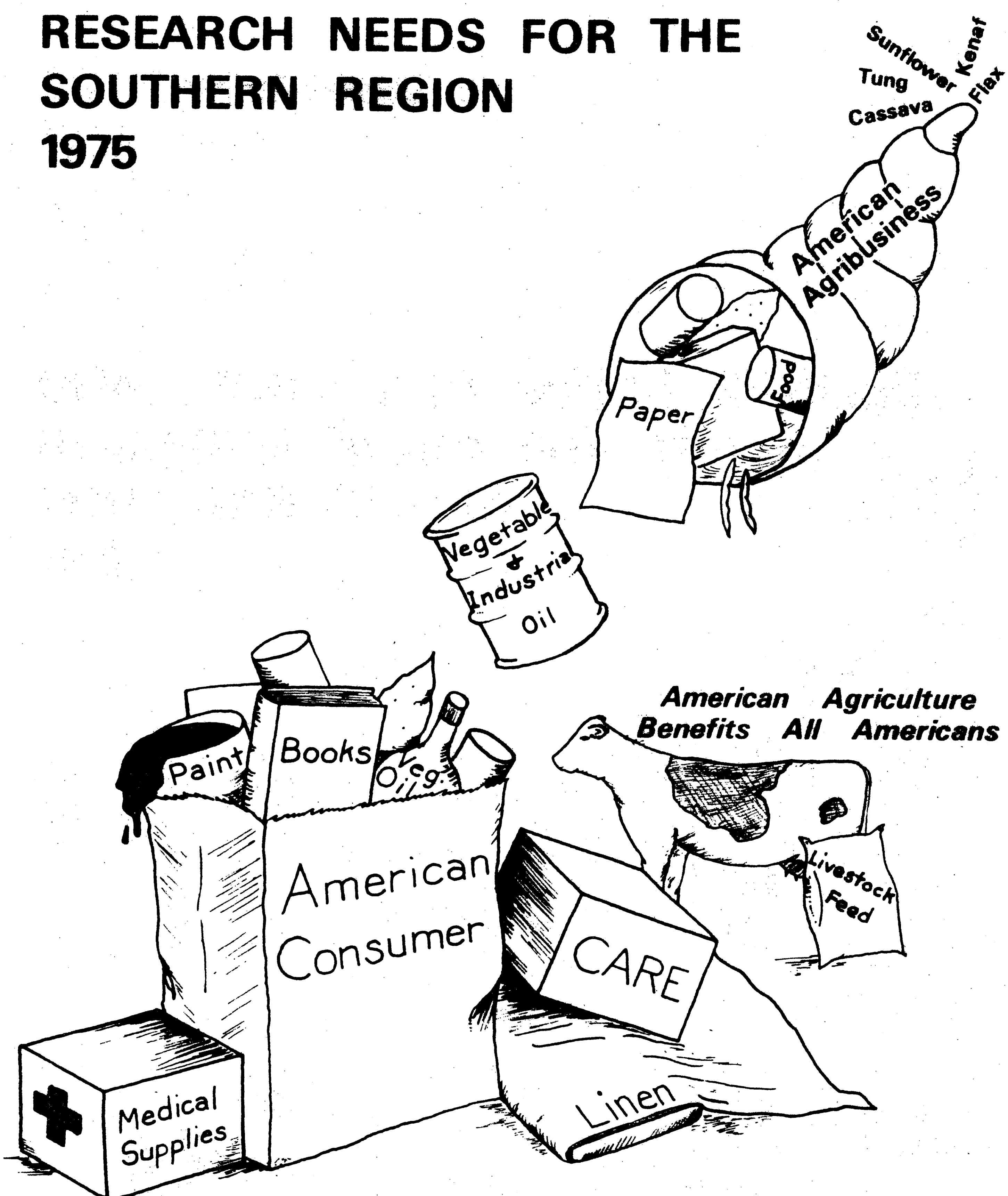
NEW CROPS AND MINOR OILSEEDS RESEARCH NEEDS FOR THE SOUTHERN REGION 1975



Prepared by
Joint Task Force of the Southern Region
Agricultural Experiment Stations
United States Department of Agriculture
and Industrial Scientists

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PREFACE

This report was prepared by a joint task force appointed by the Directors of Agricultural Experiment Stations and Administrator's Representatives of the Agricultural Research Service, USDA, of the Southern Region. Members of the task force were selected for expertise in new crops and minor oilseeds research and the group included representatives from several disciplines. The purpose of the Southern Regional New Crops and Minor Oilseeds Task Force is to evaluate present research efforts and suggest changes in research programs to meet present and future needs.

The organizational meeting of the Southern Regional Task Force on New Crops and Minor Oilseeds was held at Atlanta, Georgia on May 30 and 31, 1974. Ten members attended the first meeting and additional scientists were proposed for membership. Dr. C. D. Ranney, Representative for the Deputy Administrator of the Southern Region, ARS-USDA, and Mr. T. E. Corley, Representative for the Southern Agricultural Experiment Station Directors, presented to the group the Task Force Guidelines. These guidelines were most useful in the preparation of this report. A membership and consultants list and officers elected at the May 30-31, 1974 meeting follows.

Southern Region New Crops and Minor Oilseeds Task Force

Administrative Advisors

C. D. Ranney
ARS Deputy Administrator's Representative
Area Director, Ala.-N. Miss. Area
Southern Region, ARS-USDA
P.O. Box 1486
Starkville, Mississippi 39759

T. E. Corley
SAES Director's Representative
Assistant Director for Outlying Units
Alabama Agric. Experiment Station
Auburn, Alabama 36830

Task Force Members

R. G. Creech
Chairman, New Crops & Minor Oilseeds Task Force
Professor & Head, Agronomy Dept.
Mississippi State University
P.O. Box 5248
Mississippi State, Mississippi 39762

W. R. Langford
Secretary, New Crops & Minor Oilseeds Task Force
Regional Plant Introduction Station
Southern Region, ARS-USDA
Experiment, Georgia 30212

W. C. Adamson
U. S. Plant Introduction Station
Southern Region, ARS-USDA
Route 4, Box 433
Savannah, Georgia 31405

Carl Cater
Department of Soil & Crop Science
Texas A&M University
College Station, Texas 77843

T. F. Clark
Northern Regional Research Lab.
North Central Region, ARS-USDA
Peoria, Illinois 61604

M. H. Gaskins
Plant Science Unit
Southern Region, ARS-USDA
University of Florida
304 Newell Hall
Gainesville, Florida 32604

C. I. Harris
Cooperative State Res. Service, USDA
Administration Bldg., West Wing
Washington, D. C. 20250

P. H. Harvey
Department of Crop Science
North Carolina State University
P.O. Box 5847
Raleigh, North Carolina 27607

W. O. Hawley
U. S. Plant Introduction Station
Southern Region, ARS-USDA
Route 4, Box 433
Savannah, Georgia 31405

G. B. Killinger
Department of Agronomy
University of Florida
Gainesville, Florida 32601

J. S. Kirby
Department of Agronomy
Oklahoma State University
Stillwater, Oklahoma 74074

F. W. Martin
Federal Experiment Station
Southern Region, ARS-USDA
P.O. Box 70
Mayaguez, Puerto Rico 00708

J. A. Robertson
Richard B. Russell Agr. Res. Center
Southern Region, ARS-USDA
P.O. Box 5677
Athens, Georgia 30604

C. E. Rogers
Texas A&M Res. & Ext. Center
Southern Region, ARS-USDA
P.O. Box 1658
Vernon, Texas 76384

R. E. Stafford
Texas A&M Res. & Ext. Center
Southern Region, ARS-USDA
P.O. Box 1658
Vernon, Texas 76384

W. H. Tallent
Northern Regional Research Lab.
North Central Region, ARS-USDA
Peoria, Illinois 61604

Jesus Valez-Fortuno
Division Dept. Plant Breeding
University of Puerto Rico
Rio Piedras, Puerto Rico 00928

G. A. White
Germplasm Res. Lab.
P.G.G.I. Institute
Northeastern Region, ARS-USDA
Beltsville Research Center
Beltsville, Maryland 20705

E. L. Whiteley
Department of Soil & Crop Science
Texas A&M University
College Station, Texas 77843

F. D. Wilson
Western Cotton Res. Lab.
Western Region, ARS-USDA
4235 E. Broadway Road
Phoenix, Arizona 85040

Task Force Consultants

W. T. Fike
Department of Crop Science
North Carolina State University
P.O. Box 5847
Raleigh, North Carolina 27607

B. E. Caldwell
Staff Scientist, Nat'l. Program Staff
Plant & Entomological Science, ARS-USDA
Agricultural Research Center West
Beltsville, Maryland 20705

O. C. Cannedy
Stein-Hall & Co., Inc.
Route 5 - 201 Harrison Street
Vernon, Texas 76384

D. E. Gandy
National Cottonseed Products Assoc.
P.O. Box 12023
Memphis, Tennessee 38112

H. L. Hyland
P.G.G.I. Institute
Northeastern Region, ARS-USDA
Beltsville Research Center
Beltsville, Maryland 20705

Theodore Hymowitz
University of Illinois
Urbana-Champaign, Illinois 61801

Quentin Jones
Staff Scientist, National Program Staff
Plant & Entomological Sciences, ARS-USDA
Agricultural Research Center, West
Beltsville, Maryland 20705

T. J. Mann
Department of Genetics
North Carolina State University
P.O. Box 5487
Raleigh, North Carolina 27607

R. G. Orellana
Applied Plant Path. Lab.
Northeastern Region, ARS-USDA
Beltsville Research Center
Beltsville, Maryland 20705

H. H. Partridge
General Mills, Inc.
Vernon, Texas 76384

W. C. Young (Retired)
SRTSC-EWP-USDA
Soil Conservation Service
P.O. Box 11222
Fort Worth, Texas 76110

Writing Committee

W. C. Adamson
D. E. Gandy
W. R. Langford
R. E. Stafford
E. L. Whiteley
R. G. Creech, Chairman

INTRODUCTION

Man throughout thousands of years has screened the vegetation around him for useful products. From the estimated 250,000 species of higher plants in the world, use has been made of an exceedingly small fraction. In the United States relatively few species are cultivated. Producers in the United States cultivate about 150 species for food, fiber and industrial purposes. Between 80 and 90 species produce crops each valued at a million dollars or more. At once this fact introduces caution in expecting spectacular finds in new crops. However, it is likely that modern man with all his varying needs and his new knowledge and technology in biology, chemistry, physics, engineering, and economics could find more plants to develop into crops of significance in his life and activities.

The term "New Crops" has magic appeal to the uninitiated as an immediate solution to the needs for alternative sources of income and sources of new industrial products for an expanding economy. A new crop is neither a magic development nor a magic solution. It generally represents years of search, study, evaluation, adaptation and culture, deliberate development, and planned promotion.

A viable and productive agriculture and industry based on plant products is wholly dependent on plant variability. The development of new crops as well as the expansion of existing crops relies on an increasing base of germplasm for the development of superior varieties and hybrids.

Changes in government action on farm programs, environmental problems, and the general economic situation have great influence on the development of new crops and minor oilseeds. This Task Force is charged with the approach, identification of discipline input requirements, and estimation of scientific man years required to carry out the needed research on new crops. The strategy to produce useful research results is generally successful when the interdisciplinary approach is used.

Agriculture has long depended upon the introduction of new crops and new germplasm coupled with the breeding of superior varieties for yield, quality, new products and uses. Minor oilseed crops, as presently known, may well become major crops in the future as new germplasm and plant breeders' efforts combine with new technology to open new vistas in agriculture. New crops and minor oilseed crops may well advance agriculture through insect and disease resistance, increased yields, climatic and soil adaptation and economic acceptance.

Many of the new crops are particularly suited for specific situations, while some are adapted to general agriculture. Likewise, oilseed crops considered minor today, because of limited production, can develop into major segments of a total agricultural program.

The world demand for protein and vegetable oils has outgrown the supply during the past decade. Indications are that there will continue to be a shortage or demand for increased production of high protein and high oil producing crops. Past history shows much of the protein produced from plants in the United States has been marketed as livestock products. The efficiency of converting plant proteins into animal products is quite low and in the future it is likely that more and more plant products will be cycled directly into the human food chain. Such minor crops presently grown in the United States as sunflower, sesame, safflower, edible Dioscorea spp., water chestnuts and pulses can be grown on more acres as demand and economics improve. Such crops would have an immediate impact on the human food chain. Vegetable oils are in short supply and these supplies would increase as production of these lesser grown crops increase. There has been an increasing demand for special oils which are extracted from castor, sesame, crambe, rape, flax and tung and these crops need more exploitation.

Paper is in short supply world-wide and with our ever increasing population it behooves us to find new higher yielding pulpable crops than trees, reeds, etc. In this category we find kenaf with a yield potential of five to seven times that of pine trees. Bamboo is also a crop whose potential as a pulp crop has not been thoroughly exploited. Other high cellulose or pulpable crops not presently used in the paper industry may very well exist and need only be found. With increasing demand for food and fiber, the use of annual or short-rotation crops for the production of pulp provides flexibility for meeting these needs.

Guar is the principle single source of gums for the United States. Gums are used as stabilizing agents in numerous food and industrial products, including paper. The current domestic production provides only about one-third of the demand. The demand is constantly increasing due to new uses and expansion of established uses. Guar is an established crop in the semi-arid regions of Oklahoma and Texas. With increased research leading to increased production our domestic needs could be met.

New crops research historically has been a function of those in Plant Introduction. Research on minor oilseed crops has been tied to plant introduction and maintenance of germplasm in the past because some of the minor oilseed crops were only wild species at the beginning of their evaluation. The Task Force on New Crops and Minor Oilseed recognizes the need for other commodity task forces to consider the introduction of plant germplasm as a vital part of their studies and recommendations. The Task Force included the following crops in this study of research needs and recommendations:

1. Sunflower
2. Kenaf and related spp.
3. Pulses
4. Guar
5. Crambe
6. Tropical crops (cassava, plantain, yams)
7. Sesame
8. Brassica spp.
9. Flax
10. Safflower
11. Castor
12. Chinese waterchestnuts
13. Bamboo
14. Tung

The Task Force reviewed the crops that should be considered under the broad grouping of "New Crops and Minor Oilseeds" and developed four categories:

1. Oilseeds and Protein Crops
2. Carbohydrate Crops
3. Gum Crops
4. Germplasm, Plant Introduction and Maintenance

The Task Force established committees to determine the present status, research needs and make recommendations for obtaining the goals established for crops within each of the above categories.

As a guideline to nature and level of current research activity, a printout of all active projects in the USDA Current Research Information System on July 13, 1973, was distributed to the Task Force members. The level of activity in scientific man-years (SMY) assigned to the various Research Problem Areas (RPA) in this printout of 1972 activity was as follows:

Summary of New Crops Research Activity in the Southern Region by Research Problem Areas Documented in the Current Research Information System on July 13, 1973

Research Problem Area		1972 Research	
Number	Title	Dollars 1/	SMY 2/
205	Control of diseases and nematodes of fruit and vegetable crops	37,261	0.5
207	Control of insects, mites, snails, and slugs affecting field crops and range	26,661	0.5
208	Control of diseases and nematodes of field crops and range	239,792	2.2
209	Control of weeds and hazards of field crops and range	52,583	1.0
214	Protection of plants, animals, and man from harmful effects of pollution	24,395	0.6
304	Improvement of biological efficiency of fruit and vegetable crops	101,033	0.7
307	Improvement of biological efficiency of field crops	579,829	9.3
308	Mechanization of production of field crops	8,076	0.2
309	Production management systems for field crops	4,867	0.2
403	New and improved fruit and vegetable products and by-products	38,003	0.9

Continued -

Research Problem Area		1972 Research	
Number	Title	Dollars 1/	SMY 2/
404	Quality maintenance in storing and marketing fruits and vegetables	64,021	1.5
405	Production of field crops with improved acceptability	10,000	0.2
406	New and improved food products from field crops	1,003	0.0
407	New and improved feed, textile, and industrial products from field crops	23,964	0.1
501	Improvement of grades and standards--crop and animal products	40,802	0.5
503	Efficiency and marketing of agricultural products and production inputs	52,674	0.3
701	Insure food products free of toxic residues from agricultural sources	4,646	0.3
702	Protect food and feed supplies from harmful microorganisms and naturally occurring toxins	799	0.1
709	Reduction of hazards to health and safety	685,192	7.7
901	Alleviation of soil, water, and air pollution and disposal of wastes	38,679	0.9
Total		2,034,280	27.7

1/ Total of State and Federal funds.

2/ Scientific man-year (SMY) indicates scientists at or above the GS-11 level in Federal service, Assistant Professor in State service or equivalent rank.

Summary of Oilseed Crops Research Activity in the Southern Region by Research Problem Areas documented in the Current Research Information System on July 13, 1973

Research Problem Area		1972 Research	
Number	Title	Dollars 1/	SMY 2/
207	Control of insects, mites, snails, and slugs affecting field crops and range	37,171	1.2
208	Control of diseases and nematodes of field crops and range	76,585	1.2
209	Control of weeds and other hazards of field crops and range	4,753	0.1
307	Improvement of biological efficiency of field crops	210,180	2.9
308	Mechanization of production of field crops	1,890	0.0
405	Production of field crops with improved acceptability	28,789	0.4
406	New and improved food crops from field crops	167,199	3.1
407	New and improved feed, textile, and industrial products from field crops	165,638	3.6
506	Supply, demand, and price analysis-crop and animal products	7,471	0.0
508	Development of domestic markets for farm products	14,980	0.4
704	Home and commercial food service	7,653	0.1
708	Human nutrition	4,780	0.0
Total		727,088	13.0

1/ Total of State and Federal funds.

2/ Scientific man-year (SMY) indicates scientists at or above the GS-11 level in Federal service, Assistant Professor in State service or equivalent rank.

In reviewing the printout of 1972 research activity from the Current Research Information System (CRIS), it was apparent that actual work reported often did not match the RPA where the activity was documented in CRIS. Consequently, the four committees of this Task Force have attempted to update the SMY input into RPA's of the different crops. These data are presented in subsequent section of this report.

The requirement to organize this report in RPA's restricted documentation of the multidiscipline teamwork currently used in New Crops and Minor Oilseeds research activities. The Task Force recognizes the value of the multidiscipline team and systems approach in research activity and encourages its further development. The Task Force feels that the recent reorganization of the Agricultural Research Service enhances interface with State Agricultural Experiment Stations. It should now be possible for multiagency, multidiscipline teamwork to become a more efficient force in New Crops and Minor Oilseeds research as well as research on other commodities.

RESEARCH PRIORITIES AND RECOMMENDATIONS

Following an in-depth review of the current status of research, critical research needs, and economic opportunities for crops and crop groups the Task Force addressed itself to assigning priorities to crops and to problem areas within each crop. Factors considered in arriving at priority ratings of the crops were: (1) the current and projected regional, national, and world needs for agricultural raw materials; (2) the economic potential of these crops in the Southern Region; and (3) the time frame in which successful development is apt to be achieved.

Assignment of priority emphasis on researchable problems for each crop was based on a complexity of factors involving the level of development of the crop, degree to which problem areas are limiting further advances in crop development and commercialization, and realistic expectations of availability of research resources.

As shown in the table below, the Task Force translated these priority ratings into recommendations of SMY's of effort by crop. Details of research priorities by RPA are presented in the situation reports of the four committees, the substance of which is included in subsequent sections.

The Task Force singled out for special priority attention the maintenance and, where indicated, preliminary evaluation of germplasm of all these crops and other new crops not here considered. The Task Force also urged that a continuing effort be maintained in the introduction and evaluation of entirely new crops to meet the needs of crop diversification because of potential disease and pest problems and changing market demands.

Following is a summary of crop priorities, current research and recommended changes in SMY's assigned to each crop:

Category	Priority	SMY Current	SMY No Increase	SMY 10% Increase	SMY Recommended
Germplasm resources	1	-	-	1.0	1.0
Sunflowers	1	4.2 1/	4.2	4.2	9.0*
Kenaf (& roselle)	2	1.7	1.7	1.7	4.2*
Pulses	3	1.2	1.2	1.2	4.4
Guar	3	1.6	1.6	1.6	4.2
Crambe	4	4.0 2/	4.0 2/	4.0 2/	5.0

Continued -

Category	Priority	SMY Current	SMY No Increase	SMY 10% Increase	SMY Recommended
Tropical crops (cassava, plantains, yams)	5	3.5	3.5	3.5	5.2
Sesame	6	-	-	-	1.0
Brassica spp.*	7	-	-	-	0.5 3/
Flax	8	0.2	0.2	0.2	0.8 4/
Safflower*	9	-	-	-	0.5
Castor	10	0.1	0.1	0.1	0.1 5/
Chinese waterchestnuts	11	0.5	0.5	0.5	0.5
Bamboo	11	0.1	0.1	0.1	0.1 5/
Tung	12	-	-	-	-
Totals		13.2	13.2	14.2	32.3

* There are additional SMY's working on these in other regions.

1/ All utilization research, serving all 4 Regions, Athens, Ga.

2/ 4.0 SMY's in North Central Region; 1.0 SMY recommended for Southern Region.

3/ RPA 307, one scientist, one location, all utilization research in Peoria, Illinois.

4/ All in Texas.

5/ Germplasm maintenance.

Successful development of minor oilseeds and new crops requires ample germplasm and provision for its preservation. Evaluation data obtained at the time of initial increase will enhance the value of the germplasm to the breeders and other crop scientists. The germplasm focal point within the Southern Region is the Plant Introduction Station at Experiment, Georgia. As highest priority, the Task Force recommends that a new SMY be assigned to the Station for the evaluation, distribution, and preservation of germplasm for minor oilseeds and new crops in the South.

Recommended priorities within crops in reference to RPA's are as follows:

Sunflowers

RPA	Priority
Pest management, biological efficiency, crop management and harvesting (RPA's 207, 208, 209, 307, 308, 309, and 405)	1

Continued -

RPA	Priority
Utilization (RPA's 406, 407, 408, 501)	2
Environmental contaminants and nutrient composition (RPA's 701, 702 and 708)	3

Kenaf and Roselle

RPA	Priority
Biological efficiency, seed quality, crop management, harvesting and storage (RPA's 307, 308, 309, and 408)	1
Pest resistance and management (RPA's 207 and 208)	2

Guar

RPA	Priority
Biological efficiency, pest management, breeding and genetics, and crop management (RPA's 207, 208, 209, 307, 309, and 405)	1
Utilization and nutrient composition (RPA's 406, and 407)	2
Marketing (RPA 501)	3

Pulses

RPA	Priority
Biological efficiency, pest management, and crop management, (RPA's 207, 208, 209, 307 and 309)	1
Mechanization (RPA 308)	2

Crambe

RPA	Priority
Pest management, crop management, biological efficiency, breeding, and utilization (RPA's 207, 208, 209, 307, 406, and 407)	1

Tropical Crops (cassava, plantains, yams)

RPA	Priority
Crop management, biological efficiency (RPA's 304, 307, and 309)	1
Storage and processing, pest management (RPA's 204, 205, 206, 403, 404)	2

All other crops considered by this Task Force involves a small increase, if any, in SMY's and the details can be obtained in the subsequent sections derived from the committee reports.

GERMPLASM RELATED NEEDS OF NEW CROPS AND MINOR OILSEEDS

Germplasm Resources Committee: W. T. Fike, M. H. Gaskins, P. H. Harvey, H. L. Hyland, G. B. Killinger, J. S. Kirby, W. R. Langford, Chairman, T. J. Mann, R. E. Stafford, J. Valez-Fortuno, and G. A. White.

In keeping with the recommendations of an ad hoc subcommittee report of the Agricultural Research Policy and Advisory Committee for the USDA entitled "Recommended Actions and Policies for Minimizing the Genetic Vulnerability of Our Major Crops", this Task Force recommends that, insofar as practical, the same actions and policies be applied to new crops and minor oilseeds. <u>Almost all</u> of this country's food, feed and fiber crops are introduced species, and therefore are, historically, "new crops". Natural and directed selection in this country identified the productive genotypes, now our best varieties, from many thousands of introductions gathered from throughout the world. Had these not been available our "then new-now major" crop varieties could not exist today.

It follows then that valid assessment of a new crop requires evaluating the broadest possible spectrum of species variability. Limited or inadequate sampling of new crops leads to erroneous conclusions about their usefulness. For example, early sampling and evaluation of soybeans resulted in the conclusion that they were not adapted to the South.

Specifically there is a need for resources and personnel for (1) collection and assembly, (2) maintenance, and (3) evaluation and use of genetic resources of new crops and minor oil seeds. The relative emphasis that should be directed to each of these areas of activity will vary from crop to crop depending on their status in development and use.

In keeping with priorities established by the Task Force the germplasm related needs for specific crops are considered below.

Sunflowers have been grown on a small scale in the South. They are marketed for bird feed, food, and oil. Extraction of seed oil leaves a high quality protein meal that can be used in livestock rations. Susceptibility to insects and diseases is a major deterrent to rapid expansion of this crop. Progress has been made toward developing disease-resistant hybrids with high-oil content. Germplasm with resistance to rust, Verticillium wilt, and downy mildew is available; but resistance to insects and other diseases is needed to reduce production costs. Currently, the sunflower germplasm collection consists of about 650 accessions including over 200 native materials. Working stocks are maintained at the Regional Plant Introduction Station, Ames, Iowa. Because of the high priority assigned sunflowers by this Task Force and its increasing importance as a U.S. crop, a well-planned domestic collection and subsequent evaluation of native species is recommended.

Several foreign cultivars with high oil content have been introduced, widely tested, and grown commercially. In 1974, these cultivars comprised 80 percent of the total U.S. acreage for oil production. This percentage will decline with the advent of U.S. hybrids but nevertheless indicates the importance of continued introduction of new foreign cultivars and breeding lines.

Kenaf, *Hibiscus cannabinus* L., has shown considerable promise in the South as a new source of paper pulp. Stem yields up to 20 tons per acre on a dry weight basis have been reported, and yields of 7 to 10 tons per acre appear feasible in several areas. Results from utilization studies indicate that kenaf should prove to be a versatile raw material for various pulping applications including total finishes and blends with wood pulp. The major production problem is susceptibility to rootknot nematodes. Collections of kenaf, roselle, and related species are maintained in Maryland, Colorado, and Georgia. Most introductions (about 500) have been screened for nematode resistance. Segregants with resistance have appeared in progeny of only one kenaf accession, PI 292207 from Kenya.

The germplasm base of kenaf needs to be greatly broadened. To meet this need, an exploration in east Africa in the spring of 1975 is being planned. The first priority for new germplasm would be greenhouse screening for nematode resistance. New germplasm should also be assessed for fiber length (woody core and bast), cellulose content, and other desirable characteristics with emphasis on those materials that possess nematode resistance. Vigorous seedling development and higher yields are the major selection criteria for roselle. As resources permit other *Hibiscus* species should be evaluated for nematode resistance, growth habit, yield, and seeding potential.

Guar is a drought-tolerant, annual summer legume introduced into the United States in 1903. It is an established crop in Oklahoma and Texas, but low yields have been a deterrent to wider farm acceptance. A great potential exists to improve cultivated guar. Information is generally lacking concerning the extent of hybridization and level of heterosis in the different species. Attempts to transfer desirable characteristics from the wild species to the cultigen, *C. tetragonoloba* have not been reported in the literature.

There are three wild species of guar, *Cyamopsis senegalensis*, *C. serrata*, and *C. dentata*, which have not been studied extensively. Information on variability of gum content, gum quality, disease reaction, insect tolerance, and yield potential in all the wild species is generally lacking. Genetic and cytogenetic information in the cultivated species, *C. tetragonoloba*, is scant.

Collections of the wild species and additional collections of *C. tetragonoloba* will be helpful in establishing (a) cytogenetic relationships of different species and the extent of hybridization (b) level of variability for yield components and for quality characteristics and (c) feasibility of incorporation of desirable characters through interspecific hybridization. Such basic information will be essential for developing improved guar varieties.

Crambe germplasm consists of 133 introductions and includes four species in the section *Leptocrambe*. Only *C. abyssinica* (35 accessions) has been field tested. The three available cultivars 'Prophet', 'Indy', and 'Meyer' should be tested for adapability and yield in potential production areas of the South. Collections of *C. filiformis*, *C. hispanica*, and *C. kralikii* from the wild are undergoing initial increase and evaluation. They offer interesting potential for Crambe improvement because of different ploidy levels and possible winterhardiness. The available collection should be screened as soon as possible for disease resistance (especially *Alternaria*), winterhardiness, adaptability, desired agronomic traits, and oil content and composition. The most urgent is to procure wild accessions of *C. abyssinica* to broaden the genetic base. Adding germplasm of *C. kralikii*, especially from Algeria, should receive some emphasis as crosses of the n=45 types with *C. abyssinica* could lead to better adapted cultivars.

Interest in grain legumes or pulse crops has increased sharply because of the world need for protein. Several accessions are presently available in the regional plant germplasm collection for many of the pulse crops, yet there is little doubt that the pulse crop germplasm of the world has scarcely been sampled. The germplasm of many pulse crops is so limited in this country that they have not yet received a valid or adequate assessment. Although nearly 3000 introductions of mungbeans have been evaluated in the South, the Oklahoma Agricultural Experiment Station reported the receipt of a few accessions in 1974 that performed extremely well in initial trials. This points out the necessity of evaluating the full spectrum of genetic variability within the species. Because of the energy shortage and the associated costs of fertilizer materials, there is renewed interest in using legume materials for cover and green manure crops. A concerted effort should be made to collect legume that might serve this purpose.

Hundreds of brassicas have been introduced and analyzed chemically for oil content, oil composition, and glucosinolate content of the meal. Some contain as much erucic acid as Crambe. Most, especially summer types, are poor agronomically. Insect and disease pests are serious problems. There are winter types that contain very low levels of glucosinolates but they are also low in erucic acid. Oregon State University has a small breeding program on brassicas. An evaluation and breeding program in the South, that utilizes germplasm containing desired traits, is needed for cultivar development.

For those minor oilseed and new crops of lower research priority in the South, preservation of available germplasm and documentation of pertinent evaluation data are of prime concern. This involves vegetative maintenance of Chinese waterchestnuts, bamboo (the most complete collection of temperate species in the world) and tung. Special emphasis on preserving the late-flowering selections of tung is suggested. Castor germplasm is being transferred to the National Seed Storage Laboratory for long-term preservation. Germplasm of flax and safflower are maintained in the North Central and Western Regions, respectively.

Cassava (Manihot ultilissima), plantains (Musa spp.) and yams (Dioscorea spp.) are grown commercially in Puerto Rico and to a lesser extent in Hawaii, but not on the U.S. mainland. They are vital food crops in many countries of the tropics. Germplasm resources available from cooperating institutions in the tropics are adequate for the research and development effort given these crops in the U.S. The task force notes that, in view of the deepening world food crisis, the irretrievable loss of genetic material that accompanies population growth in primitive areas are matters of serious concern for governments and other agencies interested in development of food resources in the tropics. Cassava and plantains are among the most efficient of crops in their ability to fix solar energy. Adequate precautions should be maintained to preserve the broadest possible germplasm base in these crops for future use in their areas of adaptation, which coincide generally with areas of greatest future population pressure.

The germplasm Committee of the Task Force also recommends that ARS continue to introduce new plants for screening to identify those with potential economic value in industrial applications, foods and feeds, medicinal purposes, and other biological activity. Those with the best use potential and adaptability to the South should undergo more intensive field evaluation.

Successful development of minor oilseeds and new crops requires ample germplasm and provision for its preservation. Evaluation data obtained at the time of initial increase will enhance the value of the germplasm to the breeders and other crop scientists. The germplasm focal point within the Southern Region is the Plant Introduction Station at Experiment, Georgia. As highest priority, we recommend that a new SMY be assigned to the Station for the evaluation, distribution, and preservation of germplasm for minor oilseeds and new crops in the South.

A summary of current and recommended scientific research activity for evaluation and maintenance of germplasm of new crops and minor oilseeds in the Southern Region is presented in the following table:

Summary of Current and Recommended Scientific Research Activity for Evaluation and Maintenance of Germplasm of New Crops and Minor Oilseed in the Southern Region

Research Activity	SMY Number			
	Current	No Increase	10% Increase	Recommended
Evaluation and Maintenance of Germplasm	0.0	0.0	1.0	1.0
Total	0.0	0.0	1.0	1.0

OILSEEDS AND PROTEIN CROPS

Oilseeds and Protein Committee: C. Cater, F. R. Earle, D. E. Gandy, H. L. Hyland, J. S. Kirby, R. S. Matlock, J. A. Robertson, Vice-Chairman, R. E. Stafford, G. A. White, and E. L. Whiteley, Chairman.

Current Situation

A productive agriculture and industry based on plant products is dependent upon a steady supply of products. All the factors that influence crop production determine the supplies of oilseeds that are available for processing. The end-use products are determined by the market requirements. Many of the minor oilseeds can be developed for specialized market requirements that are not met by the major oilseeds. Much of the oil from the minor oilseeds is now marketed for special uses. The protein in the meal needs to be developed to meet the market demands for food or feed. Current demands for high protein meals should enhance the development of the minor oilseed meals.

Production of minor oilseeds is limited by crop production practices. Many minor oilseeds are grown on marginal land under marginal management practices. The minor oilseeds have many problems in common with the major crops, however many problems in production and processing are different and require the development of new techniques for successful production and processing of these crops. Increased research activities are necessary to provide farmers and processors with practical methods and procedures for solutions to the many problems of this nature.

Effective management of insect pests is one of the most important factors in efficient crop production. Reductions in yield of 10 to 20% often mean the difference between profit and loss. Many factors influence insect losses. The ultimate goal should be to develop a pest management system for the different crops that will give the minimum level of control consistent with the most economical yield and reduce environmental contamination. The specific situations are discussed under each crop.

Diseases reduce crop yields and may also reduce crop quality. Many diseases have insect vectors and disease control may be closely related to insect control. Changes in varieties, cultural practices, weather patterns, and insect control methods may result in changing disease patterns. Effective and efficient disease control methods are essential to efficient crop production.

Very little research has been conducted on weed control in new crops and minor oilseeds. The development of integrated systems of weed control is essential to the development of the minor oilseed crops. The physiological, biological, and genetic responses of minor oilseed crops to weed control measures need to be evaluated. Minimal impact on the environment is essential in the system developed.

Improving the biological efficiency of minor oilseeds has received little research support. Many factors are involved in the program. Breeding for increased yields, insect and disease resistance, improved quality, and other characters is a slow process. Cultural practices also influence biological efficiency and must be included in the program.

Many new crops and minor oilseeds are difficult to harvest with existing machinery. Engineering research should be conducted to solve the problems of harvesting, handling, and transporting these crops.

Greater knowledge of the factors that determine the quality of oilseeds and their products is needed. The influence of cultural practices, harvesting, storage, processing procedures, environmental factors, and genetic characteristics must be evaluated for their influence on crop quality. Domestic and foreign preferences may differ and both markets must be considered when quality factors are determined. The end-use of the products may determine the type of breeding program developed and the cultural practices used in the production of the crop.

The changing role of the food industry has created domestic and export markets for both oil and protein products prepared from new crops and minor oilseeds. New and improved processing and/or modification procedures are needed for the preparation of edible oils of improved flavor, color and stability for use in cooking and salad oils and other food products. Research also is needed on the development of economical industrial products and processes to increase the utilization of minor oilseeds and their byproducts. New or improved processing methods need to be developed to prepare high quality and nutritious protein meals, flours and isolates with unique functional characteristics for incorporation into food product formulations and for animal feed. Detection, prevention, or elimination of contaminants is essential to the utilization of oilseed products. Where oilseed products are used for food or feed the nutrient composition must be known along with knowledge of the availability of the nutrients.

Pulse crops are an important part of the diets of many peoples of the world. They supply vegetable proteins which are necessary to supplement the predominantly starchy diets. The two primary pulse crops grown in the Southern Region of the United States are peanuts (*Arachis hypogaea*) and soybeans (*Glycine max*). However, these are major crops for the region and their research needs are covered in individual task force reports. The pulse crop grown on the next largest acreage in the Southern Region is the cowpea or Southern pea (Vigna unguiculata, formerly Vigna sinensis). Research needs for the Southern pea are covered in the vegetable crops task force report with orientation more toward fresh market uses. However, SMY's were not specifically assigned, so Southern peas will be included with other minor pulse crops in this report. The USDA Statistical Reporting Service has not reported acreage for Southern peas since 1967. In 1967, they did report 383,000 acres of cowpeas grown for all purposes and 93,000 acres grown for peas with an average yield per acre of 8.6 bushels.

Production of dry beans (Phaseolus vulgaris) and dry peas (Pisum sp.) in the United States is substantial, however, essentially all of the production is outside of the Southern Region. The High Plains of Texas and Oklahoma probably offer the best potential for field bean production in the Southern Region.

Mungbean (Vigna radiata; syn. with Phaseolus aureus) production has been centered in Oklahoma and probably will remain there because of the need for a relatively dry climate to avoid foliar diseases. The USDA Statistical Reporting Service reported mungbean acreages for the last time in 1967. Acreages reported were for Oklahoma only since that represented essentially all of the commercial acreage. In 1967 Oklahoma reported 46,000 acres planted to mungbeans with 34,000 acres being harvested at an average yield of 400 lb/A. Other pulse crops that offer some potential for production in the Southern Region are chickpeas (Cicer arietinum), pigeon peas (Cajanus cajon), mungos (Vigna mungo), Indian beans (Phaseolus sp.), and adzuki beans (Vigna angularis). Estimates of the acreage planted to these crops in the Southern Region are not available.

It would be quite difficult, if not impossible, to establish a set pattern of detailed research that would be applicable to all pulse crops in the Southern Region. The mungbeans and Southern peas are well-established in certain areas of the region, but need additional research. The other pulse crops mentioned are still being evaluated for their production potential in various parts of the region. Nevertheless, there are a few general areas of research that would be applicable and beneficial to any of these crops, particularly in view of the very limited SMY's that have been devoted to these crops in past years. The general areas of research that will be discussed are breeding and selection, crop management, management of pests and diseases, and harvesting.

Summary of Oilseed and Protein Research Activity in Research Problem Areas (RPA) at Current and Recommended Levels of Scientific Man-Years (SMY) of Effort

RPA Number	Level of SMY Effort			
	Current	No Increase	10% Increase	Recommended
207	0.9	0.9	0.9	1.8
208	0.1	0.1	0.1	1.2
209	0.1	0.1	0.1	0.8
307	0.7	0.7	0.7	3.7
308	0.0	0.0	0.0	1.0
309	0.5	0.5	0.5	2.0
405	0.2	0.2	0.2	0.8
406	4.2	4.2	4.2	5.4
407	3.0	3.0	3.0	3.1
408	0.0	0.0	0.0	0.1
501	0.0	0.0	0.0	0.1
701	0.0	0.0	0.0	0.1
702	0.0	0.0	0.0	0.1
708	0.0	0.0	0.0	0.5
Total	9.9	9.9	9.9	20.7

Sunflower

RPA 207 Control of Insects in Sunflower

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.8	207
No Increase	0.8	207
10% Increase	0.8	207
Recommended	1.0	207

2. Priority: 1

3. Situation:

Effective management of insect pests is an important requirement for the economic production of sunflowers in the South. Frequently, in many demonstration and field plantings, insects have been the deciding factor between the success or failure of the planting. Sunflowers are attacked by at least three major insect pests, the sunflower moth, weevil complex of sunflower stems and the carrot beetle.

The sunflower moth, Homoeosoma electellum, is widely distributed and extremely damaging. Limited research has led to an understanding of the habits of this insect and to the development of substantial control using chemical treatments. The carrot beetle, Bothynus gibbosus, is a severe pest in a limited geographical area of the South, and has not responded to chemical treatment. Its presence is considered the primary limitation to commercial sunflower production on the High Plains and Rolling Plains of Texas.

Other insects, including the larva of the painted lady butterfly, sunflower beetle, sunflower midge, and cerambyciid beetles can be destructive in given geographical areas. It is expected that as sunflower production becomes more widespread in the South, some insect problems will become more acute; others may decrease in importance.

4. Objective:

   a. Develop an integrated pest management program, capable of maintaining populations of the major sunflower insects below their damaging threshold.

5. Research Approaches:

   a. Cooperate with plant scientists in a search for germplasm containing resistance to the major insect pests. Priority 1.
   b. Identify natural enemies; determine their distribution; investigate the feasibility of using parasites, predators and diseases for control. Priority 1.

c. Search for effective chemicals that can be integrated with biological control methods. Priority 2.
d. Determine how planting dates, soil fertility, irrigation, and other crop management practices can contribute to insect control. Priority 1.
e. Obtain information on carrot beetle biology and determine its life history. Priority 1.
f. Investigate the potential for using sex attractants or pheromones to control major sunflower insects. Priority 1.

RPA 208 Control of Diseases of Sunflower

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.5	208

2. Priority: 2

3. Situation:

Effective disease management in sunflowers is important in order to reduce losses in seed yield and quality. Domestic sunflowers can be attacked by rust, Verticillium wilt, downy mildew and sclerotinia stalk rot. Through research efforts, substantial progress has been made in controlling several of these diseases. Cytoplasmic male sterile lines are available which carry resistance to rust and Verticillium wilt. Disease pathogens are ever changing; the continued development of multiple disease resistant germplasm should be emphasized. There is also a need for studies involving crop rotations, management of wild sunflowers, and controlling volunteers as a means of reducing disease inoculum.

4. Objective:

a. Continue the development of germplasm with multiple disease resistance; develop an effective cropping system which will reduce economic loss from diseases.

5. Research Approaches:

a. Continue the development of parental lines which possess multiple disease resistance. Priority 1.
b. Evaluate cultural practices and cropping systems for their effectiveness in reducing disease. Priority 2.

RPA 209 Weed Control in Sunflower

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.1	209

2. Priority: 2

3. Situation:

The economics of weed control in sunflower is important in the development of the crop in the South. The development of an integrated system of weed control will enhance the potential of the crop. Any system developed must take into consideration the physiological, biological and genetic responses of sunflower. The environmental impact of the weed control methods must be evaluated. The influence of mechanical and chemical control measures on yield are important factors in developing control methods.

4. Objectives:

a. Develop an integrated system of weed control for sunflowers
b. Study the physiological, biological, and genetic response o: sunflower to weed control materials and methods.

5. Research Approaches:

a. Develop systems of weed control involving available mechanical, chemical, and rotational methods to control weeds. Priority 1.
b. Determine the effects of herbicides on yield, chemical composition, and quality of sunflower oil and meal. Priority 2.

RPA's 307 and 405 Improvement of Biological Efficiency and Production of Sunflower with Improved Acceptability

1. SMY Situation:

Support Level	SMY Number	RPA Distribution	
Current	0.2	307 - 0.1	405 - 0.1
No Increase	0.2	307 - 0.1	405 - 0.1
10% Increase	0.2	307 - 0.1	405 - 0.1
Recommended	1.0	307 - 0.5	405 - 0.5

2. Priority: 1

3. Situation:

Considerable progress has been made in developing high yielding, disease-resistant sunflower hybrids. As a result of the release of cytoplasmic male sterile and restorer lines in 1971, high oil hybrid sunflowers are a reality in the United States. A national sunflower testing program has yielded valuable information on regional adaptation and performance of sunflower hybrids. Studies to determine which single crosses and/or three way crosses are most widely adapted and which are best adapted to specific locations should be intensified.

Basic genetic and cytogenetic information should be developed to permit maximum utilization of available germplasm. There is a need for additional cytoplasmic male sterile and fertility restorer lines for use in hybrid improvement. The search for higher oil content, uniform maturity, and the development of lines with better food and nutritional qualities should be expanded.

4. Objective:

a. Provide the parental lines and hybrids necessary to establish sunflowers as a competitive crop in the Southern Region.

5. Research Approaches:

a. Collect and evaluate potentially insect-tolerant germplasm of domesticated sunflowers, wild <u>Helianthus annuus</u> or related species. Priority 1.
b. Breed for recombination of components for high yield and oil content, integrated with insect and disease tolerance. Priority 1.
c. Obtain estimates of agronomic adaptation of experimental hybrids and commercial varieties through performance testing under standard conditions in the region. Priority 2.
d. Conduct heritability studies of qualitative and quantitative traits, when analysis of such traits will materially aid the objectives of the overall breeding program. Priority 1.
e. Cooperate with plant physiologists and chemists in developing quality characteristics required for efficient processing and end-use of the products. Priority 2.

RPA's 308 and 309 Mechanization and Production Management Systems for Sunflowers

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	1.0	308 - 0.5 309 - 0.5

2. Priority: 2

3. Situation:

Sunflowers have been grown on a relatively small scale in the South. As a consequence, farm machinery manufacturers have given less attention to machine needs for this crop. Yet the success of any new crop is highly dependent upon efficient mechanization in order to compete with established crops. Machines designed for use with major crops are often used effectively for sunflowers, but modification of design would generally improve efficiency.

Limited information is available on the best cultural practices to follow for optimum production. The search for improved production practices should be continued. Further increases in yield will likely result from improved cultural practices and more efficient genotypes.

Bird damage is a universal and severe problem. Research directed toward chemical control, genetic non-preference, and crop placement in relation to bird habitats, should be initiated.

Harvest problems are intensified in the South where physiological maturity is reached before freezing weather can promote uniform drying. Research is needed to determine the earliest stage of physiological maturity at which preharvest dessication is practical, to determine the most effective and economical dessicants, and to define residue problems associated with these dessicants.

4. Objective:

   a. Develop an efficient crop management system which will maximize yield and quality of the crop.

5. Research Approaches:

   a. Determine optimum cropping sequences, plant populations, fertility, and moisture requirements for highest production. Priority 1.
   b. Develop more efficient machine components and establish guidelines for efficient harvest operations. Priority 2.
   c. Investigate the potential for using harvest-aid chemicals and obtain information on their relative efficiency and effectiveness. Priority 1.
   d. Develop effective and economical systems for reducing bird damage. Priority 1.
   e. Devise effective weed control systems. Priority 2.
   f. Study all phases of pre-harvest drying and post-harvest drying and cleaning. Priority 2.

RPA's 406, 407, 408, and 501 Processing and Utilization of Sunflower

1. SMY Situation:

Support Level	Number of SMY's ARS	Total	RPA Distribution
Current	3.2	3.2	406 (2.2) 407 (1.0) 408 (0.0) 501 (0.0)
No Increase	3.2	3.2	406 (2.2) 407 (1.0) 408 (0.0) 501 (0.0)
10% Increase	3.2	2.2	406
		1.0	407
		0.0	
Recommended	4.7	3.4	406
		1.1	407
		0.1	408
		0.1	501

2. Priority: 1 - 406, 407; 3 - 408, 501

3. Situation:

Sunflowers are produced for three markets in the Unites States - bird feed, human food and oil. Sunflower oil is a high quality oil for cooking and salad oil usage. In Europe, it has been used extensively in shortening and margarines. It is a very desirable edible oil because of its flavor and its high content of polyunsaturated fatty acids. Performance characteristics during deep-fat frying and/or heating of both Southern and Northern sunflower oils, limitations of the oils, and preferred processing such as selective hydrogenation need to be determined.

Crude sunflower oil contains a small percentage of waxes and mucilaginous materials. If these materials are not removed from the oil, a cloudy precipitate forms when the oil is stored either under refrigeration or at room temperature. Development of improved processes for degumming, winterization, bleaching and deodorization utilizing mild conditions in order to preserve in optimum concentration desired components such as the polyunsaturated fatty acids and natural antioxidants and removal of constituents which contribute to cloud formation in liquid salad oils would contribute to more economical production and greater utilization of the oil.

Sunflowers also offer a promising new source of protein for human food. However, a major problem in making sunflower protein isolates by conventional methods is the development of greyish to dark green off colors due to the presence of polyphenolic acid compounds in the meal. Improved procedures for separating chlorogenic acid from proteins are essential if sunflower concentrates and flours are to have widespread applications in foods. Investigations also must be made on conditions affecting the extractions of sunflower proteins and an evaluation made of the functional properties as they affect food formulation systems.

4. Objectives:

a. Develop processes for improved recovery of both oil and protein for food and feed. (RPA 406 & 407).
b. Develop processing methods that enhance flavor, color, and oxidative stability of sunflower oil for use in cooking and salad oils and other food products for domestic and export markets. (RPA 406).
c. Investigate the effect of optimum processing temperatures and reducing the polyphenolic acid and fiber content of sunflower meal on growth and feed utilization in swine and poultry (RPA 407).
d. Development of grades and quality standards for sunflower products and improved flavor, color and storage stability of confectinery sunflower seed and dehulled kernels. (RPA 408 & 501).
e. Develop new or improved rapid analytical methodology to evaluate sunflower seed and its products to improve quality control. (RPA 406 and/or 408).

5. Research Approaches:

a. Develop new or improved processes for degumming (hydration with surface active agents), winterization (solvent winterization), refining and bleaching crude sunflower oil to produce a finished oil of highest flavor and stability quality. Priority 1.
b. Develop information on the effect of preparation of fried food products on the flavor and oxidative stability of hydrogenated and unhydrogenated Northern and Southern sunflower oil. Priority 1.
c. Develop extraction processes such as the use of ethanolic mixtures for the reduction of the polyphenolic acid content of sunflower meals used in swine rations. Evaluate the removal of the acids on swine growth, feed intake and feed utilization. Priority 1.
d. Determine long term physiological effects on mammals of a diet of sunflower meal with and without polyphenolic acids on the development of dermatitis and hair loss, feed intake, growth and feed efficiency. Priority 1.
e. Develop and/or improve the accuracy and rapidity of analyses as needed for: (1) seed and protein product constituents including moisture, lipid, nitrogen, crude fiber, and ash; (2) sensory and physical indices of oil quality including flavor, odor, color, resistance to oxidation and solid-fate index; (3) sensory, quality, and physical indices of protein products for food and feed including flavor, odor, color, amino acids, available lysine, polyphenolic acids, protein molecular weight distribution and protein extractability; and (4) sensory, physical and microbiological indices for confectionery sunflower seed and dehulled kernels for human food including flavor and color of dehulled kernels, standard plate count, coliform count, and yeast and mold determinations. Priority 3.

f. Development of processes for the preparation of sunflower meal, flour or protein isolates with the functional properties needed for incorporation into food product formulations. Areas needing investigation include: (1) differential air classification of high fiber meals to minimize crude fiber content, (2) differential liquid extraction to remove nonprotein constituents and undesirable components such as chlorogenic acid, and (3) extraction of component proteins. Priority 1.

g. Develop food products from sunflower and its constituent proteins. Priority 3.

h. Determine the effect of storage conditions (moisture, temperature, CO_2, and length of storage) on the microbial content (total plate count, Enterobacteriaceae, and yeast and molds) and chemical deterioration (free fatty acids, peroxide value, conjugated diene concentration, fatty acid composition, etc.) of confectionery type sunflower seed. Priority 1.

RPA's 701 and 702 Environmental Contaminants in Food and Feed Products from Sunflower

1. SMY Situation:

Support Level	Number of SMY's		RPA Distribution
	ARS	Total	
Current	0.0	0.0	
No Increase	0.0	0.0	
10% Increase	0.0	0.0	
Recommended	0.2	0.1	701
		0.1	702

2. Priority: 3 - 701, 702

3. Situation:

One of the major problems to current sunflower production is the diversity of insects which attack the plant. Serious infestations from insects such as the sunflower head moth can be brought under control only by the use of chemicals such as methyl parathion and endosulfans. In addition, a number of chemicals are being investigated for use on sunflowers as defoliants and to repel birds. Sunflowers also are susceptible to a number of fungus diseases which attack the crop under certain environmental conditions. Therefore, food and feedstuffs from sunflowers could be contaminated with chemicals and microorganisms which might be toxic, antinutritional or disease producing. Detection, prevention or elimination of these contaminants is needed.

Prior to and during harvest, sunflower seeds are contaminated with a host of soil borne bacteria, yeast and molds. The seed may be harvested at high moisture content; and if conditions are favorable for the proliferation of microorganisms, oxidative biochemical transformations and production of mycotoxins could occur. In addition, a high level of contamination also can be carried over to the kernels during decortication which would be important, particularly during storage of confectionery sunflower kernels. Pathogenic organisms such as salmonella and staphylococci could be introduced into sunflower products at any step of production from harvesting to processing to packaging. Thus, physical and chemical methods are needed during the processing of sunflowers to insure low microbial levels and prevent recontamination of sunflower feed and food products.

4. Objectives:

   a. Develop technology to detect, inactivate or eliminate environmental and microbiological contamination in food and feed products.

5. Research Approaches:

   a. Develop methods for quantitative determination of insecticides and other chemical residues and devise procedures for their elimination (RPA 701). Priority 1.
   b. Investigate the nature of biochemical changes related to microbial growth, insect infestation and enzyme reactions in stored products (RPA 702). Priority 1.
   c. Develop techniques for elimination of microbial contamination and evaluate products with respect to presence of toxins or toxic materials and changes in physical and chemical characteristics. (RPA 702). Priority 3.

RPA 708 Nutrient Composition of Sunflower and Sunflower Food Products

1. SMY Situation:

Support Level	Number of SMY's		RPA Distribution
	ARS	Total	
Current	0.0	0.0	
No Increase	0.0	0.0	
10% Increase	0.0	0.0	
Recommended	0.5	0.5	708

2. Priority: 2

3. Situation:

Sunflower meal, flour and protein isolates offer considerable potential for use as protein supplements in human nutrition. Whole kernels are acceptable as a nut substitute in bakery and confectionery products. Sunflower flour, because of its high protein content and high digestibility, is considered to be a suitable food for use in infant nutrition and an excellent source of protein when partially replacing wheat flour in bread making.

Knowledge of the nutrient composition of sunflowers and sunflower products is totally inadequate because of the recency of the development of the crop in the United States. Existing data are obsolete because of outdated methodology and changes in processing practices. In addition there is great variation in the chemical composition of sunflower seed due in part to the recent introduction of new sunflower hybrids and to inherent environmental effects. Information is needed on the availability of nutrients and the effect of processing on nutrient availability. Data on the nutrient composition of protein isolates and sunflower products are urgently needed.

4. Objectives:

a. Identify and quantitatively determine the nutritive factors in sunflower kernels and food products. Develop simple, accurate and rapid methods to detect polyphenolic acids and other nonnutritive or toxic materials in sunflower products.

5. Research Approaches:

a. Determine in dehulled sunflower kernels, defatted sunflower meal, flour and protein isolates: amino acid content, nutritive value, metabolizable energy, trace elements, fatty acid composition, vitamins, and growth factors. Priority 1.
b. Develop or modify methods and determine the polyphenolic acid content of sunflower products and protein isolates. Determine the relationship to these compounds to the formation of undesirable color in sunflower kernels during storage. Priority 1.
c. Determine in sunflower kernels the identity and content of other nonnutritive or toxic materials. Priority 2.

Summary of Scientific Research Activity for Sunflower

	SMY Number			
Research Area	Current	No Increase	10% Increase	Recommended
207	0.8	0.8	0.8	1.0
208	0.0	0.0	0.0	0.5
209	0.0	0.0	0.0	0.1
307	0.1	0.1	0.1	0.5
405	0.1	0.1	0.1	0.5
308	0.0	0.0	0.0	0.5
309	0.0	0.0	0.0	0.5
406	2.2	2.2	2.2	3.4
407	1.0	1.0	1.0	1.1
408	0.0	0.0	0.0	0.1
501	0.0	0.0	0.0	0.1
701	0.0	0.0	0.0	0.1
702	0.0	0.0	0.0	0.1
708	0.0	0.0	0.0	0.5
Total	4.2	4.2	4.2	9.0

Pulses

RPA 207, 208, and 209 Control of Insect, Disease, and Weed Pests of Pulse Crops

1. SMY Situation:

Support Level	SMY Number	RPA Distribution		
		207	208	209
Current	0.3	.1	.1	.1
No Increase	0.3	.1	.1	.1
10% Increase	0.3	.1	.1	.1
Recommended	1.0	.4	.3	.3

2. Priority: 1

3. Situation:

The various pulse crops are attacked by a variety of pests (insects, mites, nematodes, bacteria, fungi, and viruses) and many species of weeds compete with the pulse crops for moisture, nutrients, and space. Some of these pests are common throughout the Southern Region while others many be much more troublesome in one area than another. The specific research needed will depend on the particular pulse crop being grown and the particular pest that is reducing production.

Pesticides provide short term but necessary control of pests. Use of pesticides and combinations of pesticides has created problems of adverse interactions on the organisms in the eco-system. Reducing the need for pesticides through breeding for pest resistance is a major objective in the breeding program of several crops. However, because of the small acreage occupied by the minor pulse crops and the few SMY's devoted to breeding of the minor pulse crops, more reliance will have to be placed on the use of chemical pesticides. Naturally, any available methods of pest suppression and control by nonchemical methods should be incorporated into a workable pest management program.

Soil and foliage insect and mite problems for the various pulse crops vary annually from field to field and between production areas. The presence of natural enemies and the influence of cultural practices, fertilization, and irrigation may affect insect population, damage, and control. It is quite necessary to determine how much feeding damage can be tolerated without affecting yield. Information on the seasonal history of insects will permit better timing of treatments to obtain optimum control of the harmful insects with minimum rates of chemicals and with minimum destruction of beneficial insects.

It is suspected that various species of nematodes are greatly reducing yields of pulse crops in some areas, e.g. the rootknot nematode on mungbeans in Oklahoma. Some effort has been put forth to develop control measures and to screen mungbean germplasm for resistance to the rootknot nematode. However, the lack of time and personnel has not permitted sufficient work to achieve success.

Many pathogenic bacteria, fungi, and viruses cause destructive diseases of the pulse crops. There is a need to develop adequate chemical control measures and to determine economic thresholds for application of the chemicals. Although insufficient SMY's have been available to screen for plant resistance and to study cultural practices which could reduce disease prevalence and buildup, these factors need to be considered and all efforts coordinated to develop effective disease control.

Weed control in the minor pulse crops can be a significant problem. There are two main problems with the use of chemical herbicides. Since the minor pulse crops are grown on such a small acreage, chemical companies cannot justify the expense of labelling a particular herbicide for a particular crop. The other problem has to do with many of the minor pulse crops being grown in double-cropping regimes. Even if a given herbicide is cleared for use on a particular pulse crop and does a beautiful job of weed control, the chemical may be too persistent and cause damage of the next crop since only three months out of the year may be devoted to production of the pulse crops. Tillage practices and planting patterns must be fully evaluated along with chemical weed control to develop safe, effective and efficient systems of weed control.

4. Objective:

   a. Identify and integrate the available methods of pest control to reduce insect, disease and weed damage to an economically acceptable level.

5. Research Approaches:

   a. Evaluate cultural practices and other nonchemical treatments for insect, disease and weed control. Priority 1.
   b. Determine the influence of cropping systems on infestations of insects, diseases and weeds. Priority 2.
   c. Develop selective chemical controls for use only as needed to prevent economic damage from insects, diseases, and weeds. Priority 1.
   d. Identify germplasm in the pulse crops that has resistance or tolerance to insects and diseases and that has increased herbicide tolerance. Priority 2.

RPA 307 Improvement of Biological Efficiency of Pulse Crops

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	.4	307
No Increase	.4	307
10% Increase	.4	307
Recommended	1.4	307

2. Priority: 1

3. Situation:

The pulse crops being discussed here occupy such a limited acreage that probably very few, if any, full scale breeding programs can be justified for these crops. However, most are highly self-pollinated and are grown extensively in other parts of the world. Numerous land races or strains have been collected and many more need to be selected for the preservation of germplasm. All accessions need to be evaluated for their production potential in various parts of the Southern Region. Many of these strains could possibly be selected for use without further breeding. As a crop becomes established and groups become more commodity oriented then extensive breeding programs would be justified.

For all of the pulse crops, varieties are needed that mature uniformly, with uniformity of size and shape of pods and seed, pods that adhere firmly to the plant at maturity without shattering, and pods and seeds that resist damage during mechanized harvesting and handling.

A major portion of the protepeas (cowpeas) and mungbeans in the Southern Region are produced in a double-cropping situation which explains, in part, the low average yields obtained. Without question however, varieties could be developed that are more drought tolerant, more resistant to insects and diseases, and that would result in higher yields of higher quality products.

4. Objective:

a. To develop through breeding and selection pulse crop varieties with higher yield potential, insect and disease resistance and improved nutritive value.

5. Research Approaches:

a. Screen the pulse crop germplasm systematically for factors important to producers, processors, and consumers. Priority 1.
b. Seek ways of successfully incorporating desirable traits into agronomically desirable varieties. Priority 1.
c. Develop varieties that combine higher yield potential, improved quality, multiple resistance or tolerance to destructive diseases and insects, adaptation to mechanical handling, and other desirable agronomic attributes. Priority 1.
d. Make additional collections of pulse crop germplasm and coordinate efforts to adequately evaluate, maintain and utilize the germplasm available. Priority 2.

RPA 308 Mechanization of Production of Pulse Crops

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.5	308

2. Priority: 2

3. Situation:

Since the minor pulse crops are grown on rather limited acreages, they are usually planted and harvested with equipment that has been designed for use with some of the major crops. Although producers must be complimented for doing a respectable job with the existing equipment, improvements certainly could be made in the operation or modification of the existing equipment, and in the design of new equipment for planting and harvesting the various pulse crops.

There are many factors during the growing season over which the producer has little control. However, it is very important initially to get a good stand of a crop and it is very important finally to harvest all of the crop that has been produced. Tillage practices should be developed that will enhance the proper functioning of the planting equipment. Engineering research should be conducted in close cooperation with agronomists to provide plants and cultural practices that will enhance the mechanical harvesting operations.

4. Objective:

   a. Develop and improve equipment for planting and harvesting pulse crops.

5. Research Approaches:

   a. Develop tillage practices that will enhance the proper function of planting equipment. Priority 1.
   b. Study the interrelated effects of plant characteristics, cultural practices (such as windrowing prior to combining) and harvesting operations to reduce harvest losses. Priority 1.
   c. Develop and/or improve machines and components for precision planting and efficient harvesting of pulse crops. Priority 2.

RPA 309 Production Management Systems for Pulse Crops

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.5	309
No Increase	0.5	309
10% Increase	0.5	309
Recommended	1.5	309

2. Priority: 1

3. Situation:

Producers of any crop are interested in high yields of a good quality product while at the same time increasing production efficiency. Producers can accept lower yields from a given crop if it fits into a double-cropping situation so that total production from the land is more efficient. Any change in management of soil, water, or plants that will contribute to increased production efficiency is not only beneficial to established crops but might well make the difference in whether or not a new or developing crop can become competitive with other crops in the area.

Most of the pulse crops have been grown in rows. Spacings between the rows have traditionally been from 36 to 42 inches, initially to accomodate horses and later to accommodate standardized machinery and equipment. Narrow rows could be expected to give increased yields, although moisture is generally the major limiting factor. Changes in planting patterns would necessitate additional research in planting dates, plant populations, and variety interactions.

Nutritional requirements and nutrient balances for vegetative growth and seed yields are not well established for many of the minor pulse crops. Responses of these pulse crops to other environmental factors such as temperature, light, and moisture are only partially understood at best.

Although municipal and industrial requirements for water are increasing at a tremendous pace, and less water will probably be available for agricultural purposes, more and more farms are developing some capacity for irrigation, and it would be extremely beneficial to have research information to use in determining what might be expected from application of limited supplies of water to the various pulse crops.

4. Objective:

   a. To develop cultural practices and cropping systems that will permit efficient production of high quality pulse crops.

5. Research Approaches:

   a. Determine the effect of various tillage practices, planting dates, plant densities, and planting patterns on growth and yield of the various pulse crops. Priority 1.

b. Determine nutritional requirements and nutrient balances for vegetative growth, flowering, and pod set and development. Priority 2.

c. Determine the effect of weather (light, temperature, drought days, relative humidity) on growth, flowering, pod set and development, and plant maturation. Priority 2.

d. Determine how much water to apply at which state or stages of growth to maximize yield and quality per unit of water available. Priority 2.

Summary of Scientific Research Activity for Pulse Crops

	SMY Number			
Research Area	Current	No Increase	10% Increase	Recommended
207, 208, 209	0.3	0.3	0.3	1.0
307	0.4	0.4	0.4	1.4
308	0.0	0.0	0.0	0.5
309	0.5	0.5	0.5	1.5
Total	1.2	1.2	1.2	4.4

Crambe and Brassica spp.

RPA 207 Control of Insects in Crambe and Brassica spp.

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.1	207

2. Priority: 1

3. Situation:

Effective management of insect pests is one of the keys to successful crop production. Losses from insects vary from year to year due to cultural practices, varieties, crop location, ecological stability, weather conditions, and control practices used on other crops grown in the area. The system of insect control developed for crambe and Brassica should include biological, chemical, cultural, ecological, mechanical, plant resistance, and insect sterility combined in the manner that gives the best control of the target insect(s). Since these crops are not grown commercially in the Southern Region, the insects that attack them will have to be identified before a control program can be developed. Known insects infesting crambe and Brassica are - false chinch bug, flea beetles, aphids, lygus bugs, leaf hoppers, and cabbage maggots.

4. Objectives:

   a. Identify insects that attack crambe and Brassica and develop an integrated system of control for these insects.
   b. Develop varieties resistant to insects.

5. Research Approaches:

   a. Develop selective controls, especially selective insecticides, for use only as needed to prevent economic damage. Investigate other methods of control that may be integrated with chemicals to give selective control. Priority 1.
   b. Identify germplasm in crambe and Brassica that may impart resistance or tolerance to the insect pests and combine with the best materials to produce high yielding varieties for release to producers. Priority 2.

RPA 208 Control of Diseases in Crambe and Brassica spp.

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.1	208

2. Priority: 2

3. Situation:

The development of diseases in crambe and Brassica depends on several factors such as environment, previous cropping systems, soil and crop management practices, and cultural practices used in production. Several diseases are known to occur in crambe and Brassica plantings. Among these are Fusarium wilt, Verticillium wilt, *Alternaria circinans* (a fungus found on stems, leaves, and fruits), a virus-like disease on the leaves, and turnip mosaic virus. Although crambe and Brassica have been remarkably free of diseases, control measures need to be developed for those diseases known to infect the crops. The previous crop and cultural practices used on that crop have influenced the degree of incidence of the diseases infecting these crops.

4. Objectives:

   a. Identify diseases found on crambe and Brassica and determine their mode of transmission.
   b. Develop methods of control.

5. Research Approaches:

   a. Catalogue symptoms of diseases found in crambe and Brassica and isolate and identify agent(s) causing the disease. Priority 1.
   b. Develop methods of controlling diseases through the use of chemicals, cultural practices, or combinations of the two. Priority 1.
   c. Screen available germplasm for resistance or tolerance to diseases found in crambe and Brassica and develop new varieties resistant or tolerant to the diseases. Priority 2.

RPA 209 Control of Weeds in Crambe and Brassica spp.

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.1	209

2. Priority: 1

3. Situation:

No research is being conducted on weed control in crambe and *Brassica* in the Southern Region. The development of weed control methods is essential to the development of these crops in the South. The effect of weeds on crop yield, insects, and diseases is not known. As herbicides are increasingly used, or as a single herbicide becomes predominant in an area, the uncontrolled spectrum of weeds may change from easily controlled weeds to problem weeds requiring greater efforts in weed control practices. Minimal impact on the environment is essential. An integrated system of weed control in crambe and *Brassica* and the other crops in the rotation is desirable.

4. Objectives:

   a. Develop effective and safe methods of weed control in crambe and *Brassica*.
   b. Assess the effect of the method on the environment.

5. Research Approaches:

   a. Screen available materials for weed control in crambe and *Brassica* and develop a system of weed control. Priority 1
   b. Determine levels of herbicide residue by analyzing both soil and plant samples. Priority 1.
   c. Investigate the interaction between systems of weed control and such factors as seed quality, other pesticides, diseases, and insects. Priority 2.

RPA 307 Improvement of Biological Efficiency of Crambe and *Brassica* spp.

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.7	307

2. Priority: 1

3. Situation:

The development and growing of low erucic acid rape varieties limited the amount of erucic acid available for industrial uses. In order to meet the demand for erucic acid, lines of crambe and *Brassica* must be developed that are high in erucic acid. Several factors limit yields of crambe and *Brassica* in the Southern Region. Winterhardiness is one of the critical factors lacking in these crops. The development of winterhardy varieties that are early maturing would enhance the potential of these crops. Varieties that can be used in a double cropping system need to be developed;

two types are needed - one for overwinter growth and another for summer planting following another crop. Breeding for high oil content, high erucic acid, winterhardiness, and high yields are critical breeding problems. Cultural practices including fertilization, plant population, spacing, time of seeding, seed treatment, and soil preparation need to be developed for the area where the crop is to be grown.

4. Objectives:

   a. Develop high yielding, high oil, high erucic acid, and winterhardy varieties of crambe and *Brassica*.
   b. Develop improved cultural practices for crambe and *Brassica*.

5. Research Approaches:

   a. Evaluate available accessions of crambe and *Brassica* for desirable characteristics. Priority 1.
   b. Combine lines with desirable characteristics into high yielding varieties. Priority 1.
   c. Develop cultural practices that consistently produce high yields through the use of field trials in the Southern Region. Priority 2.

RPA 406 and 407 New and Improved Food, Feed, Textile and Industrial Products from Crambe and *Brassica* spp.

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	4.0	406 - 2.0, 407 - 2.0
No Increase	4.0	406 - 2.0, 407 - 2.0
10% Increase	4.0	406 - 2.0, 407 - 2.0
Recommended	4.0	406 - 2.0, 407 - 2.0

2. Priority: 1

3. Situation:

Utilization research on crambe and *Brassica* spp. is conducted at the Northern Regional Research Laboratory at Peoria, Illinois. Personnel at the Laboratory are affiliated with the Southern Region through the Regional Project S-9 (New Crops) Technical Committee. Screening of new crops for materials useful in the economy of the U. S. is carried out at the laboratory. The U. S. is dependent on rapeseed oil imported from Northern Europe and Canada for industrial uses. With production in these countries shifting to low erucic acid varieties, a reliable domestic source of erucic acid is needed. One major use of erucic acid is in the production of erucamide which is used as a "slip agent" in the manufacture of polyethylene film. Another use is to make Nylon 1313 which could become an important industrial product. The development of improved processing procedures that produce high quality oil and meal are necessary to the establishment of these crops in the Southern Region. The development of new uses of the oil and meal will enhance the position of the crop.

4. Objectives:

a. Develop improved processing procedures for extracting high quality oil and protein.
b. Develop improved methods of deactivating or removing glucosinalates from the meal.

5. Research Approaches:

a. Study characteristics of seed, oil, and protein and evaluate different processing procedures. Develop procedures that produce the high quality oil and protein. Priority 1.
b. Evaluate procedures for processing meal and develop improved procedures for the deactivation or removal of toxins from the meal. Priority 1.
c. Develop new and improved procedures for separating erucic acid and splitting erucic acid into its component parts. Develop new uses for materials produced from oil. Priority 2.

Summary of Scientific Research Activity for Crambe and Brassica spp.

	SMY Number			
Research Area	Current	No Increase	10% Increase	Recommended
207	0.0	0.0	0.0	0.1
208	0.0	0.0	0.0	0.1
209	0.0	0.0	0.0	0.1
307	0.0	0.0	0.0	0.7
406*	2.0	2.0	2.0	2.0
407*	2.0	2.0	2.0	2.0
Total	4.0	4.0	4.0	5.0

*All SMY's located at Northern Regional Research Laboratory, Peoria, Illinois.

Sesame

RPA 207 Control of Insects in Sesame

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.1	207

2. Priority: 3

3. Situation:

Effective management of insect pests is one of the major factors in efficient crop production. Insecticide costs, resistance of insects to insecticides, and secondary pest problems have increased to the extent that efficient insect control is jeopardized in some crops. The banning of some pesticides has led to the use of broad spectrum insecticides that cause harm to non-target species. Two major objectives with regard to control of insects should be to accept the minimum level of control consistent with the most economical yield and the least environmental contamination. No research is being conducted on insects that attack sesame in the Southern Region.

4. Objectives:

   a. Develop control measures that will reduce losses from insect damage in sesame.
   b. Develop varieties or lines of sesame resistant to insect pests.

5. Research Approaches:

   a. Screen chemicals for best control of the insect pest population in sesame. Priority 1.
   b. Identify the germplasm in sesame that has insect resistance and combine into superior varieties. Priority 2.
   c. Integrate chemical, genetic, and cultural methods into a system of pest management that will give the highest economic returns. Priority 3.

RPA 208 Control of Diseases in Sesame

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.1	208

2. Priority: 2

3. Situation:

The development of many diseases in sesame depends on environmental and cultural practices during the growing season. Several diseases, bacterial leaf spot, Rhizoctonia root rot, Verticillum wilt, and Fusarium wilt, can become serious in some years. Resistance to most diseases is available in the sesame germplasm.

The development of disease resistant varieties offers the greatest potential in solving the disease problems in sesame production.

4. Objectives:

a. Develop high yielding disease resistant varieties through a breeding program.
b. Develop methods for evaluating, testing, and predicting diseases in sesame.
c. Evaluate the available sesame varieties and lines for resistance to sesame diseases.

5. Research Approaches:

a. Grow available sesame varieties and lines and evaluate them for their resistance to sesame diseases. Priority 1.
b. Develop laboratory and greenhouse techniques for determining disease resistance in sesame. Priority 1.
c. Transfer resistance that is found into high yielding varieties. Priority 2.

RPA 209 Control of Weeds in Sesame

1. SMY Situation:

Support Level	SMY Numbers	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.1	209

2. Priority: 1

3. Situation:

A small amount of research has been conducted on weed control in sesame. Information on weed species involved and their effect on yield and quality is not available. To develop sesame as a crop in the South, an integrated system of weed control must be developed for sesame and the crops involved in the rotation. The physiological, biological, and genetic responses of sesame to weed control will influence the development of the crop in the South. The environmental impact of weed control materials and methods must be measured to establish minimal impact on the environment.

4. Objectives:

   a. To develop safe and effective methods of controlling weeds in sesame.
   b. To study the physiological, biological and genetic responses of sesame to weed control materials and methods.
   c. To determine the economic feasibility of the weed control practices developed.

5. Research Approaches:

   a. Develop integrated systems of weed control involving available mechanical, chemical, and rotation systems to control the weed species in sesame. Priority 1.
   b. Determine the effects of sesame herbicides on soil microbiology and predisposing the crop to infection by diseases. Priority 2.
   c. Determine herbicide tolerance of sesame germplasm and the feasibility of developing varieties with increased herbicide tolerance. Priority 3.
   d. Determine the costs of weed control in sesame and other crops in the rotation and develop the most economical system of weed control. Priority 3.

RPA 307 Improvement of Biological Efficiency of Sesame

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.7	307

2. Priority: 1

3. Situation:

The research program on sesame was phased out in 1965. Several varieties were released jointly by the USDA and the Texas Agricultural Experiment Station. These varieties were non-shattering types suitable for direct combining. No sesame is produced in the Southern Region. Foreign sources of sesame seed are uncertain and other countries may follow the example of Mexico and place an embargo on sesame seed. Sesame oil is used in the food processing industries and the meal is an important source of protein used in specialty foods such as low cholesterol egg substitutes. Expanded use of plant proteins will be necessary to alleviate the shortages of food in the world.

4. Objectives:

   a. Evaluate existing lines and varieties to determine their suitability for inclusion in a breeding program.
   b. Develop non-shattering, high yielding, high oil and protein varieties suitable for the Southern Region.
   c. Develop cultural practices including fertilization, plant spacing and population, time of seeding, soil preparation, and other practices essential to production of high yields.

5. Research Approaches:

   a. Develop a breeding program for sesame by evaluation of existing lines and varieties in field plot and nursery studies. Priority 1.
   b. Test cultural practices such as fertilizers, row spacing, and other practices by use of split plot techniques to develop practices that will produce maximum yields. Priority 2.
   c. Develop high yielding, high oil varieties to fit the domestic and foreign markets. Priority 2.

Summary of Scientific Research Activity for Sesame

	SMY Number			
Research Area	Current	No Increase	10% Increase	Recommended
207	0.0	0.0	0.0	0.1
208	0.0	0.0	0.0	0.1
209	0.0	0.0	0.0	0.1
307	0.0	0.0	0.0	0.7
Total	0.0	0.0	0.0	1.0

Flax

RPA 207 Control of Insects in Flax

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.1	207

2. Priority: 2

3. Situation:

Effective management of insects is one of the most important factors in efficient crop production. Losses due to insects may vary from 0 to 20% or higher in some years. This variability may be due, in part, to cultural practices, varieties, crop location, ecological stability, and insect control practices used on other crops grown in the area. The ultimate goal should be to develop a pest management system for the different insect complexes that may be found in the flax growing area. The system should include biological, chemical, cultural, ecological, mechanical, plant resistance, and insect sterility combined in the manner that give the best control of the target insect(s).

4. Objectives:

   a. Develop methods of control for the insects attacking flax.
   b. Develop varieties of flax resistant to insects.

5. Research Approaches:

   a. Develop selective controls, especially selective insecticides, for use only as needed to prevent economic damage. Investigate other methods of control that may be integrated with chemicals that will give selective control. Priority 1.
   b. Identify germplasm in flax that may impart resistance or tolerance to insect pests and combine with the best materials to produce good varieties or hybrids for release to farmers. Priority 2.

RPA 208 Control of Diseases in Flax

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.1	208, 307

2. Priority: 3

3. Situation:

Several diseases reduce flax yields; Pasmo, Rhizoctonia root rot, curly top, rust, and seedling blight (Rhizoctonia solani) are the principle diseases in the South. Methods of disease control are paramount to flax production in the Southern states. Some disease losses may be regarded as direct (those caused by disease organisms) and others as indirect losses (reduction in seed quality). Changes in varieties, cultural practices, weather patterns, and insect control methods may result in changing disease problems.

The development of disease resistant varieties offers the greatest potential in reducing losses in flax.

Chemical treatments for seedling diseases need to be developed and utilized until disease resistance can be found in the flax germplasm and transferred to suitable varieties.

4. Objectives:

   a. Develop chemicals for treating flax seed for the control of seedling diseases.
   b. Develop resistant varieties through a breeding program.

5. Research Approaches:

   a. Test known seed treatment materials for control of seedling diseases. Priority 1.
   b. Transfer resistance that is found to flax varieties as they are developed. Priority 2.
   c. Develop laboratory, greenhouse, and genetic procedures for developing hybrid flax with multiple disease resistance. Priority 1.

RPA 209 Control of Weeds in Flax

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.1	209

2. Priority: 1

3. Situation:

Very little research on weed control in flax has been conducted in the South. The effect of weeds on crop yield, insects, and diseases of flax is not known. The development of an integrated system of weed control for flax is essential to the development of the crop in the South. The effects of herbicides on crops that follow flax in the farming system are important. Minimal impact on the environment is essential. As herbicides are increasingly used, or as a single herbicide becomes predominant in an area, the uncontrolled spectrum of weeds may change from easily controlled weeds to problem weeds requiring greater efforts in weed control studies.

4. Objectives:

a. Develop effective and safe systems of weed control in flax.
b. Assess the effect of the system on the environment and determine if undesirable levels of herbicide residue remain in the soil.

5. Research Approaches:

a. Develop integrated systems of weed control involving mechanical, chemical, or combinations of the two to effectively control the weeds in flax. Priority 1.
b. Determine if undesirable levels of herbicides remain in the soil by sampling the soil and analyzing the samples for residues. Priority 2.
c. Investigate the interaction between systems of weed control and such factors as seed quality (planted and produced), other pesticides, diseases, and insects. Priority 2.

RPA 307 Improvement of Biological Efficiency of Flax

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.1	307
No Increase	0.1	307
10% Increase	0.1	307
Recommended	0.3	307

2. Priority: 1

3. Situation:

Research to improve yields in flax is essential to continuation of this crop in the agriculture of the South. Critical shortages of linseed oil now exist and substitutes are not available for use in such items as protective coatings. Flax in the South is grown as a winter crop and winterhardiness is a critical factor in the production of flax. Flax is generally grown on marginal land and under marginal management in many areas of the U. S. Improved cultural practices including fertilization, plant population, time of seeding, weed control, seed treatment, and water management are critical factors in flax production. Flax acreage could be expanded in the South with concentrated extension effort. Breeding for high oil content, winterhardiness, and high yields are the critical breeding problems at this time. The development of hybrid flax would improve its position in the economy of the South. The Task Force members are aware of the flax research program in North Dakota; however, additional research is needed in the Southern Region because of environmental and pest differences between the regions.

4. Objectives:

   a. Develop high yielding, high oil, and winterhardy varieties for the South.
   b. Develop cultural practices that produce the most economic yields of flax.
   c. Develop hybrids suitable for growing in the South.

5. Research Approaches:

   a. Evaluate available lines of flax for desirable characteristics and transfer winterhardiness, high yield, and high oil into the better lines. Priority 1.
   b. Study the effect of cultural practices such as fertilizers, weed control, etc. on the yield of the better varieties of flax. Priority 1.
   c. Study inheritance and linkage of qualitative characters that can be used in developing hybrid flax. Priority 2.

RPA 405 Production of Flax with Improved Acceptability

1. SMY Situation:

Support Level	SMY Numbers	RPA Distribution
Current	0.1	405
No Increase	0.1	405
10% Increase	0.1	405
Recommended	0.2	405

2. Priority: 2

3. Situation:

Greater knowledge of the factors that determine quality of oil and protein is necessary to make further advances in quality. Procedures for determining quality must be developed or improved so that they can be easily determined on large numbers of samples rapidly and easily at a low cost. Cultural practices have a significant influence on quality. Quality factors are partially under genetic control, therefore genetic changes must be made in plants to improve quality. Environmental factors influence quality and studies are needed to determine the optimum environment for the production of the highest quality oil and protein.

4. Objectives:

   a. Determine quality characteristics in specific cultural situations and determine factors influencing quality.
   b. Develop a genetic base for supplying breeding material that has the desired traits for producing high quality oil and protein.

5. Research Approaches:

a. Determine quality parameters through performance testing of available lines and varieties under standard conditions. Priority 1.

b. Develop new varieties with the desired characteristics through a breeding program in combination with improved cultural practices. Priority 2.

c. Identify the cultural practices which modify metabolic pathways and physiological processes so that high quality products will be produced. Priority 1.

Summary of Scientific Research Activity for Flax

	SMY Number			
Research Area	Current	No Increase	10% Increase	Recommended
207	0.0	0.0	0.0	0.1
208	0.0	0.0	0.0	0.1
209	0.0	0.0	0.0	0.1
307	0.1	0.1	0.1	0.3
405	0.1	0.1	0.1	0.2
Total	0.2	0.2	0.2	0.8

Safflower

RPA 207 Control of Insects in Safflower

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.1	207

2. Priority: 3

3. Situation:

Insect control is one of the critical steps in crop production and should be integrated in the farming system. As crop production methods, varieties, crop location, and climate vary, the insect population may also vary. This imposes limitations on plans for insect control. Effective insect control should include biological, chemical, cultural, ecological, mechanical, plant resistance, and insect sterility in the plans for target insect(s). Changes in weather patterns are difficult to cope with but should be included in the plans for insect control. Damage from insects is usually not serious until large acreages of the crop are grown. No research on insect control in safflower is currently in progress.

4. Objectives:

   a. Develop selective insecticides that will effectively control insects in safflower.
   b. Develop insect resistant or tolerant varieties of safflower for release to farmers.

5. Research Approaches:

   a. Screen available chemicals for selective materials that will control the insects in safflower with the least damage to the environment. Priority 1.
   b. Develop resistant or tolerant lines or varieties of safflower if germplasm is available and integrate into a system of insect control. Priority 2.

RPA 208 Control of Diseases in Safflower

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.1	208

2. Priority: 1

3. Situation:

Several diseases are important in the production of safflower. Verticillium wilt, rust, Fusarium wilt, and Phytophthora root rot are the limiting diseases in safflower production. Rust resistance is available in the safflower germplasm but has not been incorporated into commercial varieties. Post-harvest flooding has been found to control rust. Fusarium wilt resistance is conditioned by two dominant genes which might be used to develop varieties resistant to this disease. All lines of safflower should be screened for resistance to Phytophthora root rot and Verticillium wilt. The development of multiple disease resistance in high yielding hybrids needs to be undertaken.

4. Objectives:

a. Develop methods for evaluating, testing and predicting diseases in safflower.
b. Develop high yielding multiple disease resistant varieties in a breeding program.

5. Research Approaches:

a. Screen all available safflower lines for resistance to diseases. Priority 1.
b. Develop laboratory and greenhouse techniques and new genetic procedures for developing multiple disease resistance in safflower. Priority 1.
c. Transfer resistance to high yielding varieties. Priority 1.

RPA 209 Control of Weeds in Safflower

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.1	209

2. Priority: 1

3. Situation:

Research in areas outside the South indicates that weeds are a serious problem in safflower production. The effects of weeds on crop yield, insects, and diseases of safflower are unknown. Integrated studies on systems of weed control can provide relatively rapid answers to many of the weed problems. If safflower is developed as a winter crop in the South, careful use of herbicides in the cropping system will be necessary in order that crop sequences can be established that will produce the greatest returns. Improved control methods will be needed and new herbicides developed to cope with the situations that may develop.

4. Objectives:

   a. Develop an integrated system of weed control that is safe and economical to use in the production of safflower.
   b. Study the physiological, biological, and genetic responses of safflower to weed control materials and methods.
   c. Study the economic feasibility of the weed control practices developed.

5. Research Approaches:

   a. Develop integrated systems of weed control involving the most effective mechanical and chemical combinations available. Studies should include weedy and weedfree checks to measure losses from weeds. Priority 1.
   b. Determine if undesirable levels of herbicide remain in the soil following various systems of weed control and determine the fate of herbicides in both soils and plants. Priority 1.
   c. Study cropping sequences to determine the long range effects of various systems of weed control. Priority 2.

RPA 307 Improvement of Biological Efficiency of Safflower

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.1	307

2. Priority: 1

3. Situation:

No research is being conducted on safflower in the South at present. Disease problems, lack of winterhardiness, and low yields have been the principal deterrents to the development of this crop in the South. The demand for high quality edible oils and protein of the type found in safflower should increase interest in this crop. Many areas of the South could grow safflower if varieties adapted to conditions found in the South were developed. Cultural practices have not been developed for safflower in the South. The discovery of winterhardiness should lead to the development of safflower varieties suitable for cool season culture of safflower in the Southern region.

4. Objectives:

   a. Develop high yielding varieties that are winterhardy in the Southern region.
   b. Develop cultural practices that will produce the most economical yields.

c. Study the inheritance and linkage of important characters in safflower.

5. Research Approaches:

a. Evaluate existing lines and varieties of safflower and select those most suitable for conditions in the Southern region. Priority 1.
b. Develop a breeding program to combine the best characteristics into varieties adapted to the South. Priority 1.
c. Study the effects of various cultural practices on the yield, oil content, and quality of safflower seed. Priority 2.

RPA 405 Production of Safflower with Improved Acceptability

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.1	405

2. Priority: 2

3. Situation:

Factors that determine quality of oil and protein must be determined before improved products can be produced. The particular use for which a crop is developed will determine to some extent the characteristics needed in the crop. Domestic and foreign preferences may differ, therefore both markets must be considered when quality factors are determined. The influence of environmental factors on quality must be measured to determine their influence and importance in breeding programs. No work on safflower is being conducted in the South at present, therefore evaluation of existing material must be carried out as the first step in a program.

4. Objectives:

a. Evaluate available materials to determine the influence of environment and cultural practices on the quality of safflower oil and protein.
b. Develop basic genetic information on inherited characters that influence quality of oil and protein.
c. Develop lines and varieties with the quality that is desired in both domestic and foreign markets.

5. Research Approaches:

a. Evaluate quality of available material through performance trials utilizing the best known cultural practices. Priority 1.

b. Identify heritable quality characteristics in a breeding program. Priority 2.

c. Develop cultural practices in field trials that produce the quality of oil and protein desired in the world markets. Priority 2.

d. Develop lines and varieties in a breeding program that have the desired quality traits. Priority 2.

Summary of Scientific Research Activity for Safflower

	SMY Number			
Research Area	Current	No Increase	10% Increase	Recommended
207	0.0	0.0	0.0	0.1
208	0.0	0.0	0.0	0.1
209	0.0	0.0	0.0	0.1
307	0.0	0.0	0.0	0.1
405	0.0	0.0	0.0	0.1
Total	0.0	0.0	0.0	0.5

Castor

RPA 307 Castor Germplasm Maintenance

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.1	307
No Increase	0.1	307
10% Increase	0.1	307
Recommended	0.0	

2. Priority: 3

3. Situation:

Domestic castor acreage has declined from about 70,000 acres in 1968 to 800 acres in 1974. Through cooperative efforts of ARS, State Experiment Stations, and commercial breeders, high-yielding disease-tolerant F_1 castor hybrids are commercially available. Although castor acreage could expand in the future, depending on economics of crop production and import supply, further research at this time is probably not justified.

Accession numbers have been assigned to castor breeding lines developed jointly by ARS and State Experiment Stations. Seed of castor breeding lines and castor plant introductions have been transferred to the National Seed Storage Laboratory for semi-permanent storage.

4. Objective:

   a. Preserve and maintain castor germplasm developed cooperatively by ARS and State Experiment Stations.

5. Research Approach:

   a. Maintain viability of castor germplasm by growing breeding lines and plant introductions at periodic intervals. Priority 1.

Tung

RPA 307 Tung Germplasm Maintenance

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	1.1	307
No Increase	1.1	307
10% Increase	1.1	307
Recommended	0.0	

2. Priority: 3

3. Situation:

Tung was considered by the committee on oilseeds and protein in its deliberations. Domestic acreage of tung has declined in recent years. Other crops have become more competitive for land devoted to tung production due to the changing economic situation. The task force recommends that all research on tung should be phased out as rapidly as possible. Germplasm of tung should be maintained in a viable condition.

4. Objective:

a. Preserve and maintain tung germplasm.

5. Research Approach:

a. Maintain germplasm in a tung nursery. Priority 1.

CARBOHYDRATE CROPS

Carbohydrates Committee: W. C. Adamson, Chairman, T. F. Clark, W. T. Fike, M. H. Gaskins, W. O. Hawley, G. B. Killinger, Vice-Chairman, F. W. Martin, J. Velez-Fortuno, G. A. White, E. L. Whiteley, and F. D. Wilson.

Current Situation

Kenaf (*Hibiscus cannabinus*) is a fast-growing annual crop of the Malvaceae. Its origin appears to be Eastern Africa. It is a potential paper pulp crop which has the advantage of producing much greater tonnage per acre per year than any of the known alternative crops, including trees. Its disadvantages are that it is very susceptible to certain species of root-knot nematode, and that the entire crop must be harvested in a limited time period and stored for the remainder of the year. Roselle (*Hibiscus sabdariffa*) is a tetraploid relative of kenaf which is resistant to root-knot, but has a lower yield potential. The commercial production of kenaf could have a great impact upon the agriculture of the Southern region. There is considerable interest in kenaf in the paper pulp and related industries which use wood fiber. There is no commercial acreage of kenaf for fiber or pulp in the United States, and its immediate large scale commercialization is not a likely prospect here. However, the eventual use of kenaf, roselle, or a similar crop seems certain if fiber demand continues to increase. Other areas of the world, which must now pay higher prices for pulping raw materials, are more likely to commercially produce kenaf or roselle for pulp in the immediate future. Kenaf and roselle work is a cooperative effort. Breeding, production and harvesting work is done in the Southern region, while utilization work is done in the North Central Region.

Bamboo can be used as a pulping material. Its major disadvantage is the fact that it must be reproduced asexually, and many years would be needed before any large acreage could be established. There is very little bamboo in the southeast and most is used for ornamental purposes.

Edible yams (*Dioscorea* spp.) are grown as one of the important staple food crops in tropical areas of high rainfall, and are particularly important in West Africa, Papua, New Guinea, islands of the Pacific, and of the Caribbean. Usually grown for subsistence purposes, the yams have not been developed for international commerce and their potential has not been tapped. To utilize yams more effectively, better cultivars are needed, as well as improved production practices. Processing methods are needed to extend the season of availability. Yams are costly to produce compared to their chief substitute, cassava, but of high nutritional value. They merit promotion.

Plantain (*Musa* spp.) is an established food crop in Puerto Rico. It is reproduced vegetatively. Some improvement through selection is likely, and improvement in processing methods could lead to increased production of the crop.

Cassava (*Manihot esculenta*) is the most important of the tropical roots and tubers in terms of world production. It is highly probable that production will increase as cassava is utilized more widely as an inexpensive source of starch or farinaceous food or feed. Since the sexual system is intact, the species can be improved by systematic breeding. Once new varieties are obtained, they can be multiplied vegetatively. Commercial cultivars could be clones of a specific genotype and therefore have any advantage associated with heterosis. The crop is of South American origin. Collections of materials are already available, and several large, international programs are underway.

Chinese waterchestnut (*Eleocharis dulcis*) is not grown commercially in the United States. Since the problem of peel removal has been solved, the crop is a good prospect for commercial production, but it is unlikely that large acreages will be grown since demand is limited largely to the Chinese-prepared food market.

Summary of Carbohydrate Research Activity in Research Problem Areas (RPA) at Current and Recommended Levels of Scientific Man-Years (SMY) of Effort

RPA Number	Level of SMY Effort			
	Current	No Increase	10% Increase	Recommended
204	0.4	0.4	0.4	0.4
205	0.8	0.8	0.8	0.8
207	0.0	0.0	0.0	0.1
208	0.2	0.2	0.2	0.9
304	1.7	1.7	1.7	2.5
307	0.2	0.3	0.3	0.7
308	0.4	0.4	0.4	1.4
309	1.1	1.0	1.0	1.1
403	0.3	0.3	0.3	0.9
404	0.3	0.3	0.3	0.7
405	0.2	0.2	0.2	0.2
406	0.0	0.0	0.0	0.1
407	0.0	0.0	0.0	0.1
408	0.1	0.1	0.1	0.1
Total	5.7	5.7	5.7	10.0

Kenaf and Roselle

RPA 307 and 308 Seed Production

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.3	307 - 0.1, 308 - 0.2

2. Priority: 3

3. Situation:

Kenaf (*Hibiscus cannabinus*) and roselle (*H. sabdariffa*) typically flower too late for effective seed production in the continental United States. While early-flowering varieties can be developed, they are not an attractive possibility because (a) seed production tends to reduce dry matter yield; (b) dual-harvesting systems would be necessary; (c) seed produced in a humid high-rainfall area, which gives maximum dry-weight yields, are usually poor in quality. Favorable growing seasons for kenaf and roselle seed production occur in the Caribbean Islands and in Central America. Research is needed in such areas in order to develop improved methods of seed production, harvesting, and storage.

4. Objectives:

   a. To determine optimum seeding rates, planting dates, fertility levels, and harvesting times for maximum seed production of kenaf and roselle varieties.
   b. To develop large-scale harvesting, handling, and storage techniques.

5. Research Approaches:

   a. Plant field tests in the area of seed production with varieties, planting dates, fertility, plant density, and harvest dates as variables. Priority 1.
   b. Harvest large-scale plantings with commercial machinery evaluating seed quality and efficiency of harvest. Evaluate commercial seed handling and storage techniques according to the same criteria. Priority 2.

RPA 405 Pulp Quality

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.2	405
No Increase	0.2	405
10% Increase	0.2	405
Recommended	0.2	405

2. Priority: 2

3. Situation:

Kenaf varieties have been selected for maximum fiber production and for mechanical decortication. It is likely that such selection has resulted in varieties having weak, pithy woody cores less desirable for pulp production than many uncultivated materials. It is desirable to identify characters such as woody core fiber length, stalk density, and cellulose production that contribute to pulp quality and incorporate them into productive kenaf varieties. Considerable variation in woody fiber length and stalk density has been found. Variation in total cellulose appears to be very small in magnitude. The situation with regard to roselle is unknown.

4. Objective:

   a. To improve the pulp quality of cultivated kenaf by incorporating desirable characters from wild types of kenaf.

5. Research Approaches:

   a. Screen new materials for stalk density cellulose percentage and woody fiber length. Priority 1.
   b. Make crosses and backcrosses as necessary to combine desirable features of wild kenaf types with the productivity of cultivated kenaf. Check progeny of such crosses and backcrosses in order to insure that the desired character is retained. Priority 2.
   c. Study the inheritance of such characters, and their susceptibility to environmental variation. Priority 3.

RPA 208 Control of Root-knot Resistance in Kenaf

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.2	208
No Increase	0.2	208
10% Increase	0.2	208
Recommended	0.5	208

2. Priority: 2

3. Situation:

Kenaf is highly susceptible to several of the prevalent species of root-knot nematodes (*Meloidogyne* spp.). A single source of moderate root-knot resistance has been found in a wild Kenyan introduction (P.I. 292207) and is now being incorporated into a more productive cultivated kenaf type. Greenhouse screening of selections from crosses with the resistant line and its derivatives, with new introductions, and with irradiated material are continuing in the effort to select better material carrying the known resistance and to find new sources of resistance. A new exploration to East Africa is needed to provide more material for this screening as well as providing variation for use in other kenaf and roselle efforts.

4. Objective:

   a. To improve the root-knot resistance of cultivated kenaf.

5. Research Approaches:

   a. To incorporate the existing moderate resistance into a productive kenaf type. Priority 1.
   b. To locate new sources of resistance in introductions and irradiated material. Priority 2.

RPA 307 Improvement of Biological Efficiency of Roselle

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.1	307
No Increase	0.2	307
10% Increase	0.2	307
Recommended	0.5	307

2. Priority: 1

3. Situation:

Roselle is typically resistant to the species of root-knot nematodes found in the Southeast; however, it is slower growing and tends to yield less under optimum conditions than kenaf. It is a tetraploid and one of its genomes is the same as that of diploid kenaf. A hexaploid hybrid between the two species is available. If the germination and seedling vigor of roselle could be improved by breeding, its yield would be equal or superior to kenaf in most southeastern areas.

4. Objective:

   a. To improve the germination and seedling growth of roselle.

5. Research Approaches:

   a. Select for seedling vigor in fiber-type roselle and in crosses of fiber types with other roselle types. Priority 1.
   b. Backcross fiber-type roselle to the kenaf-roselle hexaploid using the hexaploid as female parent. Priority 2.

RPA 308 and 408 Harvesting and Storage

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.2	308 - 0.1, 408 - 0.1
No Increase	0.2	308 - 0.1, 408 - 0.1
10% Increase	0.2	308 - 0.1, 408 - 0.1
Recommended	1.0	308 - 0.9, 408 - 0.1

2. Priority: 1

3. Situation:

Before kenaf or roselle can become a commercial crop, harvesting, handling and storage system that will economically preserve very large volumes of kenaf for periods as long as a year must be devised. Cultural practices to be used must be adapted to the harvesting system and varieties in turn must be adapted to the cultural system. Kenaf can be field-chopped with forage harvesters, but such harvesting requires a heavy expenditure of energy, especially for chopping field-dry material. Green material is chopped easier, but the storage and handling systems available for it appear to be too expensive for use. A system that would handle small stalks in densely planted stands would be desirable since such plantings tend to maximize yield and probably bast fiber percentage.

4. Objective:

   a. To develop an economical and efficient system for harvesting, handling, and storing kenaf.

5. Research Approaches:

   a. Determine the minimum necessary conditions for the storage of green and dry chopped kenaf stems, and green and dry whole stalks by observation and analysis of materials placed in bulk storage under different conditions. Priority 1.
   b. Develop machinery for the harvesting of whole stalks of kenaf. Priority 2.
   c. Modify chopping and forage handling systems for use with kenaf. Priority 3.

RPA 207 and 208 Control of Insects and Diseases

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.5	207 - 0.2, 208 - 0.3

2. Priority: 2

3. Situation:

   a. Anthracnose caused by Collectotrichum hibisci has been a serious disease of kenaf. While most varieties are now resistant, a new race of the pathogen which can overcome their resistance has been reported in Zambia.
   b. Botrytis spp. attacks seed capsules and also causes stem lesions late in the growing season. It is likely to be a major problem in seed production.
   c. Phytophtora parasitica causes root rot which is of potential importance.
   d. Powdery mildews (Erisyphe spp.) can be a serious problem in roselle and have recently been observed in field plantings of kenaf.
   e. Christularietta pyramidalis causes a zonate leaf spot which can lead to premature defoliation of kenaf.
   f. Various stalk borers and cutworms attack kenaf, but have not yet been a serious problem.
   g. Other pathogens which could cause problems when large acreages are planted are: Pythium spp., Fusarium spp., Rhizoctonia spp., Sclerotium rolfsii, Macrophomina phaseoli and Leveillula taurica.

4. Objectives:

   a. Screen advanced breeding lines of kenaf for resistance to anthracnose. Priority 1.
   b. Note any appearance of resistance to any of the above diseases or insects. Priority 2.

5. Research Approaches:

   a. Inoculate kenaf lines to be screened, with all available races of C. hibisci. Observe and rate reactions. Priority 1.
   b. Observe nurseries and field plantings for any appearance of resistance to a prevalent disease or insect. Priority 2.

RPA 309 Production Practices

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	1.0	309
No Increase	1.0	309
10% Increase	1.0	309
Recommended	1.0	309

2. Priority: 2

3. Situation:

Kenaf and roselle have been grown at many locations throughout most of the United States; however, much work remains to be done, especially in the Southeast where they are most likely to be grown commercially. Yield tends to increase with population level, but relationships of yield and population with quality factors and harvesting systems are largely unknown. Kenaf responds to high levels of nitrogen in the South. More work needs to be done in adjusting levels of other plant nutrients and in studying the effect of split applications of nutrients. Kenaf and roselle are both long season crops, and their response to late season applications of nutrients is likely on some if not most soils. New herbicides and nematicides should be evaluated for use on kenaf. Rotations of kenaf with other crops should be studied.

4. Objectives:

   a. Determine which herbicides and treatment levels are best for kenaf and roselle production.
   b. Determine optimum populations and fertility levels consistent with quality and harvest efficiency.
   c. Determine the effect of rotation with other crops upon the yield of kenaf and the total productivity of the area.

5. Research Approaches:

   a. Evaluate herbicides in field tests. Priority 1.
   b. Conduct experiments with population and fertility variables in a factorial combination. Harvest subplots of these tests by methods designed to duplicate the limitations of various machine harvesting systems (evaluating stubble, lodging and top losses). Priority 2.
   c. Grow kenaf in rotation with other crops which (a) are valuable in themselves, (b) tend to reduce root-knot populations, and (c) are compatible with a general agricultural system for kenaf. Priority 3.

RPA 406 and 407 Value as Human and Animal Food

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.2	406 - 0.1, 407 - 0.1

2. Priority: 3

3. Situation:

Kenaf has been sucessfully used as silage for cattle feed. Roselle and kenaf are reportedly used as human food in some parts of the world. Roselle seeds and sepals and kenaf stems and leaves are mentioned as food materials. The rapid growth, high-yield and comparative freedom from insect pests might make these crops attractive as food materials, provided they can be utilized.

4. Objectives:

   a. To evaluate kenaf and roselle seeds, leaves and stems as human food.
   b. To evaluate kenaf and roselle seeds, leaves and stems as animal food.

5. Research Approaches:

   a. Analyze materials for toxic substances. Priority 1.
   b. Conduct animal feeding trials with kenaf and roselle products. Priority 2.

Summary of Scientific Research Activity for Kenaf and Roselle

	SMY Number			
Research Area	Current	No Increase	10% Increase	Recommended
207	0.0	0.0	0.0	0.1
208	0.2	0.2	0.2	0.9
307	0.1	0.2	0.2	0.6
308	0.1	0.1	0.1	1.1
309	1.0	0.9	0.9	1.0
405	0.2	0.2	0.2	0.2
406	0.0	0.0	0.0	0.1
407	0.0	0.0	0.0	0.1
408	0.1	0.1	0.1	0.1
Total	1.7	1.7	1.7	4.2

Tropical Crops

RPA 204 and 205 Control of Diseases Insects and Nematodes of Dioscorea

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.5	204 - 0.25, 205 - 0.25
No Increase	0.5	204 - 0.25, 205 - 0.25
10% Increase	0.5	204 - 0.25, 205 - 0.25
Recommended	0.5	204 - 0.25, 205 - 0.25

2. Priority: 2

3. Situation:

The edible yam (Dioscorea spp.) is attacked by several fungi, insects, and nematodes. A leaf spot, caused by Glomerella cinqulata, commonly called "candelilla" in Puerto Rico, is a serious disease. White grubs of several species feed on the tubers and root-knot nematodes (Meloidogyne spp.) are a problem.

4. Objective:

 a. To control or minimize the effect of leaf spot, white grubs, and nematodes upon the production of edible yams.

5. Research Approaches:

 a. Screen varieties for resistance. Priority 1.
 b. Evaluate control methods. Priority 2.

RPA 304 Improvement of Biological Efficiency of Dioscorea

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.5	304
No Increase	0.5	304
10% Increase	0.5	304
Recommended	0.5	304

2. Priority: 1

3. Situation:

Tubers of distinct varieties of yam vary in shape, in yield, depth in the soil, quality, and protein percentage. Studies of varieties and cultural practices (weed control, staking and fertilizer requirements) are needed in order to select better varieties, to learn ways of increasing yield, and to reduce production costs.

4. Objective:

   a. To select better varieties of yams, to develop better cultural practices in order to maximize yield and quality.

5. Research Approaches:

   a. Select new varieties using selection indices. Priority 1.
   b. Evaluate new cultural practices on standard varieties. Priority 2.
   c. Establish factorial tests to study the effects of cultural practices upon different varieties. Priority 3.

RPA 403 and 404 New and Improved Products and Improved Storage of Dioscorea

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.2	403 - 0.1, 404 - 0.1
No Increase	0.2	403 - 0.1, 404 - 0.1
10% Increase	0.2	403 - 0.1, 404 - 0.1
Recommended	1.0	403 - 0.5, 404 - 0.5

2. Priority: 2

3. Situation:

The potential of yams is to serve as a farinaceous staple at both the home and commercial level. To do so the season of availability must be extended. Efficient and inexpensive methods of storage are needed. Better processing methods and new products could lead to increased production of the crop.

4. Objectives:

   a. To develop effective storage practices for yams. Priority 2.
   b. To develop new uses for yams and improve processing efficiency. Priority 1.

RPA 205 Control of Disease and Nematodes of Plantain

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.5	205
No Increase	0.5	205
10% Increase	0.5	205
Recommended	0.5	205

2. Priority: 2

3. Situation:

Plantain (<u>Musa</u> spp.) is affected by a cercospora leaf-spot, nematodes, and the banana weevil. Cercospora is largely controlled by oil sprays and nematodes by rotation systems.

4. Objective:

a. To improve control methods for the disease and parasites affecting plantains.

5. Research Approaches:

a. Evaluate new control methods in field tests. Priority 1.
b. Screen new clones for resistance. Priority 2.

RPA 304 Improvement of Biological Efficiency of Plantain

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	1.0	304
No Increase	1.0	304
10% Increase	1.0	304
Recommended	1.5	304

2. Priority: 1

3. Situation:

New plantain clones need to be evaluated especially regarding the effect of planting date and planting density. Selection within commercial plantings for numbers of fruit per bunch could be effective in increasing yields. Work on weed control and fertility requirements is needed.

4. Objective:

a. To increase yields per acre of plantains.

5. Research Approaches:

a. Select for number of fruit per bunch in commercial plantings. Priority 2.
b. Plant tests of standard clones, evaluating planting date, and planting density as they affect yield. Priority 1.
c. Evaluate new clones. Priority 3.

RPA 403 New and Improved Products from Plantain

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.2	403
No Increase	0.2	403
10% Increase	0.2	403
Recommended	0.4	403

2. Priority: 2

3. Situation:

Plantains can be processed in several ways and used for food. They are usually marketed fresh or as a fried product (chips) of some kind. Improvement of processing methods and the development of new products could improve marketing possibilities.

4. Objectives:

a. To improve processing efficiency for existing products.
b. To develop new products.

5. Research Approach:

a. Prepare plantains by all of the methods used in the preparation of similar foods. Evaluate results. Priority 1.

RPA 204 and 205 Control of Diseases and Insects of Cassava

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.2	204 - 0.1, 205 - 0.1
No Increase	0.2	204 - 0.1, 205 - 0.1
10% Increase	0.2	204 - 0.1, 205 - 0.1
Recommended	0.2	204 - 0.1, 205 - 0.1

2. Priority: 2

3. Situation:

Although cassava (_Manihot_ _esculenta_) is attacked by viruses, these are of little importance in the Western Hemisphere. _Xanthomonas_ wilt can be controlled by cultural practices. A stem borer is a serious pest that limits production and could be catastrophic. Spider mite damage also can be severe. Controls for the borer and mite are necessary.

4. Objective:

   a. To develop controls of the insect and mite pests of cassava.

5. Research Approaches:

   a. Develop control measures for mites and borers. Priority 2.
   b. Screen for spider mite and stem borer resistance. Priority. 1.

RPA 309 Production Management Systems for Cassava

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.1	309
No Increase	0.1	309
10% Increase	0.1	309
Recommended	0.1	309

2. Priority: 1

3. Situation:

Cassava has a high photosynthetic efficiency and produces a crop in 10 - 18 months. Cultural practices such as planting density, weed control, and fertility should be studied in an effort to maximize yield and quality.

4. Objective:

   a. To increase the harvested yield and quality of cassava by control of the cultural factors.

5. Research Approaches:

   a. Plant tests with cultural factors as variables. Priority 1.
   b. Narrow the range of variation in cultural factors and plant factorial tests to study the relationship among them. Priority 2.

RPA 304 Improvement of Biological Efficiency of Cassava

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.2	304
No Increase	0.2	304
10% Increase	0.2	304
Recommended	0.5	304

2. Priority: 2

3. Situation:

Cassava is a likely prospect for genetic improvement through breeding. It may be produced from seed, and the sexual cycle could be used in breeding for yield, quality and protein content; the resulting varieties or hybrids could be reproduced commercially by asexual means. New varieties would be useful throughout the Caribbean Islands.

4. Objective:

   a. To improve the pest resistance, yield, and quality of cassava through breeding.

5. Research Approaches:

   a. Grow and observe a large number of introductions. Select for characters which may be of commercial value. Priority 1.
   b. Make crosses to combine desirable characters. Priority 2.
   c. Select superior new clones and test extensively. Priority 3.

Summary of Scientific Research Activity for Tropical Crops

Research Area	SMY Number			
	Current	No Increase	10% Increase	Recommended
204	0.4	0.4	0.4	0.4
205	0.8	0.8	0.8	0.8
304	1.7	1.7	1.7	2.5
309	0.1	0.1	0.1	0.1
403	0.3	0.3	0.3	0.9
404	0.1	0.1	0.1	0.5
Total	3.4	3.4	3.4	5.2

Chinese Waterchestnut

RPA 308 Mechanization and Production of Chinese Waterchestnut

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.3	308
No Increase	0.3	308
10% Increase	0.3	308
Recommended	0.3	308

2. Priority: 3

3. Situation:

The Chinese Waterchestnut (Eleocharis dulcis) is cultivated as a hand-harvested, paddy-grown crop in China and Taiwan. High yields per acre are produced, however harvesting is difficult and even with hand-harvesting a large percentage of the crop is damaged. Cultural practices which (1) produce high yields of marketable corms (2 cm +) and (2) produce a crop harvestable by mechanical methods, are needed before the crop can be grown commercially in the United States.

4. Objective:

   a. To develop a culture and harvesting system which produces a high yield of undamaged corms over 2 cm in diameter.

5. Research Approaches:

   a. Grow waterchestnuts in varied media in flooded and non-flooded conditions. Priority 1.
   b. Attempt harvesting in soil with available root-crop harvesting machinery. Priority 2.
   c. Grow waterchestnuts in sand over a buried screen or grid which can be raised and shaken or inverted at harvest. Priority 2.

RPA 404 Quality Maintenance in Storing and Marketing Chinese Waterchestnuts

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.2	404
No Increase	0.2	404
10% Increase	0.2	404
Recommended	0.2	404

2. Priority: 2

3. Situation:

Chinese waterchestnuts have in the past been hand-peeled and preserved in brine. A new process allows them to be mechanically peeled, thereby making the crop much more likely to be commercially successful in the United States. Normally waterchestnuts are stored in sphagnum moss under refrigeration prior to processing. Shoots which develop in storage are a problem in the subsequent peeling operation. Sphagnum is relatively expensive as a storage medium and would tend to increase mass-handling cost greatly.

4. Objectives:

   a. Develop a system for storing waterchestnuts without the use of sphagnum moss.
   b. Retard or prevent the sprouting of corms in refrigerated storage.

5. Research Approaches:

   a. Evaluate pretreatment fungicidal dips. Priority 1.
   b. Evaluate the effect of varying temperature. Priority 1.
   c. Evaluate partial freeze-drying for storage. Priority 2.

Summary of Research Activity for Chinese Waterchestnuts

Research Activity	SMY Numbers			
	Current	No Increase	10% Increase	Recommended
308	0.3	0.3	0.3	0.3
404	0.2	0.2	0.2	0.2
Total	0.5	0.5	0.5	0.5

Bamboo

RPA 307 Improvement of Biological Efficiency of Bamboo

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.1	307
No Increase	0.1	307
10% Increase	0.1	307
Recommended	0.1	307

2. Priority: 3

3. Situation:

Timber bamboo (*Phyllostachys bambusoides*) flowers and produces seed. Natural crossing between this and other species flowering in the area may have occurred. This is a rare opportunity to observe seedling variation and possibly identify hybrids of one of the largest bamboos grown in North America. While no known immediate application is likely, the possibility of isolating more useful bamboo clones cannot be ruled out.

4. Objective:

   a. To maintain the current bamboo collection.
   b. To observe variation among seedlings of *Phyllostachys bambusoides* identifying hybrids with other clones if possible.

5. Research Approaches:

   a. Maintain the bamboo collection with sufficient plantings for distribution. Priority 1.
   b. Collect seed and plant a nursery of *P. bambusoides* seedlings. Priority 2.
   c. Note differences in vigor and spreading and compare characteristics with other bamboo clones now flowering. Priority 2.

Summary of Scientific Research Activity for Bamboo

Research Activity	SMY Numbers			
	Current	No Increase	10% Increase	Recommended
307	0.1	0.1	0.1	0.1
Total	0.1	0.1	0.1	0.1

GUM CROPS (GUAR)

Gum Committee: Norman Brints, O. C. Cannedy, Theodore Hymowitz, J. S. Kirby, Vice-Chairman, R. S. Matlock, R. G. Orellana, H. H. Partridge, J. A. Robertson, C. E. Rogers, and R. E. Stafford, Chairman.

Current Situation

Guar, *Cyamopsis tetragonoloba* (*L.*) *Taub.*, is a drought-tolerant summer annual legume, noted for the galactomannan gum content of its seed and for its soil building properties. Commercial production of guar began in South Texas in the early 1950's, but the center of production quickly moved to the sandy soils of the Rolling Plains area of Texas and Southwestern Oklahoma, where it has remained. Currently, domestic production supplies only about one-third of the guar gum needed for food and industrial applications in the United States; over two-thirds of the guar needed by the U. S. is imported from India and Pakistan. Guar processors indicate a need for 200 to 300 million pounds of guar beans annually to supply current guar gum requirements for food and industrial applications.

One of the most important requirements for profitable domestic guar seed production is effective management of insect pests. During the period from 1969 through 1972, midges were responsible for an estimated 20 to 30% annual loss to guar seed producers in the Texas Rolling Plains and Southwest Oklahoma. Insect problems in guar are subject to changes in severity with shifts in agronomic practices, cropping locations, weather conditions and plant phenology. The biology, ecology, and population dynamics of guar pests and their natural enemies are not well-known. It is extremely important that researchers determine these parameters, for the success of an integrated pest management program is contingent upon a knowledge of them.

Information on etiology, epidemiology, and management of disease pathogens in guar is scant. Direct losses due only to bacterial blight can range as high as 20 to 30% annually. Through cooperative federal and state research efforts, bacterial blight-tolerant cultivars have been developed. However, due to the inherent capacity of the pathogen to mutate and produce virulent new races, it is essential that an intensive effort be continued to develop blight-tolerant varieties. *Alternaria* leaf, stem, and pod blight can be a serious fungal disease. Other diseases of lesser importance now, may become more destructive as guar production becomes more intensified in its area of adaptation. Epidemiology of these diseases and host nutrition-varietal reaction relationships are not well understood. Efficient management of disease pathogens cannot be achieved without additional research on problems associated with cultural practices, insect management, and breeding and genetics.

Since commercial guar production began in the U. S., average harvested yields per acre have been only moderately increased by breeding and genetics. Harvested yields vary from about 300 to more than 2,000 pounds per acre depending upon production practices and rainfall received during the growing season. Notable advances in breeding for improved disease resistance and plant type (fine-branching growth habit) were achieved in the early 1960's. These advances stabilized guar acreage and permitted guar to become a crop of economic importance in the United States. Breeding for improved yield has been hindered by the lack of imformation on basic physiological processes, nutrient requirements, genetic analyses of quantitative and qualitative traits, and inadequate amounts of research on breeding methods and hybridization techniques. An intensive search for suitable techniques to make controlled crosses, which would culminate in hybrid guar production, is essential to any future yield improvement program and would appear to offer the greatest potential for moving above the current yield plateau.

Guar producers are interested in high yields of good quality beans while at the same time increasing production efficiency. Quantity and quality of production are a result of the interaction of several factors. Some of these appear to be beyond control, yet there are many facets within crop management that can be changed, adjusted, or managed differently to provide significant changes in total production or efficiency of production. Knowledge of the interactions or relationships between these various facets is meager compared to what will be needed to produce guar efficiently in the future. Any change in management of soil, water, plants, and machinery that will contribute to increased production efficiency will benefit the entire guar industry.

Guar is an excellent soil building crop and adapts to rotation sequences with cotton, grain sorghum, and other crops. Guar residues, including nitrogen fixation by root nodules, improve yields of succeeding crops. Research is needed to determine the economic value of guar residues and to fully evaluate guar's potential as a source of organic nitrogen fertilizer.

Processing and utilization research with guar has been conducted almost exclusively by commercial companies who have a major interest in guar and its by-products. Utilization research has produced new products and chemical derivatives, improvements in guar gum characteristics on which present utilization rests, and the removal of deficiencies which have hindered the use of guar gum. Information is generally lacking on the range of variability of quality characteristics in the raw product (guar beans). The development of small sample analytical methods to accurately measure quality attributes in the raw product needs emphasis and is essential to the development of improved gum quality through breeding techniques.

Reliable forecasts of supply, demand and price are essential to promote orderly production and marketing. Guar producers, processors and marketing firms base daily decisions upon probable future supply, demand and price information. Public economic research providing continuous appraisal of the current and probable economic position of guar is needed to make guar production more competitive with other crops in the area.

Summary of Proposed Research Activity
in Guar by Research Problem Areas (RPA)

RPA Number	Current	Proposed SMY Activity: No Increase	Proposed SMY Activity: 10% Increase	Proposed SMY Activity: Recommended
207	0.2	0.2	0.2	0.6
208	0.0	0.0	0.0	0.5
209, 309, 701	0.4	0.4	0.4	1.0
307, 405	1.0	1.0	1.0	1.5
308	0.0	0.0	0.0	0.2
406, 407	0.0	0.0	0.0	0.3
501	0.0	0.0	0.0	0.1
Total	1.6	1.6	1.6	4.2

Summary of Private Funding for Guar Research
in 1972 Not Included in CRIS Reports

RPA Number		1972 Research Dollars	SMY
207	Insect control	1000	<.1
209	Weed control	1500	<.1
Total		2500	<.2

Guar

RPA 207 Control of Insect Pests in Guar

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.2	207
No Increase	0.2	207
10% Increase	0.2	207
Recommended	0.6	207

2. Priority: 1

3. Situation:

Contarinia texana (guar midge) is the most costly insect pest of guar. Data indicate that this species is responsible for about 90% of the loss due to insects. At present diazinon is the only insecticide approved for use on guar. However, data on its efficacy are incomplete. Moreover, the biology of *C. texana* is not completely understood, nor is the injury threshold for this species known. The use of insecticides under these conditions for control of *C. texana* is not only wasteful in terms of material and labor costs, but also ecologically unsound in that it also may destroy natural enemies of the midge.

The gall midge, *Asphondylia* sp., is distributed over the entire guar production area. It often becomes abundant during August and September in the Texas Rolling Plains and South Oklahoma, and earlier in South Texas. To date it has not become economically important, primarily because of its late appearance on guar and a high degree of parasitization. Research needs to be initiated to clarify the midge-parasitoid complex relationship, and to determine how control efforts directed against *C. texana* might alter this relationship. Destruction of the parasitoids might enable *Asphondylia* sp. to become an economic pest.

Considerable stand loss due to lodging occurs in South Texas each year as a result of a girdling insect. Although less, loss of this nature also occurs in West Texas, the Texas Rolling Plains, and South Oklahoma. The insect causing this damage has not been positively identified but is presumed to be the threecornered alfalfa hopper, *Spissistilus festinus*. This insect destroyed experimental guar plantings in Arizona in 1948 and is found in the current guar production areas. An effort should be made to identify and determine the importance of the girdling insect attacking guar. Thrips and whiteflies are common and sometimes abundant on guar in South Texas but not in other production areas. Research is needed to determine the pest status of these insects on guar in the South Texas area.

4. Objective:

   a. Develop environmentally acceptable procedures for economic and selective management of insect pests of guar so that excessive use of chemicals may be prevented, and natural enemies of secondary pests may be conserved.

5. Research Approaches:

   a. Investigate the biology, ecology, and life history of insect pests in the laboratory so that valid recommendations for field management strategies may be made. Priority 1.
   b. Develop a sequential sampling technique that will enable producers to quickly detect economic infestations of _C. texana_ in guar. Priority 1.
   c. Determine the phenology of commercial varieties of guar so that the fruiting pattern of the plant may be considered in insect management. Priority 1.
   d. Cooperate with plant breeders in searching for lines of guar which may be tolerant to insect pests. Priority 2.
   e. Search for alternate wild host plants of insect pests. Priority 2.
   f. Identify natural enemies of insect pests and determine how they may be utilized in an integrated pest management program. Priority 2.
   g. Determine distribution and economic importance of secondary pests of guar. Priority 2.

RPA 208 Control of Diseases in Guar

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.5	208

2. Priority: 1

3. Situation:

Bacterial blight, incited by _Xanthomonas cyamopsidis_, is the most destructive disease of guar in the Texas-Oklahoma area, where at present most of the guar is grown. Losses due to this disease can range as high as 20 to 30% annually. Blight-tolerant guar cultivars have been developed cooperatively by ARS, the Texas and Oklahoma Agricultural Experiment Stations, and with the assistance of commercial guar producers. Because of the inherent variability of the pathogen, and its capacity to produce virulent races which can attack new tolerant cultivars, it is imperative that resistant genotypes be developed. Breeding for bacterial blight resistance should be intensified to maintain a sustained supply of guar gum and its industrial by-products.

Alternaria leaf, stem, and pod blight caused by A. cucumerina var. cyamopsidis, is also a serious fungal disease in the guar production area. This disease, when most severe, causes premature defoliation of susceptible cultivars. Members of the A. tenuis group have also been reported to cause leaf and stem blight of guar. The epidemiology of this disease and the relation of host nutrition to varietal resistance or susceptibility are not well understood and should be investigated.

Other diseases that can become economically important with the intensification of production are: Southern Blight (Sclerotium rolfsii); Leaf Spot (Pseudomonas syringae); Top Necrosis (Tobacco Ring Spot virus); and root diseases of unknown etiology. Knowledge of the epidemiology and varietal reaction to these diseases is scant.

4. Objective:

   a. Develop effective and economical methods for control of bacterial, fungal, viral, and other disease-causing agents; cooperate with plant scientists in the development of disease resistant genotypes to increase seed yield and gum content.

5. Research Approaches:

   a. Study the biology and epidemiology of economically important guar pathogens. Priority 1.
   b. Establish and maintain pure guar ecotypes as differentials for the recognition of new virulent races of the bacterial blight pathogen. Priority 1.
   c. Develop methods for the exclusion of seedborne pathogens and the production of disease free seed with special emphasis on bacterial blight. Priority 1.
   d. Cooperate with plant scientists and others in incorporating disease resistance into agronomically acceptable guar genotypes. Priority 1.
   e. Evaluate the reaction of guar cultivars, new selections and advanced generation lines to southern blight and, if warranted, to other diseases of potential importance. Priority 2.
   f. Study survival and efficiency of Rhizobium inoculants for guar. Priority 2.

RPA's 209 and 309 Production Management Systems for Guar

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.2	209 (0.0), 309 (0.2)
No Increase	0.2	209 (0.0), 309 (0.2)
10% Increase	0.2	209 (0.0), 309 (0.2)
Recommended	0.3	209 (0.1), 309 (0.2)

2. Priority: 1 - RPA 309; 2 - RPA 209

3. Situation:

Current guar varieties have the genetic potential to produce at least 3,000 lbs/a. yields of beans, yet average acre yields are only about 1/6 of this. Several factors contribute to this situation including such obvious factors as the double-cropping regimes, weather, and pests. The significance of other contributing factors is not as well known.

Much of the guar acreage is on sandy soils that are gently sloping and subject to severe erosion problems from wind and water. Many juvenile stands of guar are eradicated or damaged severely by localized dust storms. Guar seed should be planted in good soil moisture, but deep furrows should be avoided to facilitate maximum recovery of low-set beans at harvest.

Most guar is planted in 36-40 inch rows to accommodate standardized machinery and equipment. Although moisture would generally be one of the major limiting factors, narrow rows could often be expected to give increased yields. Changes in planting patterns would necessitate concomitant research in planting dates, plant populations and variety interactions.

Rotation sequences play a role in guar production through erosion control, soil conditioning and pest management. Research has shown increased yields of cotton grown on land following guar. More research is needed to develop effective practical rotations.

4. Objective:

a. Determine the effects of various tillage practices, planting dates, plant densities, planting patterns, and potential rotations on growth and yield.

5. Research Approaches:

a. Identify the optimum planting date, plant population and geometrical arrangement of plants for maximum yields and for erosion control with various cropping systems. Priority 1.
b. Determine optimum tillage practices for maximum yield and minimum soil and water loss. Priority 1.
c. Compare the advantages and disadvantages of potentially adaptable rotations. Priority 1.

RPA's 209 and 309 Nutritional and Fertility Requirements for Guar

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.2	209 (0.0), 309 (0.2)
No Increase	0.2	209 (0.0), 309 (0.2)
10% Increase	0.2	209 (0.0), 309 (0.2)
Recommended	0.3	209 (0.1), 309 (0.2)

2. Priority: 1 - RPA 309; 2 - RPA 209

3. Situation:

Mineral nutrition of guar has been studied in India using a sandculture technique. Optimum levels of zinc, boron, and copper were determined. They also attempted to identify deficiency and toxicity symptoms for each of these elements. Calcium-boron relationships and copper-molybdenum relationships were also studied. Another researcher in India studied the effect of nitrogen, phosphorus, potassium, calcium, magnesium and sulphur nutrition of guar as it related to the formation of local lesions by sunnhemp mosaic virus. In the course of this study, the optimum levels as well as deficiency and toxicity symptoms were determined for these nutrients.

It is generally stated that on fertile land, or where preceding crops have been fertilized heavily, fertilizer requirements for guar can be reduced or omitted; however, guar like most legumes, requires high levels of phosphorus. There is also information that fertilizer added to guar should be plowed down or knifed well into the root zone. However, little research has been conducted to identify critical soil pH values and to collect field calibration data for defining fertility levels of soils.

4. Objective:

   a. Determine nutritional requirements of guar and calibrate these requirements against soil test ratings for fertilizer elements and pH.

5. Research Approaches:

   a. Determine nutritional requirements and nutrient balances for vegetative growth, flowering, and pod set and development, including the relationships between vegetative growth and bean yield and including any varietal interactions with nutrients. Priority 1.
   b. Conduct field experiments to calibrate soil test ratings for pH and fertilizer nutrients on a wide range of soil types. Priority 1.
   c. Determine the effect of root depth and root proliferation in sub-soil zones on growth and yield to identify optimum placement depth of fertilizer materials. Priority 1.

d. Evaluate methods and time of application for fertilizer nutrients. Priority 2.
e. Determine relationships between soil fertility status and susceptibility to pathogens. Priority 2.
f. Determine the ability of various Rhizobium strains to fix nitrogen in guar root nodules. Priority 2.
g. Determine the economic value of guar residues including nitrogen fixation on yields of succeeding crops. Priority 2.
h. Determine the grazing value of guar residues. Priority 2.

RPA's 309 and 701 Physiology of the Guar Plant

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.2	309 (0.1), 701 (0.1)

2. Priority: 1 - RPA 309; 2 - RPA 701

3. Situation:

Basic studies on the physiology of guar are relatively limited. Research has shown that soil temperatures of 70°F or higher are needed for good guar germination. Other responses of guar to such environmental factors as temperature, light, moisture, and mineral nutrition are only partially understood at best. Guar has an indeterminate habit of flowering and will remain vegetative and continue to flower over an extended period of time. Although this provides some degree of crop insurance, the disadvantage is that pods and seeds of a wide range in maturity are present on the plants at harvest time. Research in Texas indicates that buds produced on guar plants after September 15 do not contribute significantly to yield because of insufficient time for the seed to mature. Thus, not only will the late-set pods fail to contribute to yield but the indeterminate nature keeps the plants from maturing and reaching a low enough moisture content to harvest before frost.

Excessive rainfall and humid conditions can cause deterioration of mature seed in the field. Since guar beans with light (nonweathered) seed coats are preferred by the industry, research that would lead to a more determinate guar variety either through genetic means or by the external application of growth regulators would be beneficial. Some research has been conducted to reduce plant moisture content to levels acceptable for harvest by windrowing and by the use of harvest-aid chemicals. Application of harvest-aid chemicals and other growth regulators necessitates the need for additional research to insure that the guar beans are free of toxic contaminants and residues.

4. Objective:

   a. Determine the physiological reactions that control guar growth, flowering, and fruiting and how they are affected by the environment.

5. Research Approaches:

   a. Determine the role of weather (light, temperature, drought days, relative humidity) on growth, flowering, pod set and development, and plant maturation. Priority 1.
   b. Determine role of growth regulators on flowering, pod and seed development and plant maturation. Priority 1.
   c. Determine environmental stimuli or growth regulators that encourage the prolific development of pods and seeds of nearly equal maturity without leaving toxic residues. Priority 2.
   d. Determine the effects of the above factors on gum content and quality. Priority 2.

RPA's 209 and 309 Water Management for Guar Production

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.2	209 (0.1), 309 (0.1)

2. Priority: 1 - RPA 309; 2 - RPA 209

3. Situation:

The climate and soil characteristics of the Rolling Plains are such that the guar crop is frequently subjected to periods of drought. The length and intensity of the drought periods vary considerably and are hardly predictable by current forecasting methods. Prolonged drought stress during the fruiting period is especially yield limiting. The guar plant's ability to flower and fruit profusely over an extended period of time partially alleviates potential yield restrictions caused by droughts of short duration. However, this same indeterminate nature prevents the plants from reaching acceptable moisture levels for harvest before frost, which, in turn, leads to conditions for seed deterioration if excessive rain delays harvest after frost.

Irrigation of guar has not been adopted as a general practice and the guar crop continues to be at the mercy of natural rainfall on most farms. Limited experience with present guar varieties has shown a rather low response to irrigation, thus irrigation has been reserved for crops with a higher gross return per acre. However, many farms in the Rolling Plains area have some capacity for irrigation and it would be extremely beneficial to have research information to use in determining what might be expected from application of limited supplies of water.

4. Objective:

   a. Develop criteria to use in determining when and how to apply water to get the most efficient utilization of a limited supply of water.

5. Research Approaches:

   a. Determine how much water to apply at which stage or stages of growth to maximize yield per unit of water available. Priority 1.
   b. Determine the influence of tillage practices, row-spacing, row direction, plant type, and plant population on the efficiency of utilization of limited supplies of water. Priority 1.

Summary of Proposed Research Activity for Crop Management in Guar.

	Proposed SMY Activity			
RPA Number	Current	No Increase	10% Increase	Recommended
209	0.0	0.0	0.0	0.3
309	0.4	0.4	0.4	0.6
701	0.0	0.0	0.0	0.1
Total	0.4	0.4	0.4	1.0

RPA's 307 and 405 Improvement of Biological Efficiency and Improved Acceptability of Guar

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	1.0	307 (1.0), 405 (0.0)
No Increase	1.0	307 (1.0), 405 (0.0)
10% Increase	1.0	307 (1.0), 405 (0.0)
Recommended	1.5	307 (1.0), 405 (0.5)

2. Priority: 1

3. Situation:

The success of guar as a crop in the United States will depend in large part on the availability of improved varieties resulting from genetics and breeding research. Data on the genetic analysis of both qualitative and quantitative traits are sparse. Lack of information on basic physiological processes such as photoperiodism, drought tolerance and nutrient use to inadequate amounts of research on breeding methods and hybridization techniques have greatly hindered the development of higher yielding varieties.

Guar is completely self fertile. Natural outcrossing under field conditions varies from less than one percent to about nine percent depending on genotype and environment. Due to the difficulty of making hybrids by hand emasculation, the search for techniques for making controlled crosses is imperative to any future guar varietal improvement program.

Guar beans are the source of a galactomannan gum that is able to compete successfully with other natural and synthetic gums for hundreds of uses by U. S. industry. Information on variability of gum content in guar breeding lines is generally lacking. Breeding for improved gum content has also been hindered by the lack of suitable small sample analytical techniques and equipment. With additional manpower, it may be possible to develop through breeding, higher yielding guar varieties which have desired market qualities.

4. Objective:

   a. Develop guar varieties with high yield, disease and insect resistance, improved gum quality and agronomic adaptation; evaluate breeding methods as to their effectiveness in identifying high yielding genotypes; identify ways to make controlled crosses and to increase gain per breeding cycle assist the breeding program by determing the inheritance of desirable agronomic characters.

5. Research Approaches:

   a. Evaluate guar germplasm for resistance to insects and pathogens, drought tolerance and for gum content. Priority 1.

b. Develop methods for making controlled crosses in guar. Priority 1.
c. Conduct heritability studies of qualitative and quantitative traits, when such analyses will aid the objectives of the breeding program. Priority 1.
d. Cooperate with plant physiologists and chemists in developing techniques to analyze seed for gum quantity and quality. Priority 1.
e. Obtain estimates of agronomic adaptation for experimental strains and varieties by performance testing in the region of adaptation. Priority 2.

RPA 308 Mechanization of Production of Guar

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.2	308

2. Priority: 2

3. Situation:

Guar occupies a relatively small portion of the total cropland in its area of adaptation. As a result, farm machinery manufacturers have generally given less attention to machine needs for guar, than for competitive crops. Machines designed for use with major crops are used for guar, but modification of design would generally improve efficiency.

Guar initiates flowering and pod set near the ground level, at about 4 weeks after emergence. Fruiting is continuous throughout the growing season until terminated by either physiological maturity or cold temperatures. Cultural practices, during the growing season, which leave plants in a slight depression or furrow, contribute to extensive field loss of lower pods at harvest. Under such conditions harvest losses can easily approach 30 to 40%. Research is urgently needed to develop efficiency in harvesting procedures and to develop equipment better adapted for guar harvest.

4. Objective:

a. Develop improved harvesting procedures and equipment which will minimize harvest losses.

5. Research Approaches:

a. Study relative economics of in-the-furrow vs on-the-bed plantings and their relationship to harvesting efficiency. Priority 1.

b. Develop harvesting equipment with specialized header-attachments, platform sensors, and other special devices adapted to guar harvest. Priority 1.
c. Fully investigate the potential of windrowing to reduce harvest loss and improve seed quality vs conventional harvesting methods. Priority 1.
d. Study the interrelated effects of plant characteristics and harvesting equipment to maximize harvesting efficiency. Priority 2.
e. Cooperate with plant scientists to restructure fruiting patterns of guar that will facilitate efficient harvesting. Priority 2.
f. Re-evaluate conventional harvesting equipment and develop alternatives which may be more adapted to guar harvest. Priority 2.

RPA 406 and 407 Guar Processing and Utilization

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.2	406 (0.1), 407 (0.1)

2. Priority: 2

3. Situation:

Guar beans are the source of a gum that is able to compete successfully with other natural and synthetic gums. Industrial consumption of guar gum and its derivatives depends to a great extent upon the extremely useful properties of the end products. Guar gum has literally hundreds of different uses. Each use category has its own set of specifications, which represent the qualities desired for use in a given product or products.

Guar processors have developed efficient and economical processing equipment for milling and utilizing guar beans. Markets for guar derivatives have been successfully developed. Less attention and support have been given by processors to the agronomics of guar and quality improvement of the raw product.

Effective product development will require that more attention also be given to by-products from guar seed. Gum is derived from the endosperm. Guar seed also contain from 27 to 37% protein, primarily, in the embryo and seedcoat and about 4% oil. Currently, protein from guar seed is competitively marketed as a protein supplement for use in livestock feeding. In view of the impending protein shortage in the world, research is also needed to investigate the potential of guar protein and oil for human consumption.

4. Objective:

   a. Develop new and improved food and industrial uses for guar gum derivatives and by-products.

5. Research Approaches:

   a. Cooperate with plant scientists and chemists in developing small sample analytical techniques and equipment to accurately determine gum content and quality of guar beans. Priority 1.
   b. Improve guar gum characteristics on which present utilization rests; develop new guar gum derivatives for food and industrial applications. Priority 1.
   c. Investigate the potential of using guar protein and oil for human consumption. Priority 2.

RPA 407 New and Improved Feed Products from Guar

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.1	407

2. Priority: 3

3. Situation:

Guar is a drought-tolerant summer annual legume which is well adapted to the drier areas of the Southwest. With adequate moisture, yields of 1600 to 2000 pounds per acre may be obtained. Acreage of guar is already substantial in Texas and Oklahoma and there is a good potential for expansion of the crop.

The endosperm of guar (mannogalactan), which has a number of industrial uses, can be removed by dry milling. The guar meal obtained contains approximately 36-40% protein and has been used as a protein source in livestock feeding. In general, animals perform poorly on rations containing a high percentage of raw guar meal. The meal has an odor and taste which reduces its palatability and results in poor initial performance. However, animals tend to perform satisfactorily on the meal once they become acquainted with the taste and odor. Processing methods such as toasting or steaming need to be investigated to determine ways of increasing the palatability of the meal.

4. Objective:

   a. Develop inexpensive methods of processing guar meal to produce a palatable, high protein product for feed or other uses; determine the chemical and nutritive composition of guar products; investigate the use of guar meal in animal rations.

5. Research Approaches:

a. Develop new and improved processing methods to remove gum residues and unpleasant odor and taste constituents from guar meal. Priority 1.
b. Determine the chemical composition (proximate analysis, amino acid and fatty acid composition, etc.) and nutritive value of processed guar meal products and identify trace constitutents that may affect processing and utilization of the meal. Priority 1.
c. Evaluate raw and processed guar meal in rations for livestock in terms of palatability, relative intake, growth and feed efficiency. Priority 2.

Summary of Proposed Research Activity for Processing, Utilization, and Feed Products from Guar.

	Proposed SMY Activity			
RPA Number	Current	No Increase	10% Increase	Recommended
406	0.0	0.0	0.0	0.1
407	0.0	0.0	0.0	0.2
Total	0.0	0.0	0.0	0.3

RPA 501 Improvement of Grades and Standards, Supply, Demand, and Price Analysis of Guar

1. SMY Situation:

Support Level	SMY Number	RPA Distribution
Current	0.0	
No Increase	0.0	
10% Increase	0.0	
Recommended	0.1	501

2. Priority: 3

3. Situation:

Reliable forecasts of supply, demand, and prices of guar are essential to efficient and orderly production and marketing. Timely and accurate forecasts are required to enhance guar's competitive advantage. Individual producers, processors, marketing firms, and end-users base daily decisions upon information concerning probable future supply, demand and price conditions. Some large firms employ staffs to carry out sophisticated analyses of the many interrelated factors that must be considered in forecasting supply and demand for the major crops. Small firms, farmers, and consumers do not have the resources for such analyses. Thus, public economic research is needed to provide continuous appraisal of the current and prospective economic position of guar with competitive crops.

Effective grading standards assist buyers in obtaining product characteristics they desire and sellers in obtaining appropriate returns for what they sell. The adoption of grades and grading standards for guar are needed to accurately reflect the potential use values of differing bean qualities and as a basis for establishing purchase prices of guar beans.

4. Objective:

   a. Develop new and improved data series on supply, demand and prices of guar, guar meal and guar gum; analyze the effects of changes in domestic and foreign guar supplies on prices in the U. S.; identify and evaluate guar gum quality requirements for domestic and foreign industry use; evaluate the international gum situation from all sources and its effect on U. S. guar gum trade; keep producers abreast of changes in current production, demand, and probable trends in both domestic and foreign supply and demand of all gum products.

5. Research Approaches:

   a. Identify critical gaps in domestic and foreign data for guar and other competitive gum crops. Priority 1.

b. Regularly compile, assemble, and disseminate to producers and industry the supply, demand and price situation on all gum products. Priority 1.

c. Utilize economic methodology and statistical techniques that identify and measure economic relationships and provide an accurate situation and outlook program. Priority 2.

d. Cooperate with the Agricultural Marketing Service and guar industry representatives in the development of grading standards for guar. Priority 2.