Northern Utilization
Research and Development
Division

Agricultural Research Service U. S. Department of Agriculture

United States Department of Agriculture

Agricultural Research Service

Washington 25, D.C.

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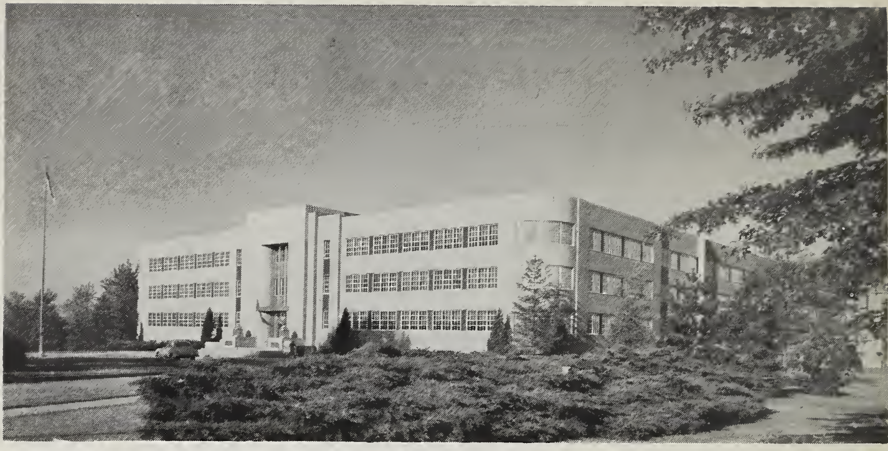
Pioneering Laboratory for Microbiological Chemistry

June, 1961

The Northern Division



A Welcome

Our guides will be glad to show you around the building and explain our work. We hope that your visit will be interesting as our guides reveal many ways in which we are finding new uses for farm crops and their products. If you have technical interests, members of our scientific staff will discuss them with you.

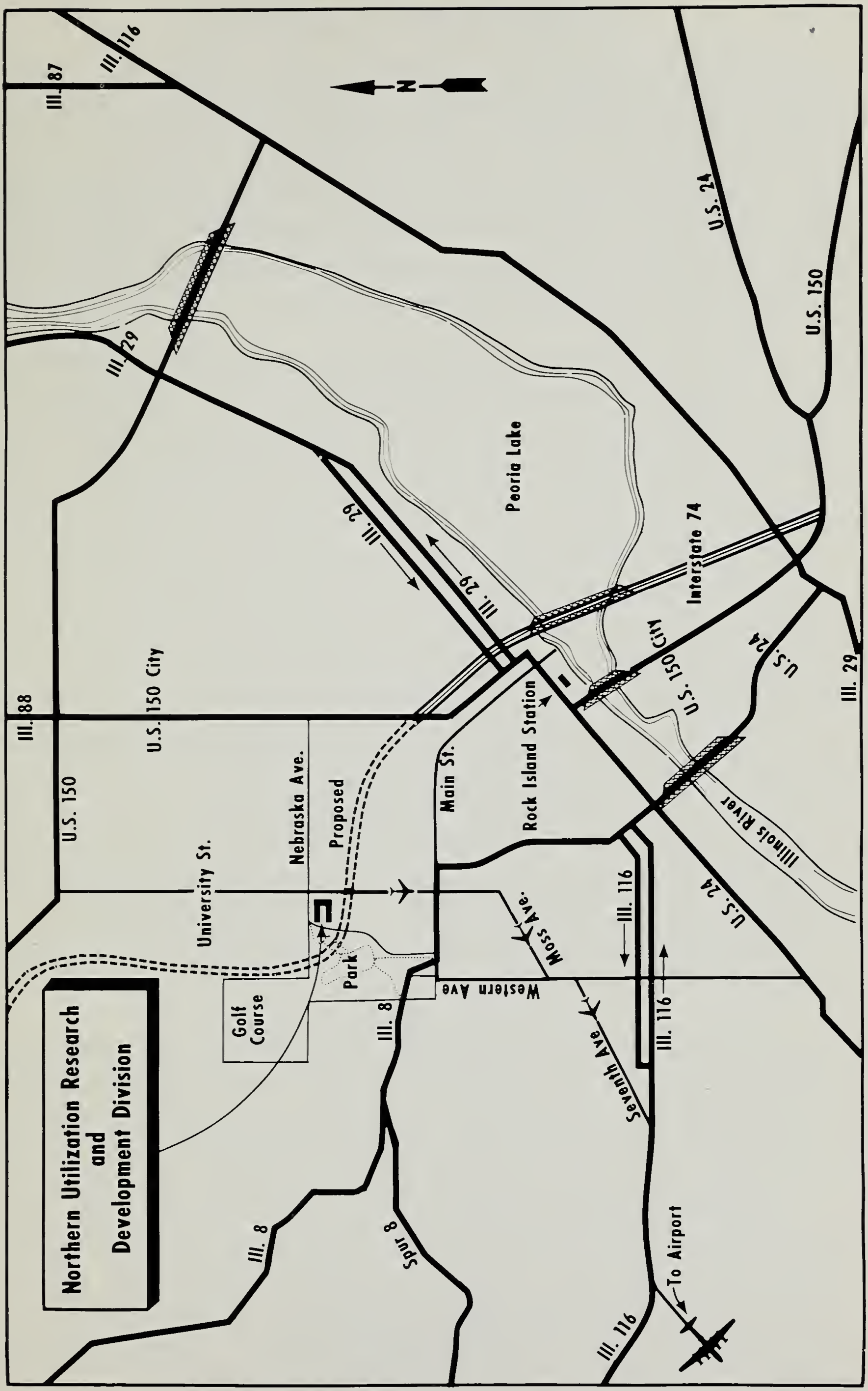
If You Plan To Bring A Group

Arrangements for tours by groups should be made in advance. Children 12 years of age or over may be included in tours. Foreign nationals must have proper clearance through their embassies or their sponsors.

About The Map

The Northern Utilization Research and Development Division is located in Peoria, Illinois, at 1815 North University Street (where University intersects Nebraska Avenue). It is about 2 miles from downtown and may be reached on the University bus. Telephone: 682-5481.

Hours: 8 a.m. to 4:30 p.m., Monday through Friday, except holidays.



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Northern Utilization Research
and
Development Division
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University St.
Nebraska Ave.
Proposed
Golf
Course
Park
Ill. 8
Spur 8
Main St.
Rock Island Station
Western Ave
Moss Ave.
Seventh Ave
Ill. 116
To Airport
Peoria Lake
Interstate 74
City
U.S. 150
U.S. 24
Illinois River
U.S. 24
U.S. 150

Origin and Purpose

Agricultural utilization research is an organized effort through science and technology to increase present uses and to discover and develop varied new uses for farm products.

Our farmers need new markets and strengthened demand for their output. This is particularly true of those commodities now in surplus. The Nation also needs the new and better products that science can create from agricultural materials.

Utilization research was carried on in small isolated laboratories until passage of the Agricultural Adjustment Act of 1938. This Act directed the Secretary of Agriculture "to establish, equip, and maintain four regional research laboratories, one in each major farm producing area, and at such laboratories to conduct researches into and to develop new scientific, chemical, and technical uses and new and extended markets for farm commodities and products and byproducts thereof. Such research and development shall be devoted primarily to those commodities in which there are regular or seasonal surpluses, and their products and byproducts. . . ."

Accordingly, a utilization research laboratory was located in each of the four major farm producing regions. They are the Northern, Southern, Eastern, and Western Utilization Research and Development Divisions. They are administered by the Agricultural Research Service of the U. S. Department of Agriculture, and they conduct research on the principal agricultural commodities in their respective regions.

General information about these Divisions is given inside the back cover.

Construction of the Northern Regional Research Laboratory, headquarters of the Northern Division, started with groundbreaking on June 8, 1939, and cornerstone ceremonies were held October 18. A staff of about 80 moved into the completed building December 16, 1940.

Important problems for inclusion in the research program are determined through discussion and consultation with (1) USDA Research and Marketing Advisory Committees representing all major interests, (2) State Agricultural Experiment Stations, (3) farm cooperatives, (4) rural or agricultural groups, (5) trade associations, and (6) industrial and other research organizations.

The Research Program

The Northern Utilization Research and Development Division conducts research on corn, wheat, grain sorghum, and other cereal grains; soybeans, flaxseed, and other oilseed crops; and new crops. Our objectives are to help farmers derive more income from their crops through expanded markets, to help industry convert agricultural raw materials into new and improved products, and to bring to consumers more of the good things needed for better living.

Some Typical Research Developments

Effectiveness of research organizations such as the Northern Division can be partially evaluated by their fundamental and applied research accomplishments. Our contributions have opened new and expanded outlets for farm products and have received national and world recognition. Several developments have provided the foundation for new or expanded industries. Many have provided fundamental information for applied and developmental research. All have contributed to new uses and outlets for agricultural products and to the betterment of man. These accomplishments are listed below, and some are described on page 21.

Cereal Crop Developments

By Fermentation

Vitamins B_2 and B_{12}
Penicillin, polymyxin, and hydroxystreptomycin
Dextran—a blood plasma expander
Gibberellin—a plant growth hormone
Sodium gluconate and 2-ketogluconic acid
Fungal amylase process for the production of industrial alcohol
War alcohol from wheat

By Chemistry and Engineering

Synthetic protein fibers from zein
Saccharic and glucuronic acid processes
Batter process to produce starch and gluten from wheat flour
Waxy corn and sorghum for new starch
Wet milling wheat for starch
Wet milling sorghum for starch, gluten
Water-soluble zein—a new commercial product from corn gluten
Process for dialdehyde starch
Development of high-amylose corn
Wheat straw pulp, paper, fiberboard
Pulping agricultural residues
Ground corncobs for soft-grit blasting

These developments alone have contributed materially to the industrial utilization of some 400 million bushels of wheat and corn and about 7 million tons of wheat straw.

Oilseed Crop Developments

Oil Products

Polyester rubber (Norepol)
Polyamide resins (Norelac)
Dimer acid derivatives
Conjugated oils

Flavor Stability — Soybean Oil

Importance of inactivating metals
Citric acid as a metal scavenger
Phytic acid as a metal scavenger
Procedures for evaluating flavor and quality
Establishment of linolenic acid as the major off-flavor precursor

Meal Products

Preparation and properties of soy protein
Adhesives for shotgun shells
Alcohol-washed flakes and Gelsoy
Toxic factor in trichloroethylene-extracted soybean oil meal
Improved export value of soybeans

These accomplishments have contributed importantly to the utilization of soybeans, a crop that amounted to nearly 600 million bushels in 1960.

New Crop Developments

Seven new types of oils having promise for industrial applications

One native weed *(Crotalaria)* producing seed that offers a source of gum to replace at least part of the 40 million pounds now imported

Species of kenaf, okra, and sorghum that give pulps comparable to wood and that produce high yields of dry matter per acre.

We aim at a goal of 1 to 5 million acres of new crops in production by 1975.

How We Operate

Our program includes fundamental and developmental research in chemistry, chemical engineering, fermentation and related physical and biological sciences.

Work on a problem is generally initiated on a small scale in the laboratory. If laboratory results are promising, chemical engineers carry out pilot-plant studies to provide engineering and cost data that will encourage early adoption and application by industry.

Major projects are undertaken by research teams composed of leading scientists and assistants in related scientific fields, drawn from two or more of the research laboratories. Our success on penicillin, vitamin B_2, dextran, fungal amylase, soybean oil flavor stability, among others, was accomplished by research teams of considerable size.

Extensive cooperative programs are undertaken with interested groups. Occasionally preliminary pilot-plant research is undertaken by industry and, when feasible, tried out on a large scale in their plants. Cooperative agreements or memoranda of understanding formalize these relationships to divide or share responsibility and cost of investigations. Research contracts are negotiated with other public or private agencies that are especially equipped to accomplish the job more effectively, in less time, or at less cost. The Northern Division serves as a center for scientific and technological research information and for consultation on the chemistry and use of our assigned commodities.

Our scientists present the results of their research at numerous regional and national scientific and technical meetings and conferences. Results of our work are published widely in scientific, trade, and agricultural journals and USDA publications.

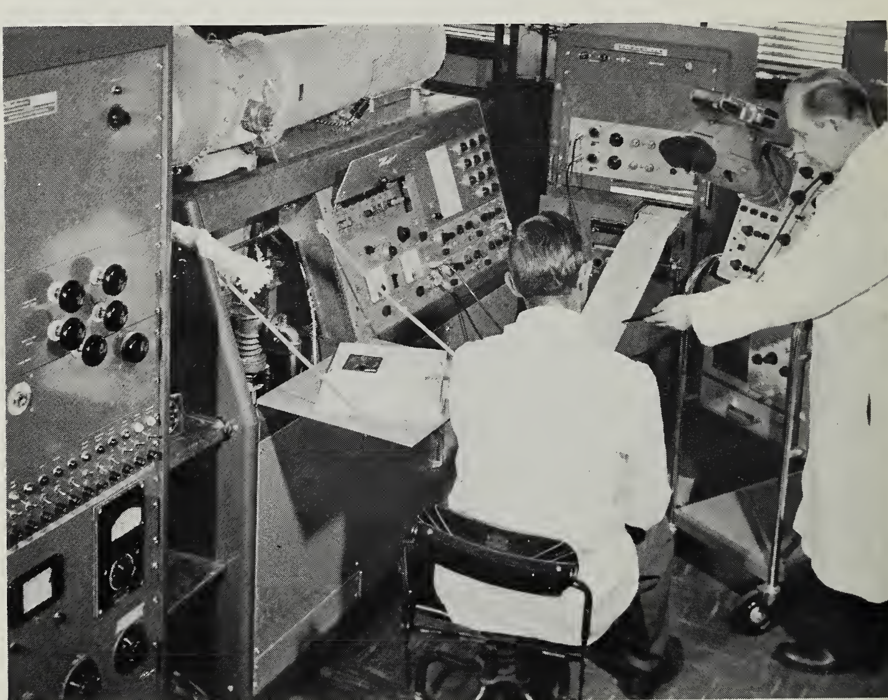
Public service patents are obtained on new methods, processes, or products, to protect the public interest. These are available to private industry under royalty-free, nonexclusive, and nontransferable licenses.

Part of the dry-milling pilot plant where wheat is milled and flour ground finer before separation by air classification into fractions for different uses.

Facilities for Research

The modern, air-conditioned laboratory building houses approximately 90 chemical and special laboratory rooms and a pilot plant, all equipped with the most modern scientific apparatus and equipment essential to the effective prosecution of our research program. The building also has a high-pressure hydrogenation room, refrigerated and other constant-temperature rooms, a taste-panel laboratory, and other specialized facilities.

Supporting facilities and services include: Engineering design and drafting service, mechanical and instrument shops, glass-blowing, scientific photographic laboratory, scientific library, technical editing, information, patent, duplicating, stenographic, and other office services.



This mass spectrometer is used to identify new fatty acids formed in the hydrogenation of soybean oil and for analysis of volatile odor and flavor components of edible oils. Built to the Northern Division's specific requirements, the instrument is the first in the world to have a heated time-of-flight tube (top, left) which facilitates the study of high-boiling compounds, including some fatty acids.

The technical library contains more than 24,000 volumes on chemistry, chemical engineering, microbiology, and related sciences and subscribes to 400 technical and trade periodicals. Collections of the Library of Congress, the USDA Library, and many other libraries are available by loan.

Organization for Research

About 300 of our staff of approximately 400 are highly trained scientists and technicians. The remainder provide administrative and office services, operation and maintenance of building, and mechanical and related services for research. All positions are within the Federal Civil Service.

The technical staff is organized into seven research laboratories, essentially on a commodity basis. The laboratories and their commodities are listed. A brief discussion of each research program follows.

Laboratories and Commodities

Cereal Properties	Corn, wheat and other cereals
Cereal Products	Corn, wheat and other cereals
Fermentation	Corn, wheat and other cereals
Oilseed Crops	Soybeans, flaxseed and other oilseeds
Industrial Crops	New crops
Engineering and Development	All commodities
Pioneering Laboratory for Microbiological Chemistry	

Cereal Properties Laboratory

A complete knowledge of the components of cereal grains and a clear understanding of the properties of these components are the foundation of applied research to develop industrial uses for cereals. Therefore, we study the composition of cereal grains and the structure of their components; develop new reactions to modify or transform these components; and investigate quality evaluation and control.

Studies of Composition

Our continuing studies on the chemical and physical-chemical properties of starch, proteins, and other cereal grain components and derived products and microscopic structure of grain kernels are providing the foundation for new and improved applications of cereal products. Analyses are conducted annually on thousands of samples of high-amylose corn as a part of our cooperative program.

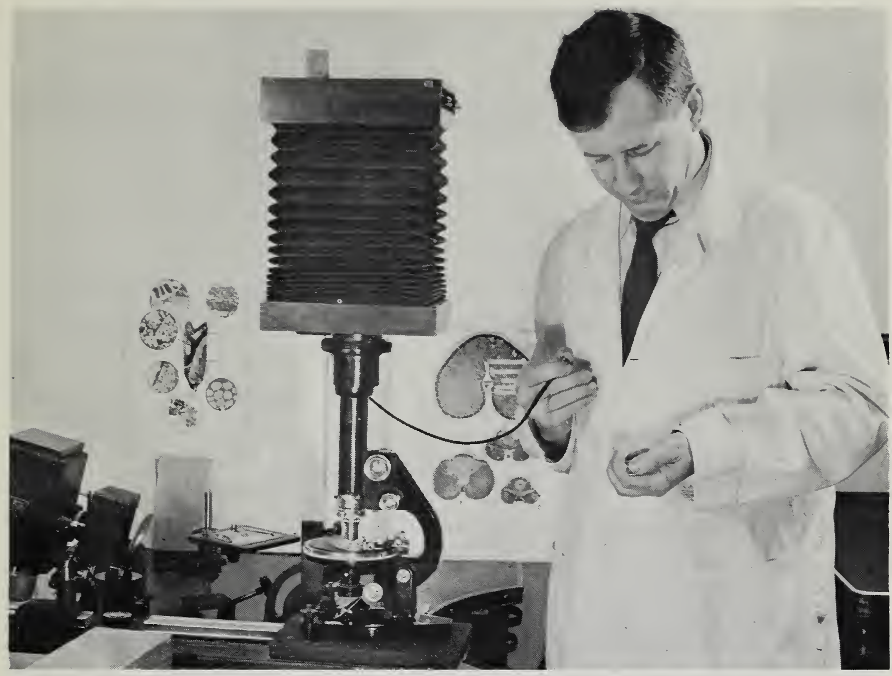
Details of composition and structure of grain kernels are showing processors the composition of their raw materials. This information is used to improve processes and to evaluate new separation procedures.

Grain Conditioning

The amount and distribution of moisture in the grain kernel affect milling. Adding moisture to grain, or conditioning it, is based largely on experience since much of the past research is inconclusive and contradictory. This is due in part to lack of methods for determining the path followed by the conditioning moisture. We have developed special procedures for determining moisture at various strata of the kernel and for determining the moisture content of starch granules. These procedures are now being used to study the effect of conditioning on the breakdown of the kernel by milling and on the release of starch and protein particles from products obtained under widely varying treatments during conditioning and milling. Such information forms the basis for practical studies on the development of new and industrially useful fractions from the milling of grain.

Starch Properties

Starch is a mixture of amylose, a linear polymer, and amylopectin, a branched-chain polymer. These components have different properties,



Basic research, including studies of the microscopic structure of cereals, provides the foundation for applied and developmental work.

which we have studied for some years. Information gained from these studies assists in developing new applications of starch. Other work includes search for new reactions which modify starch to give products with new properties.

Wheat Gluten

For many years wheat gluten was believed to be comprised of two proteins, glutenin and gliadin. Our work has shown that wheat gluten has at least seven distinct components. These components are being isolated and will be analyzed to determine their amino acid composition. The next step, which will be extremely difficult, will be to determine what each component contributes to the properties of the gluten. This work ultimately may explain, for example, the difference between gluten in wheat that makes good bread and gluten in wheat that does not. Armed with such knowledge, our chemists can use the properties of gluten to develop new industrial products.

Cereal Products Laboratory

In this laboratory we conduct research on the conversion, modification, and formulation of cereal grains, their fractions, and constituents into useful products. Then, we evaluate and develop them for use by industry.

Dialdehyde Starch

We have developed an electrolytic process and equipment to oxidize starch with periodic acid to a new polymer, dialdehyde starch. This work has resulted in promising new chemicals for use in producing stronger papers, for leather tanning, for crosslinking proteins, and as raw materials for new chemical derivatives. Dialdehyde starch is now in commercial production for industrial uses.

High-Amylose Corn

Amylose is the fraction of starch characterized by linear-type molecules. About 27 percent of the starch in ordinary corn is amylose. The rest is amylopectin in which the molecules are much branched and thus have a bush-like form. We are collaborating with plant breeders in developing corn in which most of the starch is amylose. As a result of the genetic development of corn high in amylose, semicommercial production of these new varieties has begun and several thousand bushels of high-amylose corn are now grown annually.

Amylose is potential raw material for products such as films, textile fibers, and superior sizings. Amylose films are edible; they may be excellent for wrapping foods. Chemical modification of amylose is expected to provide improved polymeric materials and chemicals for industrial applications.

Modified Starches and Flours

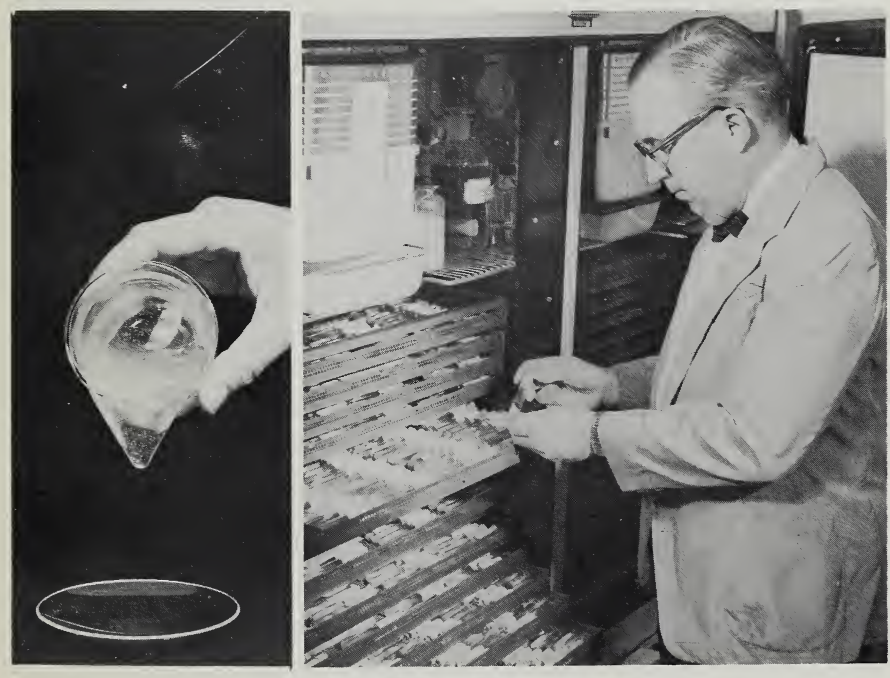
We are studying chemical and physical modifications of cereal starches and flours. Modifications may answer today's industrial demands for products having different and more valuable properties than the natural starches and flours. Demands by industries, such as paper and paper-products manufacturers, for specific and specialty materials are increasing. Hence, we seek new industrial materials from flour and starch by chemical reactions such as oxidation, etherification, esterification, chlorination, and substitution.

Fermentation Laboratory

Under man's control bacteria, molds, yeasts, and other microorganisms can perform reactions that man cannot produce with chemicals. Our Fermentation Laboratory uses microorganisms to develop new industrial processes and products and thus to achieve wider utilization of agricultural products. In this program, our fermentation scientists also conduct fundamental research and maintain a permanent collection of agriculturally and industrially important microorganisms.

ARS Culture Collection

This permanent collection is the largest of its kind in the world. It includes about 9,000 species and strains of bacteria, molds, and yeasts. From it our scientists select microorganisms and study them



A new gum produced by the action of microorganisms on a starch derivative has high viscosity at low concentrations. Bacteria, molds, and yeasts used in such research are collected and maintained in the ARS Culture Collection, part of which is shown at right, above.

for the production of antibiotics, vitamins, enzymes, organic acids, alcohol, feed supplements, polymers, and other compounds.

Typical developments resulting from the use of microorganisms are new or improved processes for the production of penicillin, vitamin B_2, vitamin B_{12}, sodium gluconate, dextran, other polysaccharide gums, and foods from soybeans. More than 2,000 cultures are furnished industrial companies and research laboratories annually for use in (1) converting agricultural commodities into many different kinds of commercial products including specialized foods and feeds, (2) controlling the harvesting and marketing of food materials, and (3) conducting scientific research.

Our scientists identify and classify microorganisms and study their characteristics and capabilities. The Mucorales, *Streptomyces, Hansenula,* and *Pseudomonas* are groups currently being investigated. The collection is constantly being expanded.

Industrial Chemicals by Fermentation

Research on the use of bacteria, molds, yeasts, and other microorganisms to convert agricultural materials into useful industrial chemicals is a continuing endeavor. Typical desired products are enzymes, solvents, and polymers. Organic acids such as citric, fumaric, itaconic, and gluconic also can be produced by fermentation of sugar or starch. Two new polymers, phosphomannan Y-2448 and polysaccharide B-1459, show promise for many uses in foods, beverages, pharmaceuticals, and industrial applications where high-quality gums are required. Many gums are now imported.

Microbial Insecticides and Insect-Control Chemicals

Production of spores of certain bacteria is being studied in the program to control the Japanese beetle. Products derived from cereal grains by fermentation may become effective and economical insecticides or insect repellents or lures. Practically all of the crops annually grown on about 400 million acres of crop land in the United States are damaged by one or more destructive insects.

Antibiotics for Controlling Plant Disease

Our microbiologists are also screening and testing large numbers of microorganisms in a search for antibiotics to control plant disease.

Oilseed Crops Laboratory

In this laboratory we conduct fundamental, applied, and developmental research on soybeans, flaxseed, and safflower seed. To extend use of these crops in foods, feeds, and industrial products our chemists study the chemical and physical properties of the oil, protein, and other constituents of the oilseeds to obtain new processes and products.

Soybean Oil in Foods

The largest single use of soybean oil is in margarine and vegetable shortening. However, very little is used as a liquid oil because one component of the oil, linolenic acid, is unstable. Our chemists seek to improve soybean oil as a liquid food oil by methods that will convert linolenic acid into a more stable form without altering the highly desirable characteristics of the oil. Additional research is needed to obtain liquid soybean oil products competitive with other liquid oils in price and quality. Basic studies on autoxidation and selective hydrogenation are being conducted.

Soybean Proteins

Crude and isolated proteins are now used commercially in adhesives and in paper sizings and coatings. Our chemists are working on methods to improve the stability toward microbial decomposition of crude soybean protein to extend its industrial application.

Soybean meal is a valuable livestock and poultry feed because it contains much high-quality protein but more information is needed about its composition and how better to eliminate or inactivate any antinutritional substances it may contain. Such components are presently inactivated by heating.

Our chemists have developed procedures for isolating pure protein components from soybean meal and are studying the chemical composition, properties, and feeding value of these components. They have also found methods for treating soybean whey to recover proteins and biologically active substances such as enzymes and a previously unknown form of the antitrypsin factor, a proteinlike substance that interferes with the digestion of protein.

Other studies concern how to make soybean food products more acceptable particularly in foreign markets. Thus, recent work that showed better ways for using American soybeans in Japanese foods resulted in sharply increased exports of soybeans to Japan.

Vinyl Ether Coatings from Soybean Oil

Industrial processes convert the fatty acids of soybean oil into their corresponding fatty alcohols. Our chemists have reacted these alcohols with acetylene to give vinyl ethers. The vinyl ethers, alone or with other monomers, can be polymerized to produce films with promising industrial possibilities as protective coatings. The coatings are flexible, adhere well to metallic surfaces, and resist many common solvents and chemicals.

Aldehyde Oils

Our chemists recently have developed reactions of soybean or linseed oils or their fatty acids with ozone to produce new materials. We call them "aldehyde" oils. They appear to have considerable possibilities for new products in industrial outlets; for example, a new kind of plastic has been made from one of them. Use of a chemical derivative of aldehyde oil as a component of polyester resins led to the discovery of a new catalytic method for crosslinking or curing these resins so that they will harden and resist heat and solvents.

Linseed Oil Emulsion Paints

The major use for linseed oil is in exterior paints. This market is being threatened by emulsion paints based on synthetic resins. Our chemists are engaged in a cooperative research program with the linseed oil industry to develop water-emulsion paints from polymerized linseed oil. Preliminary results are encouraging.

Experimental, linseed oil emulsion paints have been made.

Industrial Crops Laboratory

In a search for new agricultural sources of raw material for industry, our Industrial Crops Laboratory examines the chemical components of plants that are not grown as American crops. Of more than 250,000 known species of higher plants in the world, only 90 to 100 are cultivated commercially in the United States in quantities having a market value of $1 million or more. Possibly among the unused species are plants potentially as valuable as the soybean which, within a few decades after its introduction from the Orient, has become an important source of oil and protein in this country.

Our scientists work closely with scientists in the Crops Research Division to develop plants with components valuable to industry but that will not compete in the market with crops presently grown. The soybean, for example, generally is grown where corn could be grown, but its oil and protein do not compete on the market with corn starch.

Our new crops research initiated in 1956, includes chemical research on plants to discover and characterize components of potential value and evaluation and development of the components of new plants assigned to this Division. We evaluate the components of wild and cultivated plants from all over the world to find pulp fibers and new oils, proteins, and plant gums. Amounts and properties of the components are appraised for potential use. A species found desirable is assigned to a utilization division for development.

Erucic Acid Oils

Erucic acid oils have been assigned to this Division. Erucic acid contains 22 carbon atoms per molecule, more than ordinary fatty acids. Chemical derivatives and reaction products of erucic acid and of oils containing it are being studied to find new products.

Fibrous Products

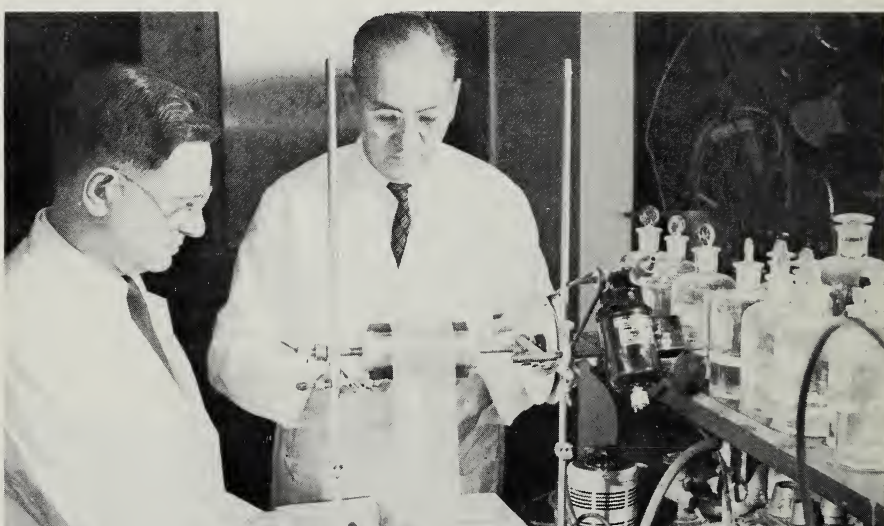
We are studying the amount and quality of cellulose fibers in annual plants and evaluating them as raw materials for the pulp and paper industry, which uses millions of tons of pulp each year.

Engineering and Development Laboratory

Our engineers convert laboratory discoveries into economic, industrial-scale processes and develop new and improved commercial processes. They design, install, and operate pilot-plant equipment to obtain operating information, commercial plant-design data, and plant and product costs. They produce pilot-plant quantities of new products for evaluation by industry.

Microbial Polysaccharides

Production of polysaccharides by microbial fermentation promises new gums from cereal derived raw materials. Our engineers have converted the laboratory processes into pilot operations. Processing improvements that will significantly reduce plant and product costs for the industrial production of these gums are our objectives. Over 175 companies have received samples of the gums for testing and evaluation. One of the gums is now being produced commercially.



Extruded amylose film is wound on a reel as it emerges from a coagulating bath. Film is a potential industrial product of high-amylose starch.

Corn Dry Milling

About 100 million bushels of corn are used annually by dry millers. Corn grits, corn oil, and feeds are typical products. We are studying equipment and processing procedures to learn how better products can be produced at lower costs. Typical studies concern tempering methods, better and cleaner degermination, and controlled fractionation of the corn kernel.

Fine Grinding and Air Classification

By a special milling technique, cereal flours may be separated into fractions that contain varied proportions of starch and protein. This is accomplished by grinding flour to a controlled degree of fineness and separating it into fractions with moving air. Our engineers are studying the technique and its adaptability to various species and types of cereal grains in a pilot plant equipped with mills, classifiers, and analytical equipment. They are especially seeking wheat-flour fractions suitable for industrial uses.

High-Amylose Corn Processing

Since processing of high-amylose corn differs from that of ordinary corn, our engineers are studying processing methods and recovery of amylose starch. This work is needed to show how to process satisfactorily the present varieties of high-amylose corn, as well as varieties containing higher amylose levels that may become available in the future, and to guide the genetic development of easy milling varieties. These processing studies also provide samples of high-amylose starch for evaluation by potential industrial users and for our own chemical research on modification and uses.

Fatty Acids from Vegetable Oils

Vegetable oils such as soybean, safflower, and linseed are excellent raw materials from which to recover fatty acids such as linoleic and linolenic acids. Recovery processes, including solvent extraction methods, are under development by this laboratory. A stable and low-cost supply of these pure fatty acids may expedite their use in materials such as coatings, plastics, and other industrial products. This would increase the use of oils obtained from important agricultural crops.

Pioneering Research

The developments described in this booklet have resulted in large part from basic information on the composition, structure, and properties of agricultural products; new reactions; and new methods, techniques, and approaches. Such basic research will continue as an essential part of each laboratory.

The scope of our research effort today is much greater than it has ever been, and to keep pace with ever-increasing demands we need pioneering research to develop and explore new theories, concepts, and principles. The Agricultural Research Service therefore in 1957 organized a number of small pioneering research laboratories to help meet this need for more long-term, basic research.

The pioneering laboratories are headed by outstanding scientists with an aptitude for pioneering research in specific fields. These scientists have the freedom to explore the unknown and to work in an atmosphere especially conducive to intensive exploration of the frontiers of science important to agricultural programs.

Pioneering Laboratory for Microbiological Chemistry

In this laboratory we study fundamental problems in microbiological chemistry. Our scientists explore the chemical pathways whereby microorganisms degrade molecules to obtain energy they need for carrying out their biological functions. This information will aid in the understanding of metabolic processes. The research includes:

(1) Isolation and structure determination of extracellular sphingolipides produced by some yeasts. The work should be helpful in elucidating the synthesis of complicated lipids in the cell.

(2) Determination of the nature of the chemical bonds that hold together light absorbing units responsible for photosynthesis in cells. This information is important to our understanding of cell functions.

(3) A detailed study of the sequence of reactions involved in the formation of zymonic acid from sugar. This acid is produced by yeasts from at least eight different genera. This suggests a basic reaction that may be used by yeasts and other forms of life.

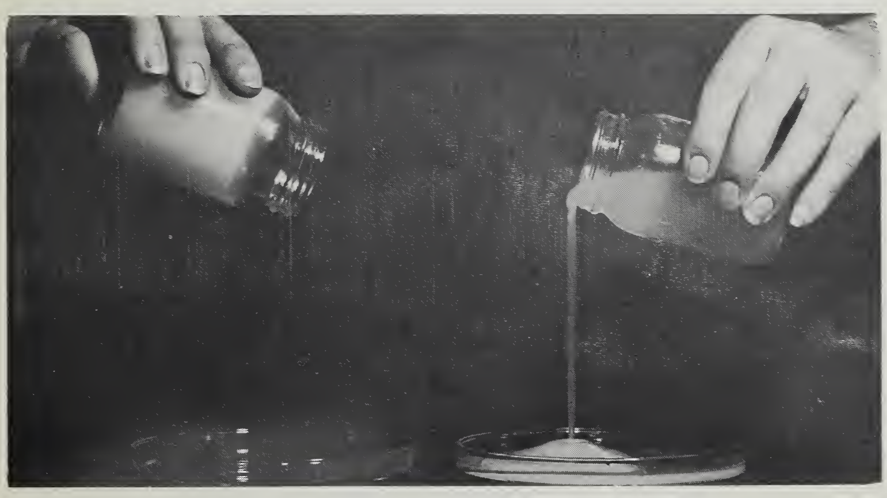
Selected Accomplishments

Publications, Presentations, and Patents

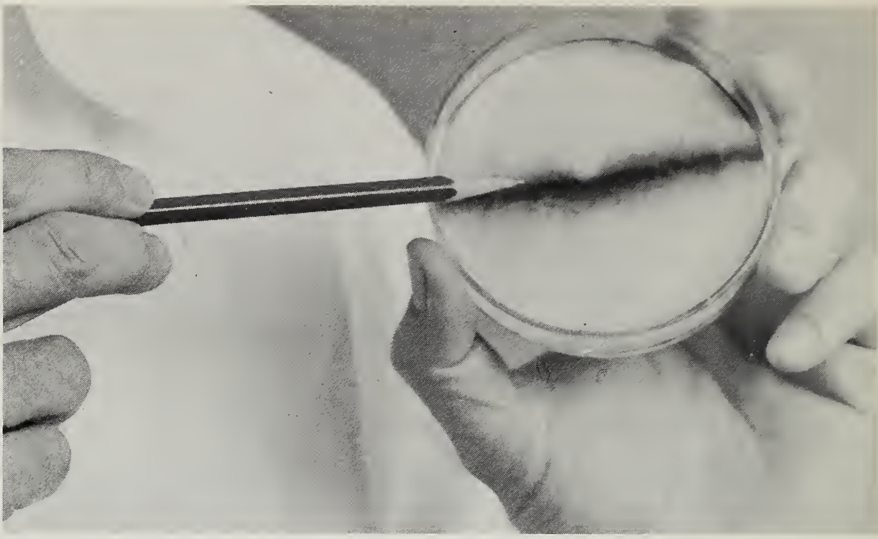
We have published over 1,100 scientific and technical papers, presented over 900 papers to technical societies describing original research. We have been granted over 250 United States patents which are assigned to the Secretary of Agriculture and dedicated to the public. These represent a major contribution to science and form the foundation for increased utilization of our commodities.

Industrial Consultation and Conferences

Furnishing the day-to-day scientific and technical information to visiting scientists interested in the utilization of agricultural products represents another major contribution and indicates recognition and standing in the field. An average of over 1,000 technical visitors seek the advice of our scientists annually. Among these visitors are those attending special conferences arranged for and requested by various commodity, industrial, and scientific groups; over 140 such conferences have been held by the Division. We meet each year with the Millers National Federation, Soybean Research Council, the Corn Industries



Pastes made from chemically modified wheat flours have potential uses as thickening agents, adhesives, and coatings and sizes for paper and textiles. The modified flours form pastes, right, in water more easily than ordinary flour.



A culture plate that has been inoculated with plus and minus strains of a mold used to produce beta-carotene by fermenting cereal grain products. Below the surface of the black zone, where the two strains mate, the culture has the typical orange color of beta-carotene. The mating increases the production of the carotene, a source of vitamin A.

Research Foundation, the National Soybean Processors Association, and the National Flaxseed Processors Association.

Awards

The U. S. Department of Agriculture has presented this Division with 5 Distinguished Service Awards and 36 Superior Service Awards, Of these, 7 were team awards. Distinguished Service Team Awards were received for penicillin (17 people) and dextran (84 people). Superior Service Team Awards were received for riboflavin (11 people), soybean oil flavor stability (18 people), fungal amylase (20 people), zein fibers (2 people), and administrative management (27 people). The other 34 awards were presented to individuals for outstanding contributions to agriculture and science in the course of their research.

We received the Lasker Group Award from the American Public Health Association in 1946 for studies leading to the mass production of penicillin.

GPO 809755—4

Other awards include: Glycerine Research Award ($1,000) from the Glycerine Producers Association for research on glyceride structure of vegetable oils by countercurrent distribution; Garvan Medal of the American Chemical Society for research on dextran as a blood plasma extender for national defense; 3 Centennial Awards by Universities for outstanding contributions in research in the fields of chemistry and fermentation; 1 Outstanding Achievement Award by the University of Minnesota for outstanding contributions to the chemistry of microorganisms; the A. E. Bailey Medal from the American Oil Chemists' Society for outstanding research contributions to the technology of soybean oils; on two occasions the American Oil Chemists' Society presented an award, including the Bond Award, for the best paper presented; Bronze Medal from the Commission of Association of Chemists of France for another paper; first place Oberly Memorial Award for the best bibliography in agriculture and related sciences, by the Association; award by Columbus Institute for Education by Radio.

Penicillin Production and Commercialization

This Division's outstanding achievement probably is the development of a process for the commercial production of penicillin. This achievement also launched the antibiotics industry, which in 1958 produced goods having a value of more than $350 million at the factory.

Our scientists developed a deep-vat process that was industrially practical. In a survey they found one mold that would produce penicillin in submerged culture. The addition of corn steep liquor and lactose to the medium increased the yield greatly. Altogether the yield was increased over a hundredfold. Methods for recovery and purification of the penicillin were found. The essential procedures are still used.

Based on our studies, penicillin was converted in a short time from a laboratory curiosity to commercial reality. It was invaluable for treating casualties in World War II. Since then it has practically removed pneumonia and a number of other diseases from the serious category. It is also widely used as an ingredient of animal feeds.

Dextran—Blood Volume Expander

In the event of atomic bombing or other national emergency, the supply of blood and blood plasma would be insufficient for adequate treatment of the enormous number of casualties occurring from burns, shock, and hemorrhage. In view of the vital need of the Armed Forces and Civilian Defense for a satisfactory blood plasma extender that could be used in such an emergency, a comprehensive program on dextran was initiated at the Northern Division early in 1951. Dextran is a starch-like carbohydrate of very large molecular weight that is produced when certain species of bacteria grow on cane or beet sugar.

About 60 scientists undertook to obtain sound scientific background on dextran and its uses and to find better ways of making it. As a result of their findings, commercial production of satisfactory clinical dextran was achieved in a comparatively short time.

Dextran has several important advantages as a plasma extender: It can be produced economically in large quantities from readily available materials; it is stable and can be stockpiled without refrigeration for future use; and it does not transmit a virus-type hepatitis (jaundice). It should be emphasized, however, that the availability of clinical dextran does not lessen the urgent need for whole blood, and the Blood Bank Program is and will continue to be necessary.

Gibberellin—A Plant-Growth Regulator

In 1951, research was initiated to develop a reliable fermentation process for the production and purification of gibberellin. A workable process based on glucose and the fungus *Fusarium moniliforme* resulted.

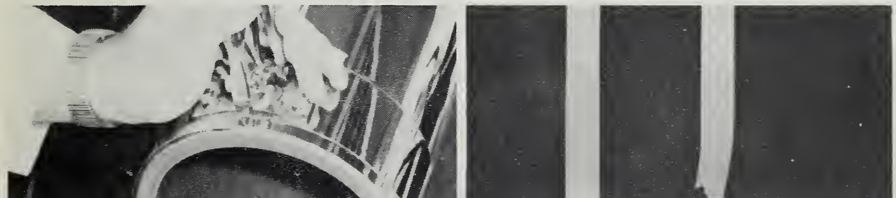
A number of companies are now producing gibberellin, and it is an important plant-growth regulator in the United States and the world. In addition to the publications reporting our laboratory and pilot-plant results, our Division has published a Source Book on Gibberellin for the period 1828-1957. This book contains 138 pages of general information and about 400 pages of abstracts.

Microbial Feed Supplements

Vitamins B_2 and B_{12} and penicillin, added to feeds, are known to increase the growth efficiency of poultry and swine. By development of fermentation processes for production of vitamins and antibiotics, our scientists aided in lowering the cost of these products for use as feed supplements and in bringing about a multi-million dollar expansion in the fermentation and feed industries. These processes use large quantities of agricultural products and byproducts such as milk sugar, corn sugar, corn steep liquor, and distillers' solubles.

Polyamide Resins from Soybean Oil

During World War II the Northern Division developed from soybean oil a new film-forming resin which has superior properties as a heat-sealing protective coating for paper and other materials. Since 1947 a variety of these resins has been produced commercially. These resins are used in the heat-sealing of food packaging materials, as a thickening agent in gel paints, as a glossy coating for paper and wood, and, mixed with sand and epoxy resins, as a patching and resurfacing material for concrete floors, ramps and roads.



At left is a device for making paper handsheets. At right, a demonstration shows that dialdehyde starch increased the wet strength of the paper on the left, which supports a load 10 times as large as the one that has broken the untreated paper.

Stable Soybean Oil for Food Uses

Basic investigations by this Division on soybean oil have shown that traces of iron and other metals in the oil hasten the development from linolenic acid (an unstable component of the oil) of the off-flavors that make the oil less suitable than competitive oils for certain food uses. Our oil chemists discovered chemical compounds and procedures for adding these compounds to soybean oil to inactivate these metals and thus retard the development of off-flavors. They also showed that it is necessary to avoid oxidative deterioration of the oil prior to deodorization because undesirable byproducts are formed that remain in the oil. Based on use of a highly trained taste panel and statistical analysis of data supplied by this panel, special methods were devised for reliable detection of differences in flavor among oil samples. These methods are now widely used by industrial producers of edible soybean oil.

The Division's research was of primary importance in the establishment of soybean oil as the major oil used in U. S. foods. Annual consumption of edible soybean oil exceeds 3 billion pounds.

Soybean Glues for Shotgun Shells

Our scientists developed a superior water-resistant glue from soybean protein. Low-priced and readily available, it is used in making over half of the millions of shotgun shells produced in this country each year and has provided a major outlet for soybean protein.

This work also contributed to the increased utilization of soybean protein as an adhesive for paper lamination in boxboard.

Fungal Amylase Processes for Alcohol

Fermentation of starch to ethyl alcohol first requires the conversion of the starch into fermentable sugars. The Northern Division surveyed several hundred fungi for new sources of starch-converting enzyme or amylase. Several strains of the fungus *Aspergillus niger* were found to produce fungal amylase, which can be used in place of barley malt, gives alcohol yields equivalent to those obtained with malt, and reduces manufacturing costs by 2 to 5 cents per gallon of alcohol. Corn and wheat, even if damaged, can be used in connection with the fungal amylase process.

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It is estimated that in 1949-1957 about 25 million bushels of grain were converted with fungal amylase. Fungal amylase is now being produced for captive industrial use and for sale to processing companies.

Paper Products From Agricultural Residues

Processes and procedures for the production of high-quality papers, insulations, and hardboards from agricultural byproducts such as wheat straw and sugarcane bagasse have been developed by our scientists. Commercial processes based on these developments are now in commercial operation and our research has been discontinued. These developments assure a continuing supply of raw materials for the pulp industry.

Soft Grits for Blast Cleaning

A procedure known as soft-grit blasting, which utilizes ground corncobs for cleaning the surface of metal in aircraft and automobile engines, motors, and machinery, was developed by our scientists. This development has provided markets for large volumes of corncobs. Largely as a result of our work in this field, the corncob-grinding industry has expanded from one plant in 1939 to approximately a dozen now.

Water-Softening Chemicals

This Division developed a fermentative process for the production of sodium gluconate from corn sugar. It is one of the most effective water-softening chemicals and is widely used for bottle washing in dairies, soft drink bottling plants, etc. It combines with and inactivates the calcium and magnesium in hard water. A chemical process developed at this Division is used to convert corn sugar to potassium acid saccharate which is also a superior water-softening chemical.

Starch Sponge

Our chemists developed a starch sponge that is used to control bleeding. It will absorb 15 times its weight of water and is soft and pliable. The dry sponge is an aid in coagulation of blood and is used by many surgeons as a hemostatic agent. It may be used as strips or blocks or may be dusted as a powder into bandages and delicate inner tissues of surgical patients. Starch sponge does not require refrigeration and may be sterilized and resterilized before use if necessary. It is absorbed by body tissues and need not be removed from wounds or incisions. Starch sponge also may be used as a carrier for medicant for slow release within the body.

Starch, protein, and oil in farm crops are the subjects of utilization research in which the objectives are to help farmers derive more income from their crops, to help industry convert agricultural raw materials into new and improved products, and to bring consumers new products for better living. Wheat and corn, illustrated by the kernel cross sections, are two of the chief crops of the North Central Region.

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The Utilization Research and Development Divisions

Division	Director	Mailing Address	Division Area*	Fields of Research
Eastern	P. A. Wells	600 E. Mermaid Lane Philadelphia 18, Pa.	Conn., Del., Ky., Maine, Md., Mass., N. H., N. J., N. Y., Pa., R. I., Vt., Va., W. Va.	Animal products: dairy, meat, fats and leather. Plant products: Eastern fruits and vegetables, tobacco, honey, maple, and new crops. Allergen studies.
Northern	F. R. Senti	1815 N. University St. Peoria 5, Illinois	Alaska, Ill., Ind., Iowa, Kans., Mich., Minn., Mo., Nebr., N. Dak., Ohio, S. Dak., Wis.	Cereal grains: corn, wheat, barley, grain sorghum, and oats. Oilseeds: soybeans, flaxseed,safflower, and erucic acid-containing oilseeds. New crops.
Southern	C. H. Fisher	1100 Robert E. Lee Blvd. New Orleans 19, La.	Ala., Ark., Fla., Ga., La., Miss., N. C., Okla., Puerto Rico, S. C., Tenn., Texas.	Cotton and cottonseed; tung fruit; pine gum; Southern fruits and vegetables including citrus, sweetpotatoes, and cucumbers; sugarcane; rice; peanuts; new crops.
Western	M. J. Copley	800 Buchanan Street Albany 10, California	Ariz., Calif., Colo., Hawaii, Idaho, Mont., Nev., N. Mex., Oreg., Utah, Wash., Wyo.	Western fruits, nuts, vegetables, rice; poultry products; forage crops; wheat; barley; wool and mohair; sugar beets; dry beans and peas; castor seed; new crops.

*States listed are those primarily served by the particular division, although the research programs of each division are of national scope and interest.

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