented to the management, protection, and use of timber, water, forage, wildlife, and recreation resources of forest and rangelands. The research addresses the problems of improving productivity of forest and related resources and protecting them from fire, insects, disease, and other destructive agents. It includes research relevant to urban forestry, land-use planning, environmental protection and enhancement, endangered plants and animals, timber harvest engineering, and forest products development and use. It also involves research in forest economics and forest products marketing plus keeping resource supply and demand information up to date. The research is intended to provide the information needed to manage and protect forest and related resources, gain maximum economic and social benefits from their use, and leave the environment unspoiled.

The overall planning, direction, and coordination of forestry research has been assigned to the Deputy Chief for Research, who has both line and staff responsibilities. He is assisted by advisers grouped into seven research staffs--Timber Management, Forest Environment, Forest Insect and Disease, Fire and Atmospheric Sciences, Forest Products and Engineering, Forest Economics and Marketing, and International Forestry. The research is done by about 1,000 scientists at 81 locations throughout the United States and Puerto Rico. Many of the scientists are located on or near university or college campuses. The research is done also at the Forest Products Laboratory at Madison, Wisconsin; the Institute of Tropical Forestry at Rio Piedras, Puerto Rico; and the following eight experiment stations.

Experiment station	Location
Northeastern	Upper Darby, Pennsylvania
Southeastern	Asheville, North Carolina
Southern	New Orleans, Louisiana
North Central	St. Paul, Minnesota
Rocky Mountain	Fort Collins, Colorado
Intermountain	Ogden, Utah
Pacific Southwest	Berkeley, California
Pacific Northwest	Portland, Oregon

The Director and Assistant Director for Research at each station have line responsibility for managing research in a prescribed geographic area. They are supported by an Assistant Director for Research Support Services and an Assistant Director for Planning and Application.

Research is done within the missions or charters of approved research work units (RWUs) and special programs under the direction of designated leaders.

RESEARCH CLASSIFICATION

The Forest Service classifies its research work into the following categories: financial projects, work projects, RWUs, and special research programs.

Financial projects encompass (1) forest and range management research, (2) forest protection research, (3) forest products and engineering research, and (4) forest resource economics research. Under each financial project, there are two or more work projects that correspond with line items in the Forest Service's budget which facilitates financial and work progress reporting.

The RWUs are the primary units for managing and financing research programs. Each represents a mission-oriented research unit. There are approximately 220 functional RWUs which normally reflect the functional program of a work project at a single location. In addition, there are about 25 multifunctional RWUs and 8 pioneering RWUs. Multifunctional RWUs address multidisciplinary problems of priority interest to more than one function and receive funding from, and contribute to, two or more work projects. Pioneering RWUs are given a broad charter outlining a problem area that can involve one or more scientists, of which the leader is designated the pioneering scientist.

Under the special research classification, there are three types of programs: multi-project programs; research and development programs; and research, development, and

application programs. As of February 4, 1976, there were about 10 special programs in operation.

Multi-project programs consist of RWUs, or parts thereof, which are organized to focus available talent and resources on especially complex and urgent researchable situations. They are financed through normal budget line-item procedures within cooperating RWUs.

Research and development programs address especially urgent problems and are designed to make research implementation feasible in 5 years or less and are appropriate when the current state of technology is sufficiently advanced so that the completion can be anticipated and adequate funding is in sight at the onset of the program. Budgeting is handled as a special item for each individual program, but may also include elements of other program funding. They can involve one or more stations, the Service's National Forest System and State and Private Forestry arms, universities, and private industry.

Research, development, and application programs are major efforts which contain a strong element of research implementation into operational programs. They generally involve both intramural and extramural efforts and a shared commitment between the research and cooperating units to develop and refine technology and to place it into operation within 5 years or less. Each program is budgeted separately but can contain elements of other program funding.

RESEARCH PROGRAM FORMULATION

Formulating the Forest Service's research program involves participation of many individuals both inside and outside the research organization. It is accomplished within the framework of laws, congressional appropriations, departmental regulations, and the interdepartmental and intradepartmental coordinating devices at the national level as well as appropriate interpretations and applications of these factors at the regional level. It also provides for a look ahead in terms of a projected program as well as the translation of urgent problems into current research.

National program

The Deputy Chief for Research is responsible for formulating long-range research programs at the national and international levels. He is assisted by the Washington research staffs. Inputs for the planning efforts are received from

the Secretary of Agriculture, the Congress, other USDA agencies, other Federal agencies, the Service's National Forest System and State and Private Forestry arms, ARPAC, universities, other scientists, and the general public.

Beginning in fiscal year 1976, the projected research was to be performed in accordance with the Forest and Rangeland Renewable Resources Planning Act of 1974 (P.L. 93-378, 88 Stat. 476), which requires an assessment of forest resources in the United States and a long-range action plan. Its documentation illustrates costs and outputs which can be expected during the period 1977-2020 under several alternative levels of management and research. Programs were to be developed and submitted to the Congress on December 31, 1975, and every 5 years thereafter. Assessments were to be submitted to the Congress on December 31, 1975, again in 1979, and every 10 years thereafter. The first report was submitted to the Congress on March 2, 1976.

Station programs

Research program development at each station begins with selecting station goals keyed to national goals. The Assistant Director for Planning and Application plays a key staff role in developing the broad program thrust of the station and has the responsibility for integrating the input of scientists into RWUs and special research programs. All additions, modifications, and deletions of the various RWUs and special programs require concurrence by the Deputy Chief for Research.

Initiating and approving RWUs

Before any research can be started, a detailed description of the work is prepared by the Assistant Director for Research. Each description summarizes the unit's mission, problems to be solved, research approach to be taken, and expected cooperation from other units. It also projects a line of investigation over a period of up to 5 years, describes from one to six high-priority problems, and outlines the general approach to be followed in the research. The descriptions are considered as flexible program guides that can be revised as needed to permit the research to be currently aimed at high-priority problems. In preparing these descriptions, the responsible assistant director generally calls upon the project leaders and other staff scientists for assistance. The descriptions are forwarded to the Washington research staffs for review, then approved by the station director with the concurrence of the Deputy Chief for Research.

Problem analysis

Following approval of the RWU description, the project leader or a designated scientist analyzes each identified problem and determines the manner in which the problem will be attacked.

He is required to prepare a problem analysis report for each selected problem for approval by the Assistant Director for Research. Following are the important points usually covered in a problem analysis report.

--Precise definition of the problem.

--Review of pertinent literature and work underway elsewhere.

--Breakdown of the problem into reasonable components.

--Research attack proposed.

--Priority of specific studies.

--Time schedule for studies to be started.

--Anticipated time for completing each problem component.

--Estimated total cost of each problem component.

--Cooperative personnel and facilities available and desirable coordination with other research.

--Predicted benefits of each problem component.

Study plan

After approval of the problem analysis report, a study plan is developed by the scientist who will perform the research with possible assistance from the project leader or a colleague. The study plan defines the proposed study or experiment and its objectives; reviews pertinent literature; and describes the methods to be used and the means of analyzing, disseminating, and applying results. It also identifies means to minimize health and safety hazards associated with the research. Further, it includes an estimate of the cost in manpower and funds and assigns responsibility for carrying it out. The purpose of the study plan is to (1) require the scientist to thoroughly plan the study or experiment and clarify its

objectives and methods, (2) facilitate technical and administrative review and make the plan available to other workers, and (3) make certain that time and personnel changes do not obscure original objectives and proposed methodology.

Initiating and approving pioneering RWUs

The concept for a pioneering RWU is initiated by a station or a Washington staff director and is presented to the Deputy Chief for Research. If he agrees, a charter and a summary proposal for the new pioneering RWU are prepared by the initiating office with the help of the candidate pioneering scientist. These are presented to the Chief of the Forest Service for his approval. Upon approval, the charter is reviewed by Administrators of other interested USDA agencies and is submitted to the Office of the Secretary for final approval. The charter is to contain the following items.

--Title.

--Justification.

--Key pioneering scientist to be assigned, including name, grade, and qualifications.

--Objectives.

--Nature and location of the research, including specific areas of investigation to be undertaken, staffing, and other resources.

--Cooperation to be carried out with others to aid the scientific endeavor and to prevent duplication.

--Recent publications of the pioneering and supporting scientists that have special significance to their assignments with the pioneering RWU.

All pioneering RWUs are assigned to stations for housing and research support services and are administered directly by the station director unless otherwise designated.

Initiating and approving multi-project programs

Multi-project programs occur when two or more RWUs are used in addressing high-priority and complex research needs. The technical operation of each multi-project program is assigned by the station director to a program leader. He is usually aided in program planning by the Assistant Director for Planning and Application and by a planning team consisting of project leaders of cooperating RWUs.

The procedures for initiating and approving these programs are basically the same as the procedures for RWUs described on pages 37 to 39.

Initiating and approving research and development programs

Research and development programs are efforts designed to address urgent problems and to implement research results within 5 years or less. These programs include research, applied studies, and developmental work which may involve one or more stations, as well as other Forest Service units, equipment-development centers, other Federal agencies, universities, and private industry. They are approved by the station director with the concurrence of the Deputy Chief for Research and the deputy chiefs of the other participating arms of the Forest Service.

Each research and development program is headed by a program manager. Although program managers are usually selected from the research arm, they can come from other arms of the Forest Service. If the program is large or complex, a policy panel and technical committee may be appointed. The policy panel, appointed by the Deputy Chief for Research, advises the responsible line officers on matters related to policy, mission, and funding. The technical team, appointed by the station director, provides technical advice to the program manager.

The idea for a research and development program can be initiated at any level; however, its formalization starts at the station level where a program description and operating plan or charter is prepared. A program charter contains the

--title,

--participating units by name and program assignment,

--responsible Forest Service organization,

--locations,

--program manager,

--justification,

--mission and objectives,

--resume of work to meet program objectives,

--schedule for accomplishment of objectives,

--environmental impacts,

--staffing,

--general assignments and locations of participating units and personnel,

--funding formula,

--facilities and equipment,

--cooperation, and

--approval signatures by the officers directly responsible for the charter's preparation.

The charter is then approved by the responsible station director, with the concurrence of the Deputy Chiefs for Research and for other participating arms of the Forest Service.

At that time, the descriptions of participating RWUs are to be revised to reflect necessary changes in assignments and operations. The research and development activities are recorded in an operating plan which includes a description of the activities designed to meet various program objectives, the assignment responsibilities, the resources available to accomplish the tasks, and the required schedule for attaining results. The plan is approved by the program manager with concurrence by the station director.

In addition, study and application plans are developed by the participating scientists and specialists to meet the program objectives. Research proposals are then forwarded to the Deputy Chief for Research for coordination. At the Washington level, a staff director is designated to coordinate reviews by Washington staffs and to keep other staffs informed of the progress being made.

Initiating and approving research, development, and application programs

The formulation of these programs follows the general pattern for formulating research and development programs described above. However, the approach for administration is different because of the increased emphasis on application into operational programs. Depending on needs, the responsibility for a research, development, and application program is assigned by the Chief of the Forest Service to a station director, a regional forester, or an area director.

These programs are established by a charter approved by the Chief. Various panels and committees are appointed to advise on program formulation and operation. Considerable emphasis is placed on pilot testing and demonstrating new technology in actual operational situations.

REVIEW OF ONGOING RESEARCH PROGRAMS

It is Forest Service policy to conduct reviews to assess progress in meeting management objectives. In addition to the continuous review of research in connection with RWU progress reports, budget formulations, seminars, technical advisory visits by Washington staff, and pre-publication of research results, the Forest Service operates a formal management review system. This system is designed to assess (1) quality of managerial processes used to achieve agreed-upon objectives, (2) work procedures and practices as they affect quantity and quality of results, (3) program coordination and cohesiveness of overall direction, and (4) relevance of policies and standards with regard to changing conditions and emerging issues.

This system is comprised of general management reviews, program reviews, and activity reviews conducted by the Washington staff, and RWU reviews conducted by responsible station line officers.

Washington reviews

A general management review involves a joint look at the research and other Forest Service activities and programs in a geographic territory. Its purpose is to coordinate the direction, performance, and output of all Forest Service programs and activities. The teams for these reviews are formed on an ad hoc basis and are headed by the Chief or Associate Chief of the Forest Service. The Deputy Chief for Research or an associate deputy is a member of the review team along with other Forest Service personnel.

A program review is defined as a review of all activities that contribute to the objectives or purposes of a single program or two or more programs under the management of a Deputy Chief. Its purpose is to determine if all activities that serve the program are coordinated, planned, and managed in a manner which achieves desired quality and quantity of results. The review team is headed by the Deputy Chief, an associate deputy, or a Washington research staff director.

An activity review is defined as a review of any action or group of interdependent actions which have a specific purpose or result. Its purpose is to determine if all actions

of the activity or activities are carried out in a desirable and beneficial manner. Activity reviews, usually made by subject-matter specialists, are generally narrow in scope and coverage and are detailed and technical in nature.

Each type of review discussed above is made on an as-needed basis and may be initiated by one or more of the following factors.

--Failure of a unit to meet its objectives and targets.

--Change in the delegated authorities and responsibilities of key personnel or organizational structure.

--Followup on implementations of changes in policy, program emphasis, or direction.

--Failure to fully carry out the agreed-upon actions of a previous review.

--Internal written or verbal communications regarding the condition of resources or the management of land, resources, people, or material basic to performing assigned jobs.

--External reports or communications regarding a unit's failure to meet objectives or targets.

--Periodic accountability reporting of programs and activities.

--Length of time since last review.

--Requests by line officers who wish to have specific problems or conditions reviewed by higher levels.

Also, for each type of review, a review report is prepared to document the team's findings and alternatives developed. On the basis of the review report, an action plan is developed and agreed upon by the principal line officers at the organizational levels involved. This plan is treated as a binding contract and the review is not formally closed until the responsible line officer certifies that all required corrective actions have been taken.

Station reviews

Each RWU or special research program is to be reviewed by the responsible line officer at the station level as frequently as deemed necessary but at least every 2 years. The procedures require that a written report be prepared on each

supervisory review. At a minimum the report is to document the following.

--Changes or modifications needed in the RWU's description, charter, problem analyses, operation plans, and study plans.

--Progress on assigned problems summarized and related to previously established targets.

--New targets for solving research problems for the next 2 years and implementation of results scheduled.

--Deficiencies in research procedures and agreements on corrective actions contemplated.

--Deficiencies noted in staffing and training and the corrective actions agreed upon.

--The unit's financial needs for both short- and long-term operations, including potential problem priority shifts.

--Occupational health and safety problem areas identified and progress made on correcting deficiencies. Consideration is to be given to special safety-health training needs for the unit's personnel.

--Problems identified with support services and research facilities.

--Progress in implementing civil rights action plans and accomplishments.

--Areas in which minority group contacts are desirable to foster understanding of Forest Service programs and participation in program activities.

--Plans and progress in research application and agreements reached on tentative publications and target dates for completion.

The supervisory report, prepared by the reviewing line officer, is reviewed and signed by the unit's leader and filed with the station director. Copies are to be sent to the concerned Washington staff directors. Reports on reviews of pioneering RWUs and research, development, and application programs are also to be sent to the Deputy Chief for Research.

EXTRAMURAL RESEARCH

The Forest Service uses grants, cooperative agreements, and contractual arrangements to obtain expertise, facilities, or equipment to further its research mission. Within this framework, research proposals of land-grant colleges or other research organizations are reviewed by Forest Service research managers and scientists for their value, quality of the proposed research, and the pertinency of meeting the research objectives. Other factors, such as cost, time to complete the work, impact on other work, and ease of introducing successful results into actual practice, are also considered. Responsibility for reviewing and approving extramural research proposals is delegated to the station directors.

Extramural research is described by a jointly approved plan for each study. The performing organization or individual is required to submit technical and financial reports to the Forest Service periodically during the life of the extramural agreement. The reports are to be evaluated by the designated contact scientist in the Forest Service who has technical competence in the research area. He may call for review by other scientists if he feels that such review is needed. We were advised that there often is a great deal of direct interchange between Forest Service scientists and scientists working on the sponsored research.

Except for the extramural research funded for USDA's Combined Forest Pest Research and Development Program, the Forest Service uses its own scientific staff to evaluate Forest Service-sponsored extramural research. The quality and appropriateness of research funded under the Combined Forest Pest Research and Development Program is evaluated by technical steering committees composed of Federal, State, academic, and private scientists, and users.

The Forest Service said that the extramural research projects (1) stimulate non-Federal forestry research, (2) provide a medium for coordinating research, (3) further the objectives of RWUs effectively, (4) aid the Service's training and recruiting efforts, and (5) increase funds available for research since the Service and the cooperator share in the cost of performing the work.

The percentage of Forest Service research appropriations used for extramural research for fiscal years 1971-75 is as follows.

Fiscal year	Percentage of research appropriations used for extramural research
1971	1.8
1972	5.2
1973	5.8
1974	8.3
1975	7.6

CHAPTER 7

ECONOMIC RESEARCH SERVICE

MISSION

ERS's mission is to develop and disseminate economic information for use by public and private decisionmakers concerned with the allocation and use of resources in agriculture and in rural America. In carrying out this work, ERS

--develops and maintains national and worldwide estimates of current resource use, output, and distribution of food and fiber,

--identifies the interrelationships among economic forces, institutions, and governmental policies and programs affecting resource use, production, and distribution of food and fiber,

--develops short-term forecasts and long-range projections of resource use, production, and distribution of food and fiber for both probable and possible future events,

--evaluates the performance of the food and fiber sector in meeting the needs and wants of consumers and goals of society on such matters as resource ownership and use, quantity and quality of goods and services, income and income distribution, and quality of life,

--identifies probable and possible structural adjustments in the food and fiber sector and in rural America and evaluates their impacts on all segments of society,

--maintains current information on the principal social and economic factors and their interrelationships affecting life in nonmetropolitan areas and identifies and evaluates alternative public and private actions which impact on those areas,

--evaluates and provides planning assistance on the use, conservation, development and control of water and land resources as they affect economic growth and the environment,

--provides direct assistance and coordinates USDA's overall program to aid agricultural development in lower income countries, and

--disseminates economic information on a timely basis for use by individual consumers and decisionmakers in the food and fiber sector and rural areas.

In outlining ERS's mission, it is important to consider its role in relation to USDA, other Federal agencies, and the Congress. According to ERS, it receives about $25 million annually but only about 70 to 75 percent of that amount is devoted to planned research because of staff-days expended on unplanned activities. These activities range from answering an average of 400 letters a month to developing background papers on topical policy issues. Examples of unplanned activities are: (1) developing background papers for the World Food Conference, (2) evaluating environmental impact statements, (3) responding to the Secretary's request to assess the Nation's capacity to produce agricultural products, and (4) responding to a congressional request for projections on U.S. agriculture's energy requirements. We were told that most of these requests require the formation of teams cutting across the organizational structure.

ORGANIZATION

ERS, headed by an administrator, is divided into two broad areas--Food and Fiber Economics and Resource and Development Economics. Each area, which is headed by a deputy administrator, is divided into three divisions, each headed by a director. The Food and Fiber Economics area, which focuses on the entire agricultural industry from farmer to consumer, is divided into the (1) Commodity Economics Division, (2) National Economic Analysis Division, and (3) Foreign Demand and Competition Division. The divisions of the other area are (1) Natural Resource Economics, (2) Economic Development, and (3) Foreign Development.

Within each division, ERS has identified from 2 to 12 major program areas, each headed by a program leader. Within each program area, there are one or more research projects, each headed by a project leader. (See app. XI for a brief description of each division and the associated program areas.)

ERS has about 1,050 employees, including about 550 researchers, to carry out its research programs. About 225 of the employees are located in about 35 States (principally at land-grant universities) and 16 employees are located in foreign countries. The remainder, or about 77 percent, are located in Washington. ERS does not have a regional organizational structure; those employees located outside Washington are tied into a specific program area.

RESEARCH PLANNING

ERS identifies four separate but interrelated steps to determine what specific research is undertaken at any given time. The steps are (1) identifying the problem, (2) establishing priorities, (3) developing specific plans, and (4) budgeting. This process is continuous with the budget cycle representing points in time when the product of the process is summarized and documented.

ERS considers problem identification to be the most important step in the planning process. We were told that it involves all researchers and research managers within ERS and requires that all be atuned to activities, problems, and ideas carried out and generated by individuals and organizations outside the agency. Problems are identified through periodic reviews of program areas (discussed on p. 50) and other information of a problem identification nature received from outside sources, including the Regional and National Research Planning System, university economists with whom ERS economists work, and professional societies. Other important sources are other USDA agencies, other Federal agencies, and the Congress. These organizations come to ERS requesting information to resolve specific problems. According to ERS, these requests, taken in their entirety, provide a useful overview of societal problems to which economic research and analysis can be directed.

Establishing priorities involves (1) converting the problems identified into researchable projects and assessing the probability of their success and (2) ranking the projects so identified. Identifying researchable projects and assessing the probability of success is carried out by program leaders or task forces of ERS researchers working with researchers in other segments of the agricultural research system.

The Administrator is responsible for establishing research priorities. He obtains inputs from other ERS officials, the Director of Agricultural Economics, and research planning and policy groups, including ARPAC, of which he is a member. After the overall research priorities have been identified, specific work plans are developed by the researchers and their managers. The plans specify how and who will do the work and what the resource requirements will be. Identifying problems, setting priorities, and developing detailed plans are the basis for budget formulation and execution.

REVIEW OF ONGOING RESEARCH PROGRAMS

ERS operates a management information system to support the planning and monitoring of its research. The system documents the long-term program objectives for each program area, the detailed plans of work for each research project within each program area, and the progress made on each research project during the past year and the specific plans for the current year. The system's informational requirements are shown in appendix XII.

ERS officials consider the annual progress reports and plans to be the system's most important aspect because they force project leaders to think about the specific things they hope to accomplish during the next year and provide ERS managers with some specific information with which to review and evaluate the research and the researchers.

ERS also reviews and evaluates its research by conducting periodic reviews of its program areas. These reviews are to focus on the following questions.

--Is what was planned getting done and at the resources estimated for the tasks?

--Is the product of acceptable quality?

--Should what was planned be continued and at what level of resources?

Each program review team is to be made up of managers and researchers from ERS and representatives from other USDA agencies and land-grant colleges.

During calendar year 1975, ERS reviewed 6 of its 47 program areas. It plans to review about 10 others during calendar year 1976.

ORGANIZATIONS THAT MAKE UP THE FEDERAL-STATE AGRICULTURAL RESEARCH SYSTEM

Department of Agriculture

Agricultural Research Service
Cooperative State Research Service
Economic Research Service
Forest Service
Farmer Cooperative Service
Statistical Reporting Service

State Agricultural Experiment Stations

Auburn University (Alabama)
University of Alaska
University of Arizona
University of Arkansas
University of California
Colorado State University
University of Connecticut
New Haven, Connecticut (not connected with a university)
University of Delaware
University of Florida
University of Georgia
University of Guam
University of Hawaii
University of Idaho
University of Illinois
Purdue University (Indiana)
Iowa State University
Kansas State University
University of Kentucky
Louisiana State University and A&M College
University of Maine
University of Maryland
University of Massachusetts
Michigan State University
University of Minnesota
Mississippi State University
University of Missouri
Montana State University
University of Nebraska
University of Nevada
University of New Hampshire
Rutgers University (New Jersey)
New Mexico State University
Cornell University (New York)
Geneva, New York (not connected with a university)

North Carolina State University
North Dakota State University
Ohio State University
Oklahoma State University
Oregon State University
Pennsylvania State University
University of Puerto Rico
University of Rhode Island
Clemson University (South Carolina)
South Dakota State University
University of Tennessee
Texas A&M University
Utah State University
University of Vermont
Virginia Polytechnic Institute and State University
College of the Virgin Islands
Washington State University
West Virginia University
University of Wisconsin
University of Wyoming

Schools of Forestry

University of Alaska
Northern Arizona University
Humboldt State University (California)
University of Idaho
Southern Illinois University
Louisiana Polytechnic Institute
University of Michigan
Michigan Technological University
University of Montana
State University of New York College of Environmental Science and Forestry
Oregon State University
Clemson University (South Carolina)
Stephen F. Austin State University (Texas)
University of Vermont
University of Washington

1890 Colleges and Tuskegee Institute

Alabama A&M University
University of Arkansas--Pine Bluff
Delaware State College
Florida A&M University
Fort Valley State College (Georgia)
Kentucky State University
Southern University (Louisiana)

APPENDIX I

University of Maryland--Eastern Shore
Alcorn State University (Mississippi)
Lincoln University (Missouri)
North Carolina A&T State University
Langston University (Oklahoma)
South Carolina State College
Tennessee State University
Prairie View A&M University (Texas)
Virginia State College
Tuskegee Institute (Alabama)

APPENDIX II

RESEARCH PROJECTS AND SCIENTIFIC MAN-YEARS EXPENDED BY GOAL AND RESEARCH PROBLEM AREA

Goal and research problem area	Number of projects at June 30, 1974	Scientific man-years expended in fiscal year 1974: USDA	State experiment stations	Other State institutions	Total all organizations
I. INSURE A STABLE AND PRODUCTIVE AGRICULTURE FOR THE FUTURE THROUGH WISE MANAGEMENT OF NATURAL RESOURCES					
Appraisal of Soil Resources	196	-	84.4	.8	85.2
Soil, Plant, Water, Nutrient Relationships	464	57.6	116.2	3.3	177.0
Management of Saline and Sodic Soils and Salinity	49	19.1	8.2	-	27.3
Alternative Uses of Land	149	23.8	27.5	.7	52.0
Conservation and Efficient Use of Water	262	74.0	46.2	-	120.3
Efficient Drainage and Irrigation Systems and Facilities	120	27.9	24.0	-	51.9
Watershed Protection and Management	203	193.7	31.3	.9	225.9
Economic and Legal Problems in Management of Water and Watersheds	42	4.0	9.5	-	13.5
Adaptation to Weather and Weather Modification	94	-	26.1	.4	26.6
Appraisal of Forest and Range Resources	93	45.8	16.3	4.5	66.6
Biology, Culture, and Management of Forests and Timber-Related Crops	387	181.1	76.0	21.4	278.5
Improvement of Range Resources	188	49.8	44.7	1.2	95.7
Remote Sensing	50	9.8	15.5	.4	25.6
Research on Management of Research	16	-	3.4	-	3.4
Subtotal	2,313	686.6	529.1	33.7	1,249.4
II. PROTECT FORESTS, CROPS, AND LIVESTOCK FROM INSECTS, DISEASES, AND OTHER HAZARDS					
Control of Insects Affecting Forests	148	101.2	38.8	5.8	145.9
Control of Diseases, Parasites, and Nematodes Affecting Forests	114	65.1	27.0	3.4	95.4
Prevention and Control of Forest and Range Fires	31	72.3	1.4	1.5	75.1
Control of Insects, Mites, Slugs, and Snails on Fruit and Vegetable Crops	397	61.0	123.0	1.6	185.6
Control of Diseases and Nematodes of Fruit and Vegetable Crops	690	55.6	200.8	.2	256.7
Control of Weeds and Other Hazards to Fruit and Vegetable Crops	153	5.3	39.8	-	45.1
Control of Insects, Mites, Snails, and Slugs Affecting Field Crops and Range	580	151.2	171.7	1.7	324.6
Control of Diseases and Nematodes of Field Crops and Range	749	131.3	191.1	3.3	325.7
Control of Weeds and Other Hazards of Field Crops and Range	288	38.4	77.9	.5	116.7
Control of Insects and External Parasites Affecting Livestock, Poultry, and Other Animals	98	28.8	26.8	-	55.6
Control of Diseases of Livestock, Poultry, and Other Animals	532	127.4	193.6	1.4	322.3
Control of Internal Parasites of Livestock, Poultry, and Other Animals	103	34.4	32.0	-	66.4
Protect Livestock, Poultry, and Other Animals from Toxic Chemicals, Poisonous Plants, and Other Hazards	103	31.1	19.5	-	50.6
Protection of Plants, Animals, and Man from Harmful Effects of Pollution	178	28.3	43.7	4.4	76.4
Subtotal	4,164	931.4	1,187.0	23.6	2,142.0
III. PRODUCE AN ADEQUATE SUPPLY OF FARM AND FOREST PRODUCTS AT DECREASING REAL PRODUCTION COSTS					
Genetics and Breeding of Forest Trees	129	39.5	31.9	4.9	76.3
New and Improved Forest Engineering Systems	24	14.7	2.4	3.1	20.2
Economics of Timber Production	34	22.5	12.5	.4	35.4
Improvement of Biological Efficiency of Fruit and Vegetable Crops	1,042	53.7	353.8	.7	408.3
Mechanization of Fruit and Vegetable Crop Production	196	16.9	55.6	-	72.5
Production Management Systems for Fruits and Vegetables	56	-	15.0	.1	15.1
Improvement of Biological Efficiency of Field Crops	1,657	164.3	594.7	12.3	771.3
Mechanization of Production of Field Crops	151	44.3	40.3	-	84.6
Production Management Systems for Field Crops	102	4.7	31.1	-	35.8
Reproductive Performance of Livestock, Poultry, and Other Animals	451	27.5	149.3	1.0	177.8
Improvement of Biological Efficiency in Production of Livestock, Poultry, and Other Animals	1,242	39.7	431.6	6.8	478.2

APPENDIX II

Goal and research problem area	Number of projects at June 30, 1974	Scientific man-years expended in fiscal year 1974: USDA	State experiment stations	Other State institutions	Total all organizations
Environmental Stress in Production of Livestock, Poultry, and Other Animals	192	12.0	60.4	1.2	73 6
Production Management Systems for Livestock, Poultry, and Other Animals	255	2.3	65.9	-	68.1
Bees and Other Pollinating Insects	49	26.6	15.4	-	42.0
Improvement of Structures, Facilities, and General-purpose Farm Supplies and Equipment	95	6.0	26.5	9	33 4
Farm Business Management	130	-	46.9	-	46.9
Mechanization and Structures Used in Production of Livestock, Poultry, and Other Animals	50	2.6	8.2	-	10.8
Noncommodity-oriented Biological Technology and Biometry	1,012	163.1	402.2	3 7	569.0
Subtotal	6,867	640.5	2,343.8	35.1	3,019.4
IV. EXPAND THE DEMAND FOR FARM AND FOREST PRODUCTS BY DEVELOPING NEW AND IMPROVED PRODUCTS AND PROCESSES AND ENHANCING PRODUCT QUALITY					
New and Improved Forest Products	197	122.1	54.6	26.8	203.5
Production of Fruit and Vegetable Crops with Improved Acceptability	222	8.9	45.6	.3	54 8
New and Improved Fruit and Vegetable Products and Byproducts	256	90.1	79.3	-	169.4
Quality Maintenance in Storing and Marketing Fruits and Vegetables	234	41.5	63.4	-	104.9
Production of Field Crops with Improved Acceptability	261	74.7	46.6	2.1	123.4
New and Improved Food Products from Field Crops	152	95.4	27.9	-	123.3
New and Improved Feed, Textile, and Industrial Products from Field Crops	139	197.4	13.1	.6	211.0
Quality Maintenance in Storing and Marketing Field Crops	123	46.3	25.8	-	72.1
Production of Animal Products with Improved Acceptability	198	14.6	44.6	1.5	60.7
New and Improved Meat, Milk, Eggs, and Other Animal Food Products	317	54.5	92.4	.7	147.6
New and Improved Nonfood Animal Products	24	52.5	2.7	-	55.2
Quality Maintenance in Marketing Animal Products	131	4.6	33.6	-	38.2
Subtotal	2,254	802.6	529.6	32.0	1,364.1
V. IMPROVE EFFICIENCY IN THE MARKETING SYSTEM					
Improvement of Grades and Standards--Crop and Animal Products	90	29.6	16.2	-	45.8
Development of Markets and Efficient Marketing of Timber and Related Products	29	29.3	3.7	-	33.0
Efficiency in Marketing Agricultural Products and Production Inputs	272	57.9	63.2	.1	121.2
Supply, Demand, and Price Analysis--Crop and Animal Products	134	68.1	35.6	.1	103.8
Competitive Interrelationships in Agriculture	62	12.4	10.1	-	22.5
Development of Domestic Markets for Farm Products	46	10.6	5.9	-	16.5
Performance of Marketing Systems	196	73.4	48.6	.4	122.3
Group Action and Market Power	63	21.6	4.7	2.5	28.8
Improvement in Agricultural Statistics	29	9.3	6.9	-	16.2
Improvement of Grades and Standards of Forest Products	22	7.9	2.5	.6	11.0
Supply, Demand, and Price Analysis--Forest Products	14	4.0	3.0	.7	7.7
Subtotal	957	324.0	200.3	4.4	528.7
VI. EXPAND EXPORT MARKETS AND ASSIST DEVELOPING NATIONS					
Foreign Market Development	77	78.0	12.5	-	90.5
Evaluation of Foreign Food Aid Programs	1	-	.2	-	.2
Technical Assistance to Developing Countries	38	9.8	21.9	.5	32.2
Product Development and Marketing for Foreign Markets	25	30.3	1.0	-	31.3
Subtotal	141	118.1	35.6	.5	154 2
VII PROTECT CONSUMER HEALTH AND IMPROVE NUTRITION AND WELL-BEING OF THE AMERICAN PEOPLE					
Insure Food Products Free of Toxic Contaminants, Including Residues from Agricultural and Other Sources	164	55.7	57.2	.4	113.3
Protect Food and Feed Supplies from Harmful Microorganisms and Naturally Occurring Toxins	221	95.2	45.8	-	141.0
Food Choices, Habits, and Consumption	112	20.3	17.2	7.7	45.1
Home and Commercial Food Service	55	4.0	14.4	1.0	19.4
Selection and Care of Clothing and Household Textiles	61	2.6	15.5	.6	18.7
Control of Insect Pests of Man and His Belongings	120	30.4	44.8	-	75.2
Prevent Transmission of Animal Diseases and Parasites to Man	32	2.8	6.7	-	9.5

APPENDIX II

Goal and research problem area	Number of projects at June 30, 1974	Scientific man-years expended in fiscal year 1974			
		USDA	State experiment stations	Other State institutions	Total all organizations
Human Nutrition	323	74.6	82.4	16.9	173.8
Reduction of Hazards to Health and Safety	87	47.8	10.1	2.3	60.3
Subtotal	1,175	333.4	294.2	28.8	656.4
VIII. ASSIST RURAL AMERICANS TO IMPROVE THEIR LEVEL OF LIVING					
Housing	55	16.3	11.8	1.0	29.0
Individual and Family Decisionmaking and Resource Use and Family Functioning	103	6.3	22 4	3.7	32.4
Causes of Poverty Among Rural People	59	-	9.4	3.3	12.8
Improvement of Economic Potential of Rural People	92	-	21.1	4.1	25.1
Communication and Education Processes	100	-	25.7	2 1	27.8
Individual and Family Adjustment to Change	142	-	34.1	3.1	37.2
Structural Changes in Agriculture	123	60.8	24.5	.2	85.5
Government Programs to Balance Farm Output and Market Demand	49	26.0	10.3	-	36.3
Subtotal	723	109.4	159.2	17.5	286.1
IX. PROMOTE COMMUNITY IMPROVEMENT INCLUDING DEVELOPMENT OF BEAUTY, RECREATION, ENVIRONMENT, ECONOMIC OPPORTUNITY, AND PUBLIC SERVICES					
Alleviation of Soil, Water, and Air Pollution and Disposal of Wastes	805	239.0	231.0	15.7	485.6
Outdoor Recreation	164	25.0	40.9	4.2	70.1
Multiple-use Potential of Forest Land and Evaluation of Forestry Programs	59	6.0	14.4	1.7	22 1
Fish and Other Marine Life, Fur-Bearing Animals and Other Wildlife	442	37.1	108.4	9.1	154.6
Trees to Enhance Rural and Urban Environment	102	16.9	22.8	.2	40.0
Culture and Protection of Ornamentals and Turf	635	43.7	203.2	-	246.9
Improved Income Opportunities in Rural Communities	176	6.6	47.3	4.5	58 4
Improvement of Rural Community Institutions and Services	276	9.5	85.6	1.2	96.4
Subtotal	2,659	383.7	753.7	36.6	1,174.0
Administrative	144	-	-	-	-
Unclassified	42	32.9	1.7	3.8	38.4
Total	21,439	4,362.7	6,034.2	215.8	10,612.7

Note: Due to rounding, totals may not foot and crossfoot.

Source: USDA's inventory of agricultural research.

APPENDIX III

RESULTS OF RESEARCH ADMINISTRATORS' PROJECTED PROGRAM FOR 1978 FROM BASE YEAR 1973

Research program	Scientific man-years				
		Estimated for 1978			
	Actual 1973	Assuming no increase	Change from 1973	Assuming 10-percent increase	Change from 1973
Natural resources:					
Soil and land use	324.2	355.8	31.6	416.4	92.2
Water and watersheds	322.4	329.1	6.7	340.7	18.3
Recreation	29.7	33.1	3.4	40.6	10.9
Environmental quality	468.4	498.8	30.4	540.2	71.8
Weather modification	31.1	27.3	-3.8	32.5	1.4
Fish and wildlife	61.2	65.8	4.6	74.9	13.7
Remote sensing	16.8	18.1	1.3	23.4	6.6
Subtotal	1,253.8	1,328.0	74.2	1,468.7	214.9
Forest resources:					
Inventory	66.6	70.7	4.1	79.4	12.7
Timber management	375.7	376.3	.6	399.9	24.2
Forest protection	312.6	324.0	11.4	352.3	39.7
Harvesting, processing, marketing	346.7	341.9	-4.9	372.1	25.4
Watersheds and pollution	159.7	158.5	-1.1	182.2	22.5
Range, fish, and wildlife	91.7	96.3	4.6	118.8	27.1
Recreation	43.3	47.0	3.7	60.2	16.9
Alternative uses of land	18.3	24.6	6.3	35.8	17.5
Technical assistance	2.0	3.4	1.3	3.3	1.3
Subtotal	1,416.4	1,442.4	26.0	1,603.7	187.3
Crops:					
Corn	275.9	268.4	- 7.4	290.1	14.2
Grain sorghum	65.8	67.6	1.8	73.4	7.6
Wheat	219.1	218.7	- .4	237.4	18.3
Small grain	108.0	110.6	2.6	116.9	8.9
Rice	44.2	48.7	4.6	61.7	17.5
Soybeans	212.7	228.6	15.9	261.1	48.4
Peanuts	61.7	61.1	- .6	67.4	5.7
Sugar	114.0	110.4	- 3.6	116.9	2.9
Forage, range, pasture	436.6	463.9	27.3	520.7	84.1
Cotton	465.2	445.9	-19.3	466.4	1.2

APPENDIX III

Crops (continued):					
Tobacco	125.7	109.5	-16.2	118.2	-7.5
New crops	134.8	129.9	- 4.9	137.6	2.8
Fruit	651.8	634.4	-17.4	679.7	27.9
Vegetable crops	600.6	572.4	-28.2	617.5	16.9
Plant enhancement, environment	284.9	279.0	- 5.9	302.4	17.5
Bees	38.7	43.1	4.4	47.1	8.4
Subtotal	3,839.9	3,792.6	-47.3	4,114.7	274.8
Animals:					
Beef	439.9	460.9	21.0	544.6	104.7
Dairy	419.0	402.9	-16.1	421.8	2.8
Poultry	329.0	321.1	- 7.9	342.5	13.5
Sheep	144.3	117.2	-27.1	129.4	-14.9
Swine	184.3	191.1	6.6	226.1	41.8
Other animals	82.8	78.9	- 3.9	87.3	4.5
Aquatic foods	43.6	41.1	- 2.5	46.2	2.6
Subtotal	1,642.8	1,613.1	-29.9	1,797.8	155.0
People, communities:					
Food and nutrition	283.1	302.0	18.9	359.7	76.6
Food safety	238.9	245.6	6.7	287.5	48.6
Rural development	389.3	382.0	- 7.3	445.3	56.0
Insects--man	69.4	72.2	2.8	75.7	6.3
Research on administration of research	2.1	1.5	- .6	3.3	1.2
Subtotal	982.7	1,003.3	20.6	1,171.4	188.7
Competition and trade:					
Farm price income	235.4	204.2	-31.2	251.9	16.5
Foreign agriculture	142.7	139.1	- 3.6	154.6	11.9
Marketing and competition	373.8	412.1	38.3	437.0	63.2
Subtotal	751.9	755.4	3.5	843.5	91.6
General resources:					
General resource technology	709.5	645.6	-63.9	678.7	-30.8
Unclassified	5.4	3.0	- 2.4	13.0	7.6
Total	10,602.3	10,583.2	-19.3	11,691.4	1,089.1

Note: Some of the figures are not mathematically correct because of rounding.

RANKING OF RESEARCH PRIORITIES IDENTIFIED BY REGIONAL PLANNING COMMITTEES FOR PLANNING PERIOD 1973 TO 1978

Rank	Description
1	Genetic modification of major grain, oilseed, cotton, and certain vegetables and fruits to increase yields and resistance to diseases and pests (includes horticultural crops)
2	Soil, plant, water, energy, and nutrient relationships underlying selection of most efficient culture and management practices in production of major crops
3	Cultural, chemical, and biological control of diseases, parasites, and nematodes in major crops
4	Improve forage production (rangeland, pasture, and forage) for red meat production
5	Land-use planning and policy
6	Waste disposal management and control of pollution from agricultural sources (these proposals closely link energy, conservation, and environmental quality)
7	Improve human nutrition
8	Improve livestock management systems and reduce environmental stress
9	Improve forest production and utilization efficiency
10	Improve livestock reproduction performance
11	Increase purity and nutritional value of food supply
12	New and supplementary sources of food for human consumption
13	Control of forest diseases and pests
14	Improve livestock biological efficiency

Rank	Description
15 tie	Control of livestock diseases and pests
15 tie	Increase efficiency in the marketing system
17	Forest land-use planning
18 tie	Efficient utilization of water
18 tie	Forest environmental quality and watershed management
18 tie	Improve quality of life in rural areas
21 tie	Alternative sources of livestock protein
21 tie	Improve the basis for economic forecasts and projections
23	Farm firm and industry adjustment to changing input scarcities
24	Wildlife habitat and recreational opportunities on forest (and nonforest) land
25	Technology of new and improved agricultural products

APPENDIX V

REGIONAL RESEARCH PLANNING COMMITTEES' GROUPS AND TASK FORCES

Region	Group or task force	Date of report
Southern	Soil and land use	June 1975
	Water and watersheds	May 1974
	Environmental quality	1974
	Fish, wildlife, and recreation	1974
	Inventory and appraisal of forest resources	1974
	Timber management	1974
	Forest protection	1974
	Harvest, process, and market of forest products	June 1974
	Forest watersheds, soils, and pollution	July 1974
	Forest amenities and alternative uses	1974
	Corn and grain sorghum	1975
	Wheat and other small grain	1974
	Rice	1974
	Soybeans	Provided input to a national report (undated)
	Peanuts	1974
	Sugar crops	1974
	Forage, range, and pasture	1974
	Cotton and cottonseed	Provided input to a national report--1973
	Tobacco	-
	New crops and minor oilseeds	1975
	Fruit and nuts	1972
	Vegetable crops	May 1974
	Bees and pollinating insects	Apr. 1974
	Beef cattle	Oct. 1973
	Dairying	Apr. 1973
	Poultry	Apr. 1972
	Aquatic food animals	Apr. 1975
	Food and nutrition	Nov. 1975
	Food safety	1974-1975
	Food processing, distribution, and acceptance	-
	Rural development and quality of family living	July 1974

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Region	Group or task force	Date of report
Southern (con't)	Insects affecting man and his possessions	Apr. 1974
	Farm adjustment, prices, and income	Nov. 1974
	Marketing and competition	Sept. 1974
Western	Applied meteorology in agriculture	-
	Energy	Oct. 1975
	Forage, range, and beef cattle	-
	Timber management	-
	Forest protection	-
	Range, wildlife, and recreation	-
	Small grains with emphasis on wheat	-
	Tropical agriculture--primarily food production	-
	Livestock research overview	-
	Dairy forage	Provided input to a national report--Feb. 1975
	Quality of life	-
	Quality of food	-
	Economics of production, processing, and distribution: consumer welfare	-
Northeastern	Rural development:	Sept. 1973
	Community services	
	Economic development	
	Vegetable:	-
	Breeding	
	Production systems	
	Pest management	
	Marketing	
	Forage:	-
	Forage breeding, production, and utilization	

Region	Group or task force	Date of report
Northeastern (con't)	Dairy--forage production systems	
	Beef and sheep--forage production systems	
	Dairy:	-
	Animal resources	
	Housing and materials	
	Feeding	
	Reproduction	
	Health	
	Marketing and economics	
	Production systems	
	Fruit:	Feb. 1975
	Breeding	
	Production management	
	Pest management	
	Marketing and processing	
	Florist and nursery crops	-
	Forestry:	-
	Inventory	
	Management	
	Protection--disease	
	Protection--insects	
	Protection--fire	
	Harvesting, processing, and marketing--logging	
	Harvesting, processing, and marketing--marketing	
	Harvesting, processing, and marketing--utilization	
	Watersheds, soil, and pollution--air	
	Watersheds, soil, and pollution--soil	
	Watersheds, soil, and pollution--water	
	Range, fish, and wildlife	
	Recreation	
	Land use	
	Economics, policy, and program affairs	

Region	Group or task force	Date of report
North Central (note a)	Animals (note b)	Mar. 1974

a
Rather than groups and task forces, the North Central Planning Committee is assisted in carrying out its planning function by 16 advisory committees, initially established in 1958, and 3 strategy committees. These committees are responsible for reviewing and evaluating the region's current research program and recommending, usually informally, the priority of those programs that should receive consideration for early additional research efforts.

The advisory committees are:

Soil research	Forestry and forest products
Animal diseases	Agricultural economics
Horticultural crops	Rural sociology
Home economics research	Plant pathology
Animal production	Entomology and economic zoology
Dairy production	Agricultural engineering
Poultry production	Natural resource development
Field and forage crops	Food science and nutrition

The strategy committees are:

Commercial agriculture
Natural resource development
Community and human resource development

b
The North Central Planning Committee, recognizing that agriculture was extremely complex and that planning procedures were not well developed and tested, decided to implement the planning process by establishing a research program group on animals on a pilot basis. After issuing that report, the decision was made not to proceed with the detailed planning effort for other research program groups because the consensus was that the use that could be made of the information did not justify the time and effort involved.

APPENDIX VI

REPORT OF THE WORKING CONFERENCE ON RESEARCH TO MEET U.S. AND WORLD FOOD NEEDS

AN INTERPRETIVE SUMMARY*

The Agricultural Research Policy Advisory Committee (ARPAC) serves as an advisor to two branches of publicly-supported agricultural research in the United States--the U.S. Department of Agriculture and, through the National Association of State Universities and Land-Grant Colleges, the land-grant universities and colleges. One ARPAC responsibility is to develop the basis for cooperation in planning and implementing national, regional, and interstate research programs. Purposes are to identify emerging problems of national significance and to maximize the use of scientists, facilities, and equipment in order to solve those problems through research.

With the achievement of these purposes in mind, as well as the current public concern over domestic and world food supplies, ARPAC convened the national Working Conference on Research to Meet U.S. and World Food Needs. The Conference was held in Kansas City, July 9-11, 1975. Its objective was to identify the most important problems requiring research during the next 10 to 15 years that affect the capacity of the United States to increase and improve domestic and world food supplies. The Conference did not attempt to suggest research approaches for solving the problems or to recommend funding or organizational changes.

CONFERENCE PARTICIPANTS

Those who took part in the Conference were:

- 167 delegates representing the wide-ranging needs of those who use or are affected by research results related to food.

- 215 other participants including research, extension, and university administrators; government agency administrators; individual researchers; farmers; representatives of agribusiness; members of the press; and others.

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* This summary parallels material presented by Dean Orville G. Bentley, Co-chairman of ARPAC, before Subcommittees of the House Committee on Science and Technology, September 24, 1975.

- The Conference also was open to the public.

SELECTION OF DELEGATES

The deliberations of any group will reflect the background and interest of its members and create a potential source of bias. Planners, therefore, took special care to obtain a balanced representation of groups and organizations with interests in food supply and consumption.

Procedures in delegate selection were to:

- Identify agencies or organizations with food interests that were national in character insofar as possible;

- achieve a balance among groups such as consumers, nutritionists, farmers and farm organizations, agricultural and food industries, marketing firms, conservation groups, labor unions, government agencies, international development organizations, scientists, and others;

- request that these organizations name their own delegates; and

- distribute the delegates among some 16 work groups at the Conference so that each included an appropriate representation of interests.

Execution of these procedures was imperfect because of late cancellations and failure of some organizations to send delegates. Nevertheless, the overall balance of delegate interests among work groups and in the Conference was within reasonable limits.

BACKGROUND MATERIALS

To help in making their decisions, delegates and other participants received several sources of information:

- Detailed situation statements for the various research need areas.

- A list of specific suggested problems requiring research. These problems were suggested by more than 700 agricultural researchers, extension personnel, and other scientists within the United States. The problems were reviewed intensively by several dozen scientists and administrators during a Pre-Conference Review in Beltsville, Maryland, in May 1975. The

list of problems were provided as suggestions to delegates and other participants.

- Background information on the world food situation, on agricultural and food policies of the United States, and on the U.S. agricultural research establishment.

CONFERENCE PROCEDURES

Delegates and other participants in the Conference first had the opportunity to suggest and to evaluate specific problems within 49 research need areas. For this part of the Conference, delegates joined 16 work groups according to their interests and expertise. They developed lists of up to 40 problems pertinent to a specific research need area and then rated each problem according to its importance for meeting the stated objective of the area. The delegate ratings permitted the problems to be ranked so the top 20 could be included in the final report of the Conference. A total of 1011 problems were selected.

Later in the Conference, delegates and other participants rated 89 research need areas and subareas according to the importance each area or subarea had as a means of increasing and improving domestic and world food supplies.

After the Conference, the most important 10 percent of the 1011 problems were selected by a procedure that considered both the area rating and the relative rating of the problem within its area.

CONFERENCE RESULTS

The findings of the Conference relate to three broad categories: (1) Human needs for food; (2) organization of resources to provide food; and (3) management of resources to provide food.

Category I: Human Needs for Food

The higher rated areas were nutrient requirements, nutrient composition, nutrition education, other food programs, food technology, and food safety.

There were 17 most important problems in this category:

- They emphasized the urgent need to determine more fully nutrient requirements of people, particularly for high risk groups such as pregnancy, lactation, infancy, adolescence, and aging.

- They called for more information on nutrient composition of foods, especially as food itself changes after harvest or slaughter and during processing and distribution.

- They urged development of workable guidelines to determine the significance of minute residues in food products. (The support for research of this kind was widespread in this category and in others.)

- They stressed needs to reduce wastes in processing and to develop and evaluate alternative nutrition education programs.

Category II: Organization of Resources to Provide Food

The research need areas in this category had the highest average rating of the three categories. The areas that contributed to that high average were human resources, social institutions, public policy, finance, international development, production inputs and services, production systems, and marketing systems.

There were 18 most important problems from this category.

- Five were in public policy and finance and reflected the concern regarding the influence that public policy has on food prices and supply stability, both domestically and internationally.

- Nine were in the areas of international development and pointed to the need of developing countries for additional technical knowledge so they can increase their food production.

- The other four related to problems of farm labor and long term sources of raw materials for production inputs.

Category III: Management of Resources to Provide Food

This third category contained 70 of the 89 areas and subareas, including those for natural resources and all the crop and livestock commodities. Of these 70, there were 26 rated higher than the average of all areas and subareas. Most of this higher group emphasized needs that were barriers to increased production. Energy, soybean production, water, and basic plant research were the highest four of all areas rated by the delegates. Other above average areas in this category were in the production of 10 specific crops, 3 classes of livestock, poultry, and aquatic foods. Consumer need areas for soybeans and aquatic foods and market and processing needs for corn and aquatic foods also received above average ratings.

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There were 66 most important problems in this category:

- In natural resources they emphasized energy, water, and land conservation and use. Several of these were policy problems indicating need to evaluate the impact on food supplies of alternative natural resource policies. Additional energy problems called for the development of substitutes for fossil fuels.

- In crop production they were dominated by basic research needs in photosynthesis and nitrogen fixation plus the development of new varieties with greater pest resistance and adaptability to diverse environments. Also included were further mechanization of vegetable production, minimization of water loss on ranges, and systems studies in crop management.

- In livestock they were on improving selection of superior dairy cattle, increasing the reproductive performance of beef cattle and swine, reducing losses from respiratory and enteric problems of cattle, and increasing the utilization of forages by both dairy and beef cattle.

IMPLICATIONS OF THE CONFERENCE RESULTS

In June of this year, the co-chairmen of ARPAC appointed two committees to develop follow-up plans for the Conference.

One committee will ensure that the publicly-supported research systems:

- will be fully apprised of the Conference results;

- will systematically consider the products of the Conference in terms of applicability to and implications for current and future research programs; and

- will continue dialogue with delegates and other public participants in the Conference.

The second committee will establish an acceptable data base regarding ongoing research as related to the priorities that resulted from the Conference.

The relative importance of the areas and subareas as rated by the Conference delegates provides these committees with a starting point for evaluating the general allocation of effort in ongoing food research. They are beginning by obtaining information from the Current Research Information System (CRIS) on the amount of research

APPENDIX VI

in all the areas. This information should be helpful in identifying any obvious discrepancies in effort allocation.

Of course, the data alone will not give the complete story. It will be necessary to look at the areas and determine how the nature of the research affects the effort requirements. It also will be necessary to keep in mind that some areas which received below average ratings may be essential to certain commodities or to regions of the United States. This should help to avoid concluding prematurely that areas with lower ratings do not deserve continued research support.

The most important problems, which were selected by considering both area and within area ratings, represent the driving edge of research needs. They are the problems which should receive special consideration by research administrators, planners, and individual scientists. Many of the other 1011 problems identified as important at the Conference also must be solved if the United States and world food needs are to be met. Nevertheless, the most important deserve at least first consideration in program formulation and cooperative planning. Some of them may serve as central needs around which other problems can be evaluated.

The initial steps visualized for further analyzing these most important problems are to:

- obtain the project outlines on all work in each problem;
- make a preliminary evaluation of the adequacy of the research in relation to the problem needs;
- organize task forces of leading scientists to develop comprehensive plans for the most effective programs to solve the problems;
- develop the division of responsibilities for the programs by mutual agreement among the universities, USDA, and industry according to the needs of the programs and the capabilities of the institutions and agencies; and
- make or obtain the necessary decisions on implementing the plans.

The results of the Conference, along with other necessary considerations, furnish the basis for marshalling funds and manpower to meet the needs for food research in the universities and the USDA. They provide the priority problems around which existing programs can be modified and new programs developed. They form the framework within which new and more effective methods of research coordination,

APPENDIX VI

administration, and conduct can be explored. They give impetus to meeting the expanding need for additional research in the basic sciences related to food.

These results will influence the direction of food research for many years to come. Careful targeting of effort on the areas and problems of greatest importance can contribute greatly to supplying consumers with ample food at reasonable prices, to alleviating the intermittent crises and chronic incidence of world hunger. They can help increase the stability and well-being of the U.S. agricultural industry.

PROGRAM STRUCTURE FOR PLANNING AND MANAGING RESEARCH WITHIN THE AGRICULTURAL RESEARCH SERVICE

1. MISSION

Agricultural production efficiency

GOAL

New knowledge to increase productivity

NATIONAL RESEARCH PROGRAMS

Breeding and production--fruits and nuts
Breeding and production--vegetables
Breeding and production--florist and nursery crops
Breeding and production--corn, sorghum, and millets
Breeding and production--small grains
Breeding and production--cotton
Breeding and production--tobacco
Breeding and production--oilseeds
Breeding and production--sugar crops
Breeding and production--forage crops
Range management
Plant germplasm--introduction and evaluation
Physiology and biochemistry technology--plants
Bees--pollination and honey
Crop mechanization
Insect control--horticultural crops
Insect control--cotton and tobacco
Insect control--field crops
Insect control--noncommodity
Biological agents for pest control
Crop disease and nematode control
Weed control
Pesticides and growth regulator technology
Pest control equipment
Dairy production
Beef production
Swine production
Production of sheep and other animals
Poultry production
Farmstead mechanization
Control of cattle diseases
Control of swine diseases
Control of sheep and other animal diseases
Control of poultry diseases
Control of foreign animal diseases
Toxicology of chemicals and poison plants
Insect control for livestock

2. MISSION

Agricultural marketing and distribution

GOAL

Research for new products and processes and for reducing marketing costs

NATIONAL RESEARCH PROGRAMS

Processing of fruits and vegetables
Processing of field crops
Processing of animal products
Industrial uses of farm products
Technologies for fiber uses
Marketing horticultural crops
Marketing field crops
Marketing livestock and animal products
Technologies and facilities for marketing
Insect control in marketing

3. MISSION

Agricultural exports

GOAL

Develop commercial agricultural markets through promotion, representation, and research

NATIONAL RESEARCH PROGRAMS

Products to increase exports
Systems for overseas marketing

4. MISSION

Rural development

GOAL

Housing assistance in rural America to increase the supply of adequate housing and to promote ownership

NATIONAL RESEARCH PROGRAM

Research on housing

5. MISSION

Environmental improvement and resource development and use

GOAL

Land and water resource improvement to maintain and improve the quality of environment and the natural resource base, and to enhance the development of rural communities

NATIONAL RESEARCH PROGRAMS

Erosion and sedimentation
Hydrology
Salinity
Irrigation and drainage
Tillage practices
Water use efficiency
Stripmine reclamation
Soil fertility
Pollution

6. MISSION

Consumer services and human resource development

GOAL

New knowledge to reduce health hazards and improve family living

NATIONAL RESEARCH PROGRAMS

Safety of food and feed
Safe products and processes
Natural toxins in food and feed
Control of insects affecting man
Family use of resources

7. MISSION

Food and nutrition

GOAL

Food and nutrition research and information services

NATIONAL RESEARCH PROGRAMS

Food composition and fortification
Human requirements for nutrients
Food consumption and use

8. MISSION

Foreign agricultural development

GOAL

Research to help countries accelerate their agricultural development process and to improve markets for U.S. agricultural commodities

NATIONAL RESEARCH PROGRAMS

Special foreign currency (special project)
Tropical and subtropical agricultural research (special project)

OTHER SPECIAL NATIONAL RESEARCH PROGRAMS

Pilot testing of alternative methods for pest control
Minor use pesticides
Genetic vulnerability
Production and control of narcotic plants
Energy research using pass-through funds
Remote sensing

MAJOR FUNCTIONS OF THE AGRICULTURAL RESEARCH SERVICE'S MANAGEMENT AND PLANNING SYSTEM

1. Planning

Establish missions, goals, and objectives
Determine 10-year needs and opportunities
Establish 10-year research targets
Develop statements of national research programs for achieving the objectives
Develop systems and procedures

2. Budgeting

a. Allocation of resources to regions

--Adjust and redirect programs as a result of assessment

--Use contingency, reserve, and other special funds

b. Development of requests for additional funds

--Regions develop and evaluate requests

--Headquarters evaluates and adjusts requests from regions

--Coordinate plans with other agencies

--Agency request to Department

--Departmental request to Office of Management and Budget

--President's budget to Congress

--Congressional appropriation

3. Execution

Allotments to regions
Financial and management control by work reporting units
Program reporting by work reporting units' annual reports and plans and by CRIS
Summaries of research results for scientists and administrators in ARS and for users

4. Assessment

Base program examination annually with emphasis on work reporting units and national research programs--monitor performance and set priorities

Indepth assessment of each national research program at 5-year intervals--monitor, track, examine technological barriers, opportunities, possible side effects, etc.

Economic and other indepth studies, including benefit and cost analysis on a selective basis

Continuous program reviews and workshops

Budget support by use of scoring models by panels to screen and evaluate requests for increase proposals

APPENDIX IX

ARS-NRP No: 20040
USDA Program No: 22-677

NATIONAL RESEARCH PROGRAM FOR BREEDING AND PRODUCTION (Corn, Sorghum, and Millets)

Sub Program Commodity/Function Headings — Page

Technological Objectives (Summary)

1. New and improved genetic populations, breeding lines, and varieties of corn, sorghum and millets that combine improved yield potentials and favored quality characters, including reduced contents of undesirable constituents, with better resistance to pests, tolerance to environmental stress, and adaptation for mechanized culture, harvesting, and handling. Develop basic genetic, cytogenetic, physiologic, and biochemical knowledge necessary to accomplish these goals.

2. New and improved cultural and management practices that increase corn, sorghum and millet yields, minimize production losses, improve quality attributes, and conserve and use scarce resources efficiently.

GAO note: Abbreviations, acronyms, and symbols used in this appendix include:

A	acres	NCR	north central region
A_1,A_2	sterile cytoplasm	NER	northeastern region
ARS	Agricultural Research Service	NRP	National Research Program
B_1,B_2	fertile cytoplasm	P	phosphorus
bu(s)	bushel(s)	PACS	Program Analysis and Coordination Staff
C_4	carbon 4 plants, such as corn and sugarcane	PARIS	Program and Resource Information System
Ca	calcium	RPA	research problem area
CRIS	Current Research Information System	SAES	State agricultural experiment station
F_1	The first generation offspring following a cross of two unrelated parent plants	SR	southern region
		SY	scientist year
		TA	technical advisor
Mg	magnesium	TDN	total digestible nutrient
Mn	manganese	USDA	U.S. Department of Agriculture
N	nitrogen		

I. Introduction

Corn and sorghum for grain were harvested from 81,414,000 acres during 1975 in the U.S.A. A combined harvest of 6,573,290,000 bus. very nearly equals the record production of 1973. These two crops are also annually planted on 14,000,000 A. for silage and forage. Pearl millet is presently planted on a very limited acreage for grain production but is used in southern regions as a forage crop. Production efficiency research to maintain and increase the production of these grain crops is a very vital part of the USDA-ARS Mission. Sound, basic biological research related to these crops is essential to the long-run supply of our feed grains.

The USDA-ARS research program is frequently located at state agricultural research stations where ARS scientists work closely with state scientists. One must consider these federal-state teams to understand and justify many of the ARS projects which are referred to in this NRP. Because of this close working relationship, it is not possible to clearly separate the research activities of ARS outlined in this document from similar or complementary research activities in state programs.

II. Program Summary

A. Current Technology

Corn, sorghum and millet grain production has been based either on the high productivity of F_1 hybrid cultivars or the potential of the development of such cultivars. The redesigning of the plant structure has played a major role in the acceptance of these crops to large-scale mechanized farming operations. Controlling plant height by genetic means along with greatly improved root and stalk strength has adapted these three grain crops to extensive production with relatively low economic inputs required. Progress has been made in grain quality, especially in protein quality and quantity, but the potential for further improvement is great. The development of insect and disease resistant hybrids and improvement of cultural systems have been reasonably successful in increasing production.

1. Breeding procedures are being investigated to provide greater production efficiency. Russell 1975 has shown a continuous contribution to corn production of roughly 1 percent per year since the introduction of hybrids.

2. Selected physiologic factors are being incorporated into improved hybrids. Better physiological information is being used in improved crop management practices. Current research findings have provided hybrids with greater resistance to environmental stress factors. These hybrids are able to better respond to the improved cultural and fertilizer practices.

3. Morphological modifications of plant structure have been very important in improving all three crops. The control of dwarf genes is essential in both grain sorghum and grain millet. A conversion program to change tall growing, late maturing tropical varieties to dwarf, early maturing stocks is proving very valuable in developing new sorghum hybrids.

4. Genetic improvement of quality in grain has created new potentials in the use of this grain for both feed and food processes. Cropping systems have been developed which improve and standardize grain quality.

5. The incorporation of disease and nematode resistance is a major research goal in most breeding programs. Other methods of reducing losses caused by diseases and nematodes have been developed such as chemical treatments, crop rotations, fertilizer and cultural practices.

6. Control of insect pests remains a prime objective to increase grain production. The use of breeding methods, chemical control, and cultural practices should all be combined to give the best production systems.

7. The use of herbicides and combinations of herbicides, mechanical tillage and cropping systems have been successful in keeping weed losses relatively low. Research has shown the importance of weed control in the early stages of crop growth.

B. Visualized Technology

Breeding procedures and germplasm developments should improve corn, sorghum and millet grain yield 8 to 10 percent in 10 years. An added benefit will be the reduction in genetic vulnerability as these new strains are brought into production. Improved systems of cropping and control of weeds, insects, and diseases will also contribute 8 to 10 percent to grain production.

1. Corn and sorghum will be genetically more diverse as a result of the wider use of new breeding strains. Visualized technology should develop strains adapted to special environmental conditions thus encouraging farmers to use more diverse hybrid strains.

2. Production hazard caused losses will be reduced by better adapted hybrids and by improved management practices of soil, water, fertilizer, and plant population rates.

3. Hybrids of these crops will be selected for their plant structure (short, strong stalks) which respond favorably to changes in cultural practices and are easily handled in mechanical harvesting.

4. Develop hybrids with increased protein quantity and improved quality and digestibility. Develop improved cultural and management practices including fertilizer usages to maximize grain quality.

5. Improved procedures are available for studying the host-parasite interactions of nematodes and disease organisms. The genetic mechanisms of host resistances are well enough understood to encourage the development of resistant cultivars. New cultural and management practices and use of new biological and chemical controls of diseases will reduce crop losses. The interrelationships among micro-organisms, insect damage, and the development of toxins on the grain will be studied to improve corn grain quality and to increase the potential for use of corn as a feed and food grain.

6. Incorporate factors for plant resistance to insect attack into varieties with otherwise desirable characteristics. Study the morphological, physiological, and biochemical factors responsible for resistance.

7. Develop several alternate systems of controlling weeds for each production region that would restrict crop losses to less than 3 percent of the crop value.

C. Consequences of Combined Visualized Technology

Corn and grain sorghum make up six-sevenths of our feed grain production and both are growing in importance. Increasing the production of these grains is essential if we are to meet the growing demand for meat, milk, and eggs in the U. S. and in world markets.

Adoption of new technology will:

1. Develop genetic populations with greater potential grain production because of superior combinations of agronomic characteristics and broader use of cytoplasmic factors.

2. Utilize physiological potential in these crops to respond favorably to such stress conditions as heat, drought and shortages of mineral nutrients.

3. Make greater use of morphological characteristics in developing new hybrids. These modifications often contribute materially to the ease of harvest and to total production.

4. Enable the improvement in quantity and quality of protein in these grains. Modification in kind of starch is possible for specialized uses.

5. Make more efficient use of chemicals for nematodes and disease control saving cost of both material and labor and reducing chances of pollution during crop production.

6. Reduce use of chemical insecticides thus lowering the chances of residues on feed and food crops, lessen hazards to beneficial insects and wildlife, and reduce chemical pollution in air, water and soil.

7. Minimize grain losses by better management of weeds in the cropping system. Improved weed control will also reduce difficulty of harvest and lessen trash in grain.

D. Total Potential Benefits

The next 10 years should see increases in grain production of these crops in the amounts of 19 to 20 percent* as a direct result of research discussed above. Such increases in feed grains would have a cash farm value of $2,000,000,000 at today's prices.

1. Agronomic improvements, including new hybrids, will contribute nearly half of the increases in yield and value of the crops.

2. Physiological efficiency will be important in bringing about improvements in these crops but these are here combined with item 1.

*Based on similar national averages from 1965 and 1975, see SRS reports

3. Effects of morphological modifications also have been combined with item 1.

4. Biochemical alteration of grain will increase the value of the production by an estimated 5 percent on that portion of the crop so modified.

5. Crop losses due to diseases vary widely from region to region and season to season. Visualized research will reduce such loss on the overall crop by 3 to 4 percent and will help stabilize production.

6. In recent years insect pests have intensified on these grain crops. Better systems of crop management and incorporation of genetic resistance into hybrids to reduce insect damage will reduce losses by 3 to 4 percent on the whole production.

7. Weed control with better systems will reduce crop losses and costs of materials and applications by 3 to 4 percent. The savings will be much greater on many fields where weeds are a special problem.

E. Total Research Effort

The research effort on these feed grains is reasonably large but one must look at the importance of the crops and in terms of the benefits which can be derived when research findings can be extended over many millions of acres of production. The national research program is supported by both federal and state programs often being very closely interlocked. The figures given below include all aspects of corn and sorghum research and is given in more detail under the separate commodities.

		Current Support		Expanded Support
	Year	SY's	Gross Dollars	SY's (ARS only)
ARS	FY 75*	46.5	2,582,000	61.4
SAES	FY 74#	164.0	10,009,913	--
Total	FY 74 & 75	210.5	12,591,913	--
Years required for ARS to achieve the visualized technology			8-10	5-6

*PARIS printout 11/24/75
#CRIS " 9/8/75

III. Technological Objectives

Corn

III.1 To develop improved genetic and breeding populations, breeding lines, and hybrids which combine agronomically acceptable characteristics with pest resistance, environmental stress tolerance and adaptation to mechanical production and handling. Develop basic genetic, cytogenetic, physiologic, and biochemical knowledge necessary to accomplish these goals.

A. Current Technology

1. Presently available breeding lines through their hybrids are capable of producing 175 to 200 bu/A. under good growing conditions. Much of the progress has been obtained by using empirical methods.

2. Over the past 10 years single cross hybrids (or similar modifications) have increased up to 70 percent of the acreage thus replacing double cross hybrids. This change has drastically changed the corn seed production, processing and merchandising.

3. Inbred strains differ in their potential for uptake and utilization of plant nutrients. Hybrids have been selected which respond favorably to high plant densities under high levels of soil fertility. (see Russell 1975)

4. Some present hybrids are resistant to most of the old pest problems, such as smut, ear rots, etc. There is little available resistance to some diseases such as southern corn rust, grey leaf spot, etc.

5. Progress has been made in the past 5 years in understanding the role of viruses and their insect vectors in corn. Inbred lines and hybrids with good tolerances have been identified and such information has been published.

6. Most corn hybrids are now produced using N (normal) cytoplasm which is resistant to the toxin produced by Helminthosporium maydis race T which caused great losses in 1970. However, because the commercial lines currently used have similar genetic backgrounds, the vulnerability of present hybrids to insect pests and disease organisms is possibly as great or greater than in 1970.

7. Sources of resistance to European corn borer, Southwestern corn borer, and other insects have been identified. Many hybrids being produced today have good resistance to European corn borer.

8. Corn for silage is grown on approximately 10,000,000 acres. Research has shown that hybrids bred for high grain production are generally best for silage since they produce the most TDN per unit of land. Very little research is currently being conducted on silage corns (see King, Thompson and Burns, 1972).

B. Visualized Technology

1. Increased utilization of both diverse domestic and exotic germplasm is underway in both public and private breeding programs. Continued selection, development, and evaluation of these diverse genotypes will lessen the vulnerability of the hybrids offered corn producers in the next 8 to 10 years.

2. Cytoplasmic and genetic research can contribute new knowledge and germplasm which will contribute to hybrid improvement.

3. Development of breeding strains with cold tolerance for early planting, resistance to seedling diseases and physiology factors for fast dry-down of grain in fall will reduce energy requirements in production by making maximum use of solar energy. Such strains will also work well in multiple cropping systems.

4. Accelerate the development and use of prolific (multiple-ear) inbreds and hybrids to increase grain yield and stabilize production over a wide range of cultural and weather conditions. Some inbreds have been released and others are near release. These may be in hybrid production in 5 years on 10 percent of corn acreage.

5. Genetic and breeding research is improving the nutritional value of this grain crop for both human food and feeding of especially nonruminant animals. High lysine hybrids are becoming available and should be in moderate scale production in 6 to 8 years.

6. Studies will continue on such diseases as Southern and Northern leaf blights, stalk rots, and the development of breeding populations with increased resistance. Much progress has been made in recent years on developing resistance to these problems, but they continue to be real threats to corn production.

7. With changing of germplasm used in hybrids and seasonal changes, other diseases or insects have become more important. Germplasm screening has identified sources of resistance to anthracnose, downy mildew, Southern leaf rust, and viruses.

8. Studies will begin which focus attention on combining resistance to insects and resistance to the development of toxin producing fungi in hybrids. Such combinations are necessary in commercial hybrids to improve the quality of grain, particularly that to be used for human consumption.

9. New sources of resistance to European and Southwestern corn borer, corn earworm, maize weevil, and other insects are being studied. Some of these will be in breeding programs this year and hybrids should be developed within 6 to 8 years.

10. Corn strains will be developed with tolerance to the northern and western rootworm by selecting for better root systems or antibiotic factors.

C. Research Approaches

To determine efficient and effective breeding procedures which will aid in the development of populations with the following characteristics:

1. More diverse genetic and cytoplasmic germplasm (RPA 307). (NCR, Ames, Ia., Brookings, S.D., Columbia, Mo., Wooster, Oh., Urbana, Ill.; SR, Gainesville, Fla., Raleigh, N.C., Starkville, Miss., Tifton, Ga.).

2. Increased physiological efficiency including responses to nutrient elements such as N, P, Mg, Ca and Mn (RPA 307 and 405 and coordinated with NRP 20170, 20750). (NCR, Urbana, Ill.; SR, Raleigh, N.C.).

3. Improved tolerance to stresses of the field such as weeds, frost, cool soils, and drought and better utilization of solar energy for more grain of better quality (RPA 209, 307, and coordinated with NRP 20170, 20280). (NCR, Ames, Ia.).

4. Good root and stalk strength and other agronomic traits (RPA 307 and 405). (NCR, Ames, Ia., Brookings, S.D., Columbia, Mo., Wooster, Oh.; SR, Raleigh, N.C.).

5. Adaptable to mechanized operations (RPA 307 and 308). (NCR, Columbia, Mo.).

6. Improved protein quality and other grain quality components to increase feed and food value (RPA 307 and 405). (NCR, Ames, Ia., Columbia, Mo., Urbana, Ill.; SR, Raleigh, N.C., Tifton, Ga.).

7. Improved resistance to diseases (RPA 208, 307 and coordinated with NRP 20270). (NCR, Ames, Ia., Brookings, S.D., Columbia, Mo., W. Lafayette, Ind., Wooster, Oh.; SR, Miss. State, Miss., Gainesville, Fla., Raleigh, N.C.).

8. Improved resistance to insects (RPA 207, 307 and coordinated with NRP 20240). (NCR, Ames, Ia., Brookings, S.D., Columbia, Mo.; SR, Miss. State, Miss., Tifton, Ga.).

Study the modes of inheritance of the above traits, develop new genetic methods for identifying superior germplasm and the detection of favorable genes for incorporation into improved breeding lines and commercial hybrids. (RPA 307 and coordinated with SP-Genetic vulnerability). (NCR, Columbia, Mo., Ames, Ia., Brookings, S.D., Urbana, Ill.; SR, Gainesville, Fla., Starkville, Miss., Raleigh, N.C.).

Develop basic cytogenetic and genetic information of potential value in breeding programs. (RPA 307 and coordinated with SP-Genetic vulnerability) (NCR, Columbia, Mo., Ames, Ia.; SR, Gainesville, Fla., Raleigh, N.C.).

Develop and evaluate new germplasm by use of conventional and nonconventional techniques (tissue and anther culture, etc.) (RPA 307 and coordinated with NRP 20170). (NER, Beltsville, Md., Columbia, Mo.; SR, Raleigh, N.C., Gainesville, Fla.).

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D. Consequences of Visualized Technology

1. Better genetic potential will aid in stabilizing and increasing supplies of meat, milk and eggs for the U.S. and world markets.

2. Increase the net income of corn producers and reduce energy requirements per unit of corn production.

3. Increase consumer demand for higher quality corn products. This includes more and better protein quality and the supplying of sweeteners to the commercial market in the form of high fructose corn syrup.

4. Provide cheaper food and feed with minimal losses in nutrition and customer acceptability.

5. Reduced need for pesticides will reduce hazards to beneficial insects and wildlife.

6. Intensify the need for developments of new markets for grain, both domestic and foreign.

7. Reduce losses to environmental stresses such as cold and excessively high temperatures, excessive drought or early frost.

8. Additional storage and shipping equipment will be necessary in order to handle the increased volume of grain.

E. Potential Benefits

1. The program has been responsible for the release of the following inbreds during 1973, 1974, and 1975. Fourteen genetically improved inbreds, 7 inbreds with disease resistance, and 6 with insect resistance, for a total of 27 releases to commercial breeders. During the same period, 8 genetic populations, 9 with improved resistance to disease, and 3 with improved resistance to insects were released. Such inbreds and populations in the past have made very important contributions to the improvement of corn hybrids for farm production.

2. Agronomic production. An estimated 5 percent increase in grain yield on the 1975 crop would have a value of $871,875,000. Based on past improvements, we should reasonably expect a 5 percent increase in grain yield.

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3. Quality of grain. Based on one billion bushels for food and industrial uses, a 5 percent gain in value would return a potential benefit of $150,000,000.

4. Insect resistant hybrids should contribute 3 percent increase in returns to corn producers. This would amount to a total value of $523,125,000 annually (based on 1975 yield returns and market value of $2.50 per bu.).

5. Disease resistant hybrids should also net a 3 percent increase annually in returns to the producers. This likewise would be valued at $523,125,000.

The cost/benefit ratio is very favorable for these programs. Since corn is grown on roughly 75 million acres annually, any small improvement has a very high return value.

F. Research Effort

	Year	Current Support SY's	Gross $'s	Expanded Support SY's
ARS	1974	28.7	$1,753,375	36
SAES	1974	93.2	6,193,737	--

Years required to achieve the visualized technologies	Current Support	Expanded Support
	10	6-8

III.2 To increase production by developing improved cultural and crop management systems.

A. Current Technology

1. Disease and insect control. Cultural practices that promote optimum growing conditions may reduce the severity of some diseases and insect damage. Field operations that improve drainage and soil temperatures materially affect the incidence of seedling blights and stalk rots. Rotation of corn with other crops, where feasible, is effective in reducing the presence of soil borne diseases, insects, and other pests. Where corn is grown continuously on the same land or where increasing populations of plants are grown under a minimum cultivation regime, other means of control of the root and stalk rots and seedling blights and insects are needed such as genetic resistance or other biological controls.

Insect vector of corn diseases. At the present we do not have an effective method or methods to prevent or reduce the spread of plant viruses by control of the insect vectors. Use of insecticides reduces vector populations but does not prevent the spread of virus diseases. Cultural practices may reduce the amount of corn virus spread into a field. Much additional information is needed on vectors and their relationship to plant diseases.

2. Weed control. Several combinations of cultivation with herbicides will effectively control some of the weed species that infest corn. Some of the herbicides we now use pose problems in residual toxicity to following crops. Corn land in 35 counties of North and South Carolina is infested by parasitic witchweed. An eradication program against witchweed is underway but the job is expensive and time-consuming. Weeds against which our best available practices are only marginally effective (current primary targets for research), and the acreages they infest in each region, are estimated as follows:

Weed	Acres infested by production regions			
	Northeast	North Central	South	West
Johnsongrass	221,000	3,102,000	2,626,000	3,000
Nutsedge	646,000	1,663,000	1,826,000	--
Giant foxtail	243,000	14,477,000	479,000	--
Quackgrass	1,604,000	6,185,000	--	42,000
Canada thistle	148,000	5,467,000	--	14,000
Wild cane	--	1,554,000	--	9,000
Sandbur	--	--	414,000	39,000
Witchweed	0	0	250,000	0
Shatter cane	0	100,000	150,000	0

3. Agronomic contributions to grain yield. In the Corn Belt, hybrid corn was adopted as a single factor innovation. Other changes in production practices followed. In other areas, these innovations often accompanied the shift to hybrids. These included increasing use of fertilizers, particularly nitrogen, and heavier plant populations. Detailed data from Iowa are considered representative:

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Year	Yield bu/acre	Fertilizer lbs.N/A
1930	34.0	.08
1940	52.5	.06
1950	48.5	4.14
1960	63.5	22.00
1965	82.0	82.14
1970	85.8	108.10
1975	92.0	98.00

Detailed data are lacking, but it is estimated that plant populations increased by 50 percent during this same period. The yield increases indicated are the joint effect of improved varieties, increased fertilization, better control of insects, diseases, and weeds and higher plant populations. Present studies show both the promise and dangers in growing higher plant populations and utilizing high rates of fertilization. Much more work is needed to determine genotype stability before maximum yields can be obtained with minimum risk.

4. Quality of grain. Proven practices of planting at the proper time and into suitable seed beds fertilized with the right amounts and kinds of fertilizing elements have generally been successful, and minimum research efforts have been directed toward studying the effect of cultural practices on starch and oil content or on seed quality. Additional work is needed to determine the effect of different practices on the nutritional quality of the grain. Results have shown that mechanical harvesting can be detrimental to storage and seed quality if moisture is too high or the combine cylinder speed is too great.

B. Visualized Technology

1. Disease and insect control. To develop, for each production region, cultural practices and population densities that will reduce losses due to stalk and root rots, seedling blights, foliar diseases, nematodes and insects by at least 5 percent.

To develop cultural and chemical control practices to eliminate nematode losses that contribute to reduced yields, poor stands and quality, eliminate nematode induced diseases, and improve efficiency of production by better utilization of water and fertilizer.

The use of minimum tillage practices and multiple cropping may increase either diseases or insects so continued research is necessary to avoid build up of these pests.

Insect vector of corn diseases. This research activity has as its visualized technology the development of new control methods for insect vectors of corn diseases which may be used locally or on an area-wide basis.

2. Weed control. To develop, for each production region, several alternate systems of controlling weeds in corn that will restrict losses to 3 percent of the crop value for a cost of $12/A, minimize or avoid problems of herbicides, residues in soil and exert effective pressure against weeds resistant to current treatments. Such systems should also reduce energy requirements in crop production.

3. Agronomic contributions to grain yield. To develop for each production region improved cultural practices (including different methods of seeding and cultivation and differences in crop sequence) and population densities that will permit yield increases of at least 10 percent.

4. Quality control in grain production. To develop, for each production region, improved cultural and management practices that will increase the value of corn for food and industrial uses by 5 percent.

C. Research Approaches

1. Disease and insect control (RPA 207, 208 and coordinated with NRP 20240, 20270). (NER, Beltsville, Md., Frederick, Md.; NCR, Brookings, S.D., Columbia, Mo., Ankeny, Ia., W. Lafayette, Ind., Wooster, Ohio, Morris, Minn.; SR, Raleigh, N.C., Mississippi State, Miss., Tifton, Ga., Lubbock, Tx., Baton Rouge, La.).

   a. Evaluate cultural and management practices and explore ways of reducing losses from soil-borne diseases, nematodes, and insects.

   b. Evaluate the effect of environment and plant populations on insects, diseases and nematodes.

   c. Determine the relationship of fertilization practices on incidence of disease under different plant populations.

2. Weed control (RPA 209 and coordinated with NRP 20280). (NCR, Urbana, Ill., Columbia, Mo., Ames, Ia.; SR, Stoneville, Miss., Tifton, Ga.)

   a. Evaluate new herbicides and explore ways of improving the safety and effectiveness of new and older herbicides in corn production systems.

   b. Develop rotations and cropping systems that will permit variation in types of pressure against problem weeds in corn production.

3. Agronomic contributions to grain yield (RPA 307) (NCR, Brookings, S. D., Ames, Ia., Columbia, Mo.; SR, Raleigh, N.C., Tifton, Ga., Miss. State, Miss.)

   a. Investigate existing hybrids for responses to nutrients and population densities.

   b. Study existing hybrids for responses to different methods of seeding.

   c. Manipulate population densities and cultural practices to make more efficient use of sunlight and water resources.

   d. Study cultural practices as to their effect on root development.

4. Quality of grain (RPA 405) (NCR, Lafayette, Ind.)

   a. Evaluate effect of plant densities on quality of grain.

      1. Can protein content and amino acid balance be influenced by plant populations?

      2. Is starch quality related to plant densities or other cultural practices?

      3. Can oil content be altered significantly through cultural means?

      4. Can maximum yields under dense plant stands be produced with consistently high grain quality?

APPENDIX IX

b. Relate plant nutrition to the nutritive value of the grain.

1. Can total protein and amino acid balance be altered by fertilization practices?

2. Can starch content and quality be influenced by fertilization of the crop?

D. Consequences of Visualized Technology

1. Provide cheaper food and feed with minimal loss in nutrition or consumer acceptability.

2. Increase net income of corn producers.

3. Intensify the need for development of expanded use of corn.

4. Increase the need for greater skills in farm labor.

5. Decrease problems in environmental pollution.

6. Prevent spread of a parasitic weed to areas not now infested.

7. Increase consumer demand through higher quality corn.

8. Reduce or eliminate pesticide residues on food crops.

9. Decrease amount of energy required to produce a given unit of grain.

10. Reduce need for pesticides thus reducing hazards to beneficial insects and wildlife.

11. Reduce air, water, and soil pollution by pesticides.

E. Potential Benefits

1. Insect control. Based on 1975 crop data and price estimate a 1 percent increase in grain production would return $145,000,000 as a consequence of insect control by cultural practices.

2. Disease control. Based on a 5.8 billion bus. crop and a potential benefit of 1-1/2 percent increase in grain, an estimated $217,500,000 gross return would be expected (with $2.50 per bushel price).

3. Weed control. Based on a 75 million acre crop, the magnitude of the potential benefits is as follows:

a. Reduction of losses caused by weeds and injury from control measures.....	$256,500,000
b. Reduced cost of controlling weeds.....	183,750,000
c. Total potential benefits.....	$440,250,000

4. Agronomic contributions to grain yield. Based on a 75 million acre crop, the magnitude of potential yield benefits is $871,875,000. (5 percent increase in yield and corn priced at $2.50 per bu.).

5. Quality of grain. Based on 1 million bushels for food and industrial uses, a 5 percent gain in value would give a potential benefit of $125,000,000.

F. Research Effort

	Year	Current Support SY's	Current Support Gross $'s	Expanded Support SY's
ARS	1974	11.8	$ 650,522	16
SAES	1974	26.8	1,416,104	--

	Current Support	Expanded Support
Years required to achieve the visualized technologies	10	5-6

Sorghum

III.1 To develop improved genetic and breeding populations, breeding lines, and hybrids which combine agronomically acceptable characteristics with pest resistance, environmental stress tolerance and adaptation to mechanical production and handling. Develop basic genetic, cytogenetic, physiologic, and biochemical knowledge necessary to accomplish these goals.

A. Current Technology

1. Yields of sorghum have increased regularly and substantially since the introduction of hybrids in 1957 (an average of 42.6 bushels for the 1960-64 period had increased to approximately 53 bushels per acre in 1970-72). The major increase has been achieved under irrigation and eastern part of sorghum production area where both water and fertility may be controlled. Under these conditions, present yield levels do not approach the potential for the crop.

   Only one source of cytoplasmic male sterility is being used in hybrid seed production. Work on cytoplasmic traits is bringing new knowledge concerning these traits.

2. Sorghum is grown in areas where drought and excessive heat occur often. Current hybrids are better adapted to such stress conditions than older varieties.

3. U.S. sorghum production is based on a small fraction of the known genetic diversity. Studies are underway to introduce the necessary height and maturity genes into a selected sample of exotic types which would permit their use by breeders and farmers.

4. Improved quality and quantity of protein is available in breeding strains. Modified forms of starch are known which have been utilized for special processes.

5. Some of the diseases that cause damage are anthracnose, smuts, foliar diseases, stalk rots, and fusarium head blight.

   a. Downy mildew is present in a wider geographic area each year. It seems to spread on seed of sudan x sorghum hybrids which are highly susceptible. Host resistance appears to be the most promising means of control but little is known of the genetics of host-pathogen reactions.

b. Nematode caused losses, their distribution, means of spread, life cycles, and pathogenicity are largely unknown but present evidence indicates that cotton root knot nematodes cause considerable damage to grain sorghum on the High Plains of Texas. Highly resistant varieties are not available or adaptable to all areas.

6. Progress has been made in developing strains with resistance to certain insect pests.

a. Resistance to greenbugs has been identified in sorghums and this trait is being incorporated into lines with good agronomic and quality characteristics including resistance to stalk rots and with better seedling vigor.

b. The corn earworm may be serious under some conditions. Selecting open-panicle types has helped reduce losses of grain.

c. The sorghum midge causes serious losses in yield in some areas. Resistance to the midge is being incorporated into lines having other desirable agronomic traits.

7. The production of grain sorghum in southeastern U.S. is limited due to depredation by birds. Brown seeded types are resistant to birds, but are also poorly digested by animals, especially ruminants.

B. Visualized Technology

1. Investigate genetic and cytoplasmic traits which will contribute to improved hybrids. Search for new and usable sources of cytoplasmic male sterility is urgently needed to lessen the vulnerbility of sorghum hybrids.

2. Reduction of hazards will come about by the development of better adapted varieties with high net photosynthetic rates, improved tolerance to drought and to soil acidity or alkalinity, superior root development and pest resistance. Such traits should result in better use of growing seasons by early planting or delayed cropping and may be useful in multiple cropping systems.

3. Research must continue on plant height and strength of stalks and roots. The conversion of exotic germplasm strains is essential to bring in improved plant characteristics and widen the genetic base for commercial hybrids.

4. Develop varieties with increased protein quantity and quality with improved digestibility and higher yields. The short-range goals are for improvement in digestibility and protein quality by 10 percent and doubling the lysine content.

5. Develop varieties with resistance to anthracnose, smuts, foliar diseases, downy mildew, stalk rot, fusarium head blight, viral diseases, and those caused by viral-like factors.

   a. Investigate occurrence of fungi, such as Aspergillus sp. and the conditions which produce mycotoxins in grain both in pre- and post-harvest stages.

   b. Determine the distribution, life cycles, and pathogenicity of nematodes. Develop nematode resistant varieties that will reduce nematode losses.

6. Incorporate factors for plant resistance to insect attack into varieties with other desirable characteristics. Work should include research on greenbugs, corn earworm, sorghum webworm, chinch bug, European and Southwestern corn borer, sorghum midge, and Bank's grass mite. Study the morphological, physiological, and biochemical factors responsible for resistance. Determine the genetic basis for resistance to insects.

7. Develop varieties that are resistant to birds but have maximum digestibility by animals.

C. Research Approaches

Determine effective and efficient breeding procedures and develop populations with the following characteristics:

1. Improved grain yield traits (such as, twin seeded) and cytoplasmically divergent sources of male sterility (RPA 307). (NCR, Manhattan, Ks., Lincoln, Neb.; SR, Mayaguez, P.R., College Station, Tx.).

2. Improved tolerance to stresses of the field such as weeds, frost, cool soils, and drought. Increase physiological efficiency and mineral nutrient utilization. (RPA 209, 307 and coordinated with NRP 20280). (NCR, Lincoln, Neb.).

3. Improved plant morphology and agronomic traits. (RPA 307). (NCR, Manhattan, Ks., Lincoln, Neb.; SR, Mayaguez, P.R., College Station, Tx.).

4. Improved grain and stalk digestibility including quality and quantity of protein. (RPA 307 and 405). (NCR, Manhattan, Ks., Lincoln, Neb.; SR, Mayaguez, P.R., College Station, Tx.).

5. Improved resistance to major diseases. (RPA 208, 307 and coordinated with NRP 20270). (NCR, Manhattan, Ks., Brookings, S.D.; SR, College Station, Tx., Mayaguez, P.R.).

6. Improved resistance to major sorghum insect pests. (RPA 207, 307 and coordinated with NRP 20240). (SR, Stillwater, Okla., and Mayaguez, P.R.).

7. Resistant to bird damage and with good digestibility by animals. (RPA 209, 307). (NCR, Manhattan, Ks., College Station, Tx.).

8. Adaptable to mechanized operations. (RPA 307, 308 and coordinated with NRP 20190). (NCR, Manhattan, Ks., Lincoln, Neb.; SR, Mayaguez, P.R., College Station, Tx.).

D. Consequences of Visualized Technology

1. Increase stability of grain sorghum production for feed and food markets in the U.S. and for export.

2. Improve the nutritional level of sorghum products.

3. Reduced cost of production and increased yields will give increased income for the producer.

4. Improve reliability in planning for production needs and controls.

5. Decrease problems in environmental pollution.

6. Increase consumer demand through higher quality sorghum.

7. Technology will decrease the use of energy per unit of grain production.

E. Potential Benefits

1. Eleven insect resistant breeding lines, 2 breeding populations and 303 conversion lines have been released during the past 3 years. These are being used in hybrids for farm grain production. Greenbug resistance was of special value in reducing the need for chemical pest control.

2. An improvement in grain yield of 10 percent on 25 percent of the acreage based on a 14,000,000 acre crop could return $46,000,000 annually (@$2.25/bus.).

3. A 2 percent increase in value based on improved quality would be worth $3,512,000 if extended to 1/10 of a 825,000,000 bus. crop.

4. Losses to diseases are estimated to be approximately 9 percent of the crop annually. The disease losses based on a 825,000,000 bushel crop are $167,000,000. Damage caused by the following diseases are included: charcoal and other stalk rots, head smut, seed rots, and seedling diseases, bacterial blights, Helminthosporium leaf blight, weak neck, anthracnose, foliar and virus diseases.

5. While some progress has been made in controlling insects in sorghum production, an estimated 8 percent loss is reported. The losses based on a 825,000,000 bushel crop amount to $148,500,000 (@$2.25/bus.). This includes damage caused by corn earworm, sorghum webworm, sorghum greenbug, sorghum midge, chinch bug, cutworms, armyworms, Banks grass mite, and Southwestern corn borer.

6. Based on a 14,000,000 acre crop, the magnitude of the potential benefits from weed control is as follows:

a. Reduction in losses caused by weeds and injury from control treatments	$24,558,400
b. Reduced cost of controlling weeds	34,300,000
Total Benefits	$58,858,400

F. Research Effort

	Year	Current Support SY's	Current Support Gross $'s	Expanded Support SY's
ARS	1974	6.2	$ 406,311	10
SAES	1974	37.5	2,119,978	--

III.2 To increase production by developing improved cultural and crop management systems.

A. Current Technology

1. Disease control. A combination of delayed planting and seed treatment is moderately effective in the control of seed rots, seedling blights, and loose and covered smuts. Cultural practices that minimize drought stress during the period of maturation reduce the severity of charcoal rot. Crop rotation reduces losses from diseases and nematodes but does not provide adequate control. Downy mildew has been spreading in sorghum producing areas. No known chemical or production practices offer practical control. Maize Dwarf Mosaic virus has become increasingly prevalent in sorghum fields. There is evidence that the greenbug attacking sorghum transmits the virus but practical controls are not available.

2. Insect control. Greenbugs have been a major pest to grain sorghum in many regions. Present cropping systems have not reduced losses effectively. The cropping system is only partially effective in controlling other pests: midge, aphids, stalk borers, and corn earworm.

3. Weed control. The herbicide 2,4-D, applied postemergence, controls many species of broadleaf weeds, but often it adversely affects the crop, and weeds may damage grain sorghum before the herbicide can be applied. Atrazine and propazine can persist in amounts toxic to following crops grown in rotation. Postemergence applications of atrazine in oil frequently cause significant damage to sorghum. Our best available systems for controlling weeds in grain sorghum are only partially effective against wild cane, johnsongrass, Texas panicum, giant foxtail, and bur ragweed.

4. Agronomic contributions to grain production. Essentially all of the grain sorghum acreage is now planted to hybrids. With this shift to improved types has come an increasing use of fertilizer in irrigation. Extensive work has been done on time of planting. Much less work has been done on efficient use of fertilizer or water. Current practice is still geared to information accumulated with the older varieties with a much lower yield potential. Enough work has been done to indicate that plant spacing and arrangements and manner of application and timing of water and nutrients are important factors but optimums are not known. Means of maximizing responses have not been developed.

5. Quality of grain. Information is needed but almost completely lacking on the effect of fertilization, irrigation, seed treatment, and other chemical applications on the digestibility and nutritive value of the grain.

B. Visualized Technology

1. Disease control. To develop for each production region information on cultural, management, fertilization, and water use practices which will reduce losses due to diseases and nematodes by at least 5 percent. This will involve finding improved seed treatment chemicals, improved control of vectors of virus diseases, chemical control of mildew, and identification of virus reservoirs and development of methods of eradicating them.

2. Insect control. To develop management practices to reduce by 5 percent losses due to insects such as greenbug, midge, aphids, stalk borers, and corn earworm.

3. Weed control. To develop for each production region, several alternative systems of controlling weeds in grain sorghum that will restrict losses to 4 percent of the crop value and minimize problems of herbicide residues at a profit.

4. Agronomic contributions to grain production. To develop information on cultural, management, fertilization, and water use practices which will permit efficient yield increases of at least 10 percent.

5. Quality of grain. To develop information on cultural, management, fertilization, and water use practices which will improve the value of the grain by at least 7 percent by increasing protein quantity and quality and improving digestibility.

C. Research Approaches

1. Disease control (RPA 208, 309 and coordinated with NRP 20270, 20740, 20750) (NCR, Manhattan, Ks., Lafayette, Ind.; SR, College Station, Tx.)

a. Develop cultural, management, fertilizer, and water use practices to reduce disease losses.

2. Insect control (RPA 207, 309 and coordinated with NRP 20240) (SR, Stillwater, Okla., Tifton, Ga.)

   Develop pest management systems to control damage by insects.

   1. Determine the effects of management practices on soil inhabiting insects.

   2. Determine the alternate hosts of insects and develop cultural practices to control those hosts.

   3. Develop rotations and cropping systems to decrease damage by insects.

3. Weed control (RPA 209, 309 and coordinated with NRP 20280) (SR, Stoneville, Miss.)

   a. Evaluate new herbicides and explore ways of improving the safety and effectiveness of new and older herbicides as used in cropping systems.

4. Agronomic contributions to grain productions. (RPA 309 and coordinated with NRP 20740, 20750) (NCR, Manhattan, Ks., Lincoln, Neb.; SR, College Station, Tx.).

   a. Cultural, management, fertilizer, and water use studies.

      1. Study alterations in planting pattern and density to increase the utilization of sunlight.

      2. Investigate heat and drought stresses for improved fertilizer utilization.

5. Quality of grain (RPA 405 and coordinated with NRP 20740, 20750) (NCR, Manhattan, Ks., Lincoln, Neb.).

   a. Cultural, management, fertilizer, and water use studies.

      1. Investigate alterations in planting pattern and density that may influence protein quantity and quality and digestibility.

      2. Study the digestibility and protein quantity and quality as affected by fertilizer practices and time and amount of irrigation.

D. Consequences of Visualized Technology

1. Reduce cost of production by reducing production inputs and increasing production.

2. Increase net income of grain sorghum producers by reducing the adverse effects of stress conditions during the growing season.

3. More efficient use of conventional fuels and of solar energy.

4. Decrease problems in environmental pollution.

5. Increase need for greater managerial skills in agriculture.

E. Potential Benefits

1. Disease control. Based on a 825,000,000 bushel crop, the magnitude of potential benefits from a 3 percent increase in yield resulting from a reduction in disease losses is estimated to be $55,687,000.

2. Insect control. Based on 1975 production yield, potential benefit of 2 percent from crop management to reduce insect losses is estimated to be $37,125,000.

3. Weed control. Based on a 14,000,000 acre crop, the magnitude of the potential benefits is as follows:

a. Reduction in losses caused by weeds and injury from control treatments-------	$24,558,400
b. Reduced cost of controlling weeds--------	34,300,000
Total benefit	$58,858,400

4. Agronomic contributions to grain production. Based on a 14,000,000 acre crop and a 3 percent increase in yield, the potential benefit is $55,687,000.

5. Quality of grain. Based on a 825,000,000 bushel crop, the magnitude of potential benefits from a 2 percent increase in value is estimated at $37,125,000.

F. Research Effort

	Year	Current Support SY's	Current Support Gross $'s	Expanded Support SY's
ARS	1974	1.4	$109,441	3
SAES	1974	6.5	380,094	-
Years required to achieve the visualized technology			10	6-8

Millets (Grain)

III.1 To develop improved genetic and breeding populations, breeding lines, and hybrids which combine agronomically acceptable characteristics with pest resistance, environmental stress tolerance and adaptation to mechanical production and handling. Develop basic genetic, cytogenetic, physiologic, and biochemical knowledge necessary to accomplish these goals.

A. Current Technology

Millets have been grown mainly as forage and hay crops in the U.S. There is interest in developing millets, primarily pearl millet, as a grain crop to be used interchangeably with corn and sorghum in parts of the Corn Belt and in the Great Plains.

Pearl millet, like corn and sorghum, has a tremendous potential because it has the efficient C_4 metabolic pathway, it responds to high levels of light intensity, seedlings will recover from frost damage if the growing point has not emerged above ground level, and they are suited to mechanization. Pearl millet has resistance to some insects and diseases that attack corn or sorghum. The technology for producing hybrid seed on large scale has been developed in the forage program (SR, Tifton, Ga.). Also dwarf, male sterile and restorer lines are available for breeding and evaluation of hybrids for their grain-yielding potential.

B. Visualized Technology

Since preliminary research indicates the yield potential of grain millets could be equal to grain sorghum and to corn in certain areas, further breeding work should be promising. The screening of pearl millet plant introductions for their potential value for grain production and use in hybrid cultivars needs to be continued.

Such characters as earlier maturity, dwarf plant stature, cold tolerance, increased seed size, lodging resistance, and B_1 and B_2 fertility reaction to the A_1 and A_2 cytoplasmic sterility systems must be investigated to adapt the crop to the Great Plains area.

Accelerated work to adapt this crop to a relatively new use (grain vs. forage) should result in hybrids equal to grain sorghum in yield and with improved protein quality in 6 to 8 years.

C. Research Approaches

Determine effective and efficient breeding procedures and develop populations as sources for new hybrids with improved agronomic performance and acceptable resistance to diseases and insects. Work on diseases and insects is closely tied to similar work on forage types and grain sorghum. (RPA 207, 208 and 307 and coordinated with NRP 20240, 20270, 20100). (NCR, Hays and Manhattan, Ks.; SR, Tifton, Ga., College Station, Tx., Mayaguez, P.R.).

D. Consequences of Visualized Technology

1. Would reduce genetic vulnerability of feed grain crops by offering farmers an alternative grain crop.

2. Provide a high quality grain with good amino acid balanced protein.

3. Make more efficient utilization of hot, relatively dry and short growing seasons in areas where such seasons commonly occur.

E. Potential Benefits

The addition of a new grain crop for areas with extreme weather stresses, such as, hot, dry, short growing seasons will spread the risk in grain production. In other areas, the short season pearl millets could increase double cropping of land. Since the grain has a high feed and food quality, this would upgrade the supply offered on grain market. Millet is used extensively in India and Africa as a human food.

F. Research Effort

The current support in ARS is small for millets as a grain crop. Work which is related is given under NRP 20100 forage crops. Some interest in the millet program has been shown by sorghum workers and 1/4 SY is assigned to this crop at Manhattan, Kansas.

An expanded support of 1/2 SY and $10,000 support money would be minimal and 1 SY and $20,000 support would more than double the expectations of success. This research should be located in Kansas, Nebraska, Texas or Oklahoma.

III.2 To increase production by developing improved cultural and crop management systems.

A. Current Technology

Management systems for millets as forage, hay, and to a very limited extent for grain (mostly as seed), have been developed for local regions. Little is known about the proper crop management needed to obtain maximum grain yield.

B. Visualized Technology

To accompany the development of improved varieties suitable for grain production, a whole new set of agronomic practices may need to be developed. Items similar to those listed under sorghum should be considered (see III.2, B).

C. Research Approaches

The same kinds of research approaches as used for sorghum will be needed for millets (see III.2, C). There will be some carry-over from sorghum work since the crops are similar in growth requirements.

D. Consequences of Visualized Technology

The potential for an alternative grain crop is good especially for the Great Plains region. As a new use of the crop it can only be estimated that it will find acceptance by farmers and the market place.

E. Potential Benefits
See millets (grain) III.1,E

F. Research Effort

See millets (grain) III.1, F

References:

1. A National Program of Research for Corn and Grain Sorghum, 1969. Prepared by: A Joint Task Force of the U.S.D.A. and the Land Grant Colleges.

2. Corn, Sorghum and Pearl Millet, Research Needs Southern Region, 1975. Prepared by: A Joint Task Force of the Southern Region Agricultural Experiment Stations and U.S.D.A. research scientists.

3. Russell, W. A., 1975. Comparative Performance for Maize Hybrids Representing Different Eras of Maize Breeding. Proceedings of the Twenty-ninth Annual Corn and Sorghum Research Conference, American Seed Trade Association, Washington, D.C. 20005.

4. Research to Meet U.S. and World Food Needs Report of a Working Conference, Volume 1, Kansas City, Missouri, July 9-11, 1975.

5. King, C. C., Jr., D. L. Thompson and J. C. Burns, 1972. Plant Component Yield and Cell Contents of an Adapted and a Tropical Corn, Zea mays L. Crop Sci. 12:446-449.

IV. Principal Contributors

NPS, P. H. Harvey, L. P. Reitz; TA's C. W. Stuber, A. R. Hallauer, K. F. Schertz, H. L. Warren.

V. Approval

Recommend _____ _____
Responsible NPS Scientist Date

Concur _____ _____
Assistant Administrator Date

Concur _____ _____
Director, PACS Date

Approval _____ _____
Associate Administrator Date

Score Sheet for Evaluating FY 1978 One-Page Budget Increase Proposals

Name of participant_____

Panel: Region /___/, NPS /___/, PACS /___/

Proposal ID No._____ Score (1-5)[1]

Criteria:

1. IMPORTANCE OF THE PROBLEM /_____/

The relative importances of problems can be most universally compared through their cost/benefit (C/B) ratios, i.e., through comparisons of the costs of solutions considered in the light of the benefits to be derived therefrom. These may be scaled from .5 (C/B extremely small) to 1 (C/B large, i.e., C/B $\geq$ 1.0).[2] In the absence of information to develop a C/B ratio one may consider the magnitude or extent of the problem (or the impact of its solution—or nonsolution). Importance is heightened by urgency. Inclusion of a problem area in the priority guidelines is an indication of importance.

2. RELEVANCE AND APPROPRIATENESS TO ARS /_____/

Relevance refers to the legal authority of ARS to conduct such work as the proposal calls for. Relevance is modified by appropriateness which should take into account the relatedness of the work to specific goals and objectives of the Department and ARS, whether the work is of such nature that the only feasible approach is through publicly supported research, and whether any changing trends of need for, or public interest in, such work have been developing.

3. RESOURCE UTILIZATION /_____/

Resource utilization should consider human, physical and economic resources, and should give special attention to any unique ARS resources. It should consider the likely efficiency of the proposed resources in this research effort and whether such use would preclude more efficient usage in some other research effort.

4. SCIENTIFIC MERIT OR FEASIBILITY /_____/

Scientific merit or feasibility should consider the soundness and adequacy of the approaches and procedures to be used. It should also consider any evidence of innovation and fresh approaches. There would seem to be some linkage between feasibility and probability of success.

---

[1] Scores are from 1 (poorest or least desirable for funding) to 5 (best or most desirable or most necessary for funding). A score of 3 represents an average or mid-range value indicating an indifference as to the desirability of or need for funding.

[2] Helpful discussion on developing the information required to calculate a C/B ratio is contained in Appendix 6, Instructions for Developing ARS-NRP's, in MAPS.

APPENDIX XI

ECONOMIC RESEARCH SERVICE'S DIVISIONS AND PROGRAM AREAS

FOOD AND FIBER ECONOMICS

Commodity Economics Division

The Commodity Economics Division carries out a national program of economic research and analysis, statistical programs, and other work relating to the production and marketing of farm commodities. It includes evaluations of the organization and performance of major commodity subsectors; costs and returns to farmers and marketers; situation and outlook; commodity projections; price spreads; and analysis of U.S. farm commodity programs.

Program areas are:

- Commodity Programs and Policy Analysis
- Fibers
- Grains and Feeds
- Oil Crops
- Fruits, Vegetables, Sweeteners, and Tobacco
- Meat Animals
- Dairy
- Poultry

National Economic Analysis Division

The National Economic Analysis Division deals with the entire agriculture sector and centers around the more aggregative issues cutting across commodity lines. This includes consumer demand analysis; agricultural finance; farm inputs; pricing, policy and program analysis; structure and adjustments in the agriculture sector; long-run projections; and overall performance measures in agriculture such as farm income, the marketing bill, and others.

Program areas are:

- Agricultural History
- Technology and Innovation in the Food and Fiber Sector
- Structure and Adjustments
- Inputs and Finance

APPENDIX XI

Transportation

Sector Performance Measures

Economic Projections and Analytical Systems

Pricing, Policy and Program Analysis

Consumer Economics and Demand Analysis

Distribution Analysis

Foreign Demand and Competition Division

The Foreign Demand and Competition Division focuses on worldwide supply and demand conditions; the impact of U.S. and foreign policies on world farm trade; and publishes information that traders, government officials, and trade negotiators need to tap world markets.

Program areas are:

Developed Countries and Agricultural Trade Policy

Weather and Climate

Latin America

Africa and Middle East

Asia

Eastern Europe

Soviet Union

Communist Asia

Commodities

Statistics

International Money and Finance

Economic Development and Trade

APPENDIX XI

RESOURCE AND DEVELOPMENT ECONOMICS

Natural Resource Economics Division

The Natural Resource Economics Division centers its research on the use, conservation, development, and control of natural resources and their contribution to local, regional, and national economic growth. Analysis of environmental issues is an important element of this Division's responsibility.

Program areas are:

- Agricultural Resources and Environment
- Rural Resources and Environment
- Resource Inventory and Use
- Resource Organization and Control
- Resource Projections and Analytical Systems
- Resource Program Studies (funded by Soil Conservation Service)

Economic Development Division

The Economic Development Division maintains current information on the principal social and economic factors affecting life in non-metropolitan areas and identifies and evaluates alternative public and private actions which impact on these areas.

Program areas are:

- Housing
- Industrial Location
- Health and Education
- Regional Analysis
- State and Local Government
- Income
- Manpower
- Population
- Rural Development Indicators

APPENDIX XI

Foreign Development Division

The Foreign Development Division provides direct assistance and coordinates the USDA's overall program to aid agricultural development in lower income countries. The Agency for International Development provides most of the funds for the operation of this Division.

Major programs are:

International Training

Technical Assistance

APPENDIX XII

INFORMATION REQUIRED FOR ECONOMIC RESEARCH SERVICE'S MANAGEMENT INFORMATION SYSTEM

ERS-MIS 1

Economic Research Service PROGRAM AREA STATEMENT	Division:
Identification No.:	Title:

1. Overview of the Program Area:

   A brief statement of the problems encompassed by the program area. Central concerns and limits of those concerns are to be emphasized.

2. Objectives of Program:

   A list of specific objectives of the program of ERS work over a period of time--3 to 5 years. Include a discussion of data that will be developed, as well as how the objectives will relate to ERS staff responsibilities and other work of ERS, universities and other cooperators.

3. Reason for Achieving the Objectives:

   A brief statement of why the objectives listed should be accomplished and who would benefit. Be as specific as possible. The time horizon should be consistent with the time horizon of the objectives; i.e., 3 to 5 years.

Recommended: _____ _____
Division Director Date

Concurred: _____ _____
Deputy Administrator Date

Approved: _____ _____
Administrator Date

ERS-MIS 1
Program Area ID No. _____
Page ____ of ____

APPENDIX XII

ERS-MIS 2

Economic Research Service DETAILED PROJECT STATEMENT (NARRATIVE)	Division:
Project Identification No.:	Project Title:
Title and ID No. of Program Area:	Title & ID No. of ERS Departmental Program:

1. Objectives:

   Identify specific objectives to be accomplished in output oriented terms.

2. Justification:

   Identify who will be benefited and how they will be benefited by accomplishment of the objectives.

3. Approach:

   Identify general analytic approaches and specific analytical techniques to be used; and sources of data. Specify the target date for accomplishment of each major element or phase of the project.

4. Dissemination of Results:

   Provide a detailed plan outlining the techniques to be used in disseminating results to the intended clientele groups, including planned or anticipated staff work. Include title or subject matter description and expected issuance date of staff reports and publications.

5. Project Leader:

6. Completion Date:

   If continuous, so state.

APPENDIX XII

ERS-MIS 2
Project ID No. _____
Page 2 of 2

7.

Financial Resources ($000)	FY (Current)	FY (Next)	Total est. cost over life of project or for next 5 years
Salaries and benefits			
Data acquisition (including surveys)			
Research agreements to support staff located outside Wash., D.C.			
Other contracts/agreements			
All other costs			
Total			

8.

Personnel Resources	FY (Current)	FY (Next)
Name, grade and Division (Title and grade for vacant positions) of prof. personnel		
Subtotal, Professional		
Total, all other manyears		
Total, all manyears		

Recommended: _____ (Title) _____ Date

Concurred: _____ Division Director _____ Date

Approved: _____ Deputy Administrator _____ Date

ERS-MIS 2
Project ID No. _____
Page ____ of ____

APPENDIX XII

ERS-MIS 3

Economic Research Service ANNUAL PLAN OF WORK	Fiscal year: Progress-1975 Plans-1976	Division:
Project Identification No.:	Project Title:	
Title and ID No. of Program Area:	Title and ID No. of ERS Department Program	

1. Progress:

   Progress to date relative to overall project objectives with specific reference to plans (accountability factors) for fiscal year 1975. Be brief and specific; but provide sufficient detail to permit development of the CRIS progress reports from the MIS-3. List (1) manuscripts in draft form and working papers, (2) reports published during FY 1975, and (3) speeches. All such documents should be cited in the same format used for reporting in CRIS and the publication ERS-368.

2. Recommended modifications of overall project objectives:

3. Planned accomplishments in FY 1976:

   Identify, in priority order, planned accomplishments toward project objectives during fiscal year 1976 and target completion dates for each. Identify and provide target completion dates for subparts of major accomplishments and title or subject matter of anticipated reports and publications.

4.

Personnel Resources	Manyears	
	FY 1975	FY 1976
Name, grade and division (Title and grade for vacant positions) of professional personnel		
Subtotal, professional		
All other manyears		
Total, all manyears		

APPENDIX XII

ERS-MIS 3
Project ID No. _____
Plan for FY 76
Page 2 of 3

5.

Financial Resources		FY 1975	FY 1976
Salaries and benefits			
Data acquisition (including surveys)			
Research agreements to support staff located outside Washington, D.C.			
Other contracts and agreements			
All other costs			
Total			
Estimate of total by source of funds:	Appropriated		
	Other (identify source)		

5a. Data acquisition:

Identify source, cost, and principal data elements

(a) FY 1975:

(b) FY 1976: (in priority order)

5b. Research agreements to support staff located outside Washington, D.C.:

Identify institution and individual(s) supported by the agreement and cost of each agreement.

(a) FY 1975:

(b) FY 1976: (in priority order)

5c. Other contracts and agreements:

Identify institution and briefly describe the content of each; give cost of each contract and agreement.

(a) FY 1975:

(b) FY 1976: (in priority order)

APPENDIX XII

ERS-MIS 3
Project ID No. _____
Plan for FY 76
Page 3 of 3

6. General comments:

Provide any other information that would be useful in assessing progress and plans for FY 1976 for this project.

Recommended: _____ (Title) _____ Date

Concurred: _____ Division Director _____ Date

Approved: _____ Deputy Administrator _____ Date

ERS-MIS 3
Project ID No. _____
Plan for FY 76
Page ____ of ____

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