

# Symposium on World-Wide Research Programs in Agricultural Chemistry

## INTRODUCTION

Some of the work of the U. S. Department of Agriculture in developing new markets for farm products, through chemical research at home and abroad, is presented in this symposium on "World-Wide Research Programs in Agricultural Chemistry." The variety of subjects covered parallels the broad spectrum of agricultural utilization research which is being conducted at the four regional research laboratories in Albany, Calif.; Peoria, Ill.; Philadelphia, Pa.; and New Orleans, La. These laboratories seek new and improved industrial, food, or feed uses for each of the important U. S.-produced agricultural commodities—including wheat, corn, fruits, vegetables, cotton, wool, mohair, oilseeds, and animal products.

A significant part of the programs of the regional research laboratories is conducted in the United States under contracts and grants, and in other countries under grants supported by Public Law 480 currencies. Speakers from various parts of the world have presented here a sampling of the work conducted under the PL 480

program to enrich our chemical knowledge of agriculture; USDA has placed more than 180 such grants with about one hundred institutions in 19 foreign countries.

This symposium was inspired and introduced by Dr. Fred E. Deatherage of Ohio State University, 1964 chairman of the Division of Agricultural and Food Chemistry; it was arranged by Dr. George W. Irving, Associate Administrator, ARS, USDA, with the collaboration of Samuel B. Detwiler, Jr., Assistant to the Administrator, ARS.

Presiding Officers for Symposium Sessions:

Michael J. Copley, Director, Western Laboratory, Albany, Calif.

Percy A. Wells, Director, Eastern Laboratory, Philadelphia, Pa.

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## WORLD-WIDE RESEARCH

### The Foreign Agricultural Research Program under Public Law 480

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Foreign scientists are working in the interest of American farmers, as well as for the agriculture of their own countries, through a program initiated several years ago by the U. S. Department of Agriculture as a supplement to its domestic research program. This program is financed by foreign currencies accruing from overseas sales of U. S. farm surpluses under the Agricultural Trade Development and Assistance Act of 1954 (Public Law 480, 83rd Congress). Part of the proceeds of these sales is used by U. S. government agencies to pay their overseas obligations; a relatively small fraction is assigned to the Department of Agriculture for research. None can be converted into dollars for use in the United States. This program encompasses not only chemical research aimed at developing new uses for farm crops, but also crop production, animal husbandry, forestry, human nutrition, agricultural marketing, and agricultural economics.

**I**N THE early part of the last decade, many financially impoverished countries in need of food and fiber were unable to purchase our surplus agricultural commodities because of a shortage of hard currency. This problem was resolved by passage of the Agricultural Trade Development and Assistance Act of 1954, generally referred to as

Public Law 480. This law authorizes the Department of Agriculture to sell surplus agricultural commodities for the currency of a country which does not have dollars to purchase these products. Since passage of this law, large quantities of surplus commodities have been sold to many countries for foreign currency.

Foreign currency obtained from the sale of surplus farm commodities is used for a variety of purposes. Some is used to pay United States' obligations in the country. A large portion is lent back to the foreign country for economic development. Up to 25% of the funds may be reserved for loans to private industry for use in the country

where currency is available. In addition, the foreign currency is used to finance scientific, medical, cultural, and educational activities in the country.

Two provisions under Public Law 480 authorize the financing of scientific activities with foreign currencies accruing to the United States through the sale of surplus agricultural commodities. Section 104(k) provides for programs and projects of scientific cooperation between the United States and other countries. Under this provision, research programs abroad have been initiated by the Departments of Agriculture; Health, Education, and Welfare; Commerce; and Interior. These programs, including a part of that of the Department of Agriculture, are now restricted to countries in which the United States has foreign currency in excess of its normal and anticipated needs. At present, the so-called excess currency countries are India, Pakistan, Burma, Israel, Egypt, Yugoslavia, and Poland. A few years ago, funds were provided to support farm and forestry research in a number of nonexcess currency countries in South America, Asia, and Europe.

Section 104(a), the other provision of the law dealing with research, authorizes the funding of activities facilitating the development of expanded dollar markets abroad for our agricultural commodities. Research on the development of new and extended uses for farm products and marketing and nutrition research are financed under this section. Funds to implement activities provided under Section 104(a) are authorized only for the Department of Agriculture.

There is an important distinction in the availability of foreign currencies for funding activities under Sections 104(a) and 104(k). Research of broad international interest conducted under 104(k) is limited to the excess currency countries, but research conducted under Section 104(a) is not so restricted. Market development research on agricultural commodities also may be financed in hard currency countries, such as the United Kingdom, France, and Italy. Funds in the hard currency countries are obtained through conversion of a limited amount of the currency of the excess currency countries. Therefore, the 104(a) research program involves many more countries than the 104(k) program.

In 1958, the Department of Agriculture initiated its broad program of agricultural and forestry research under Public Law 480, including plant and animal production and economic research. Project ideas may come from various sources—from research groups within the department, foreign research institutes, or domestic research and agricultural commodity organiza-

tions. Proposals are reviewed and screened by the research specialists of the department.

The most important criterion in the selection of projects is that they benefit American agriculture. Any project acceptable to the foreign country can be expected to be mutually beneficial. The research is carried out in foreign governmental or nongovernmental research organizations, universities, and colleges. It includes both basic and applied research, but the stress is upon fundamental studies, in which foreign scientists have made many important contributions.

Grants are used primarily for activation and control of the foreign research projects, and particularly for fundamental and basic research, which by its nature is difficult and sometimes impossible to outline in precise contract specifications. A few contracts have been used for applied research in which the plan of work can be spelled out in detail. The life of a grant or contract may extend up to five years.

Grants have been executed in 30 countries in Europe, Asia, and South America. Regional offices have been established in Rome to negotiate agreements and supervise administration of the projects in Europe (director W. F. Talburt) and in New Delhi, India, to administer the Asian program (director Alvin D. Ayers). Projects in South America are administered by the Washington staff.

### **Farm and Forestry Research Grants**

Financing of farm and forestry research which cannot be performed in the United States or could be conducted only with difficulty or at great cost is given top priority in the foreign research program. More information is needed on foreign destructive insects, noxious weeds, and plant and animal diseases which we do not have in the United States. As travel between nations continues to expand, the danger of inadvertently introducing these foreign pests increases. The more information we have on these pests, the easier it will be to identify and control them should they appear in this country. Destructive insects and noxious weeds which have gained entry into this country in recent years frequently spread very rapidly because of the absence of natural enemies. The search abroad for, and introduction of, predators for these pests which have a foothold here is one means of attempting to control them.

Most of the farm and forestry research grants fall into a few major areas: Forty deal with biological control of destructive insects and noxious weeds; 70 are on plant and animal diseases; 55 concern new plant and animal germ plasm; and about 125 are in a miscel-

laneous group on the physiology and nutrition of plants and animals, agricultural engineering, soil and water research, and agricultural economics.

Specific farm research projects now under way are: in Brazil, evaluation of corn and beans native to Central and South America as sources of germ plasm for use in breeding programs in the United States; in Colombia, studies of the pathogenic potentialities of oat stem rust and sources and genetics of resistance in oats; in Egypt, induced sterility of males of the Mediterranean fruit fly as a means of controlling and possibly eradicating that pest; in India, investigations of parasites, predators, and pathogens of sugar cane borers; in Turkey, the transmission, distribution, and bioeconomics of liver fluke disease of domestic animals; and in Spain, investigation on the virus diseases of leguminous plants.

Typical examples of forestry research being financed abroad are: in Chile, investigation of the role of photoperiod in the rooting and growth induction of short shoots of pine; in Finland, investigation of the orienting stimuli guiding insect pests of forests to suitable host trees, by determining the attractiveness to the insects of various extracts from bark, foliage, and wood of trees; in Poland, biological and chemical control of forest insects; in Brazil, disease and insect susceptibility and species adaptability of some North American pine species; and in Taiwan, important epidemic diseases of forest trees.

### **Utilization Research Grants**

About 40% of the grants cover research on the utilization and marketing of agricultural commodities, particularly crops in serious surplus. About 50 grants have been executed for research on utilization and marketing of cereal grains, primarily wheat and corn; 30 deal with cotton and wool; 40 are on fats and oils, including oilseeds; 25 concern dairy and animal products; and 25 are on fruits and vegetables.

Specific utilization research grants include: in France, fractionation of zein protein of corn and a study of the rheological and physical-chemical properties, chemical composition, and structure of the fractions; in Australia, measurement of viscoelastic properties of wheat flour doughs; in Sweden, fundamental investigation of setting reactions for cotton fabrics and garments; in Holland, fundamental study of the role of the structural elements of cotton fiber in response to stress in deformation and recovery; in India, investigation of addition of carbenes to unsaturated fatty components of cottonseed oil; in Japan, isolation, characterization, and quantitative determina-

tion of the sterols in soybeans; in West Germany, investigations of the chemical changes occurring at the surface of the fat globules in stored foam-dried whole milk; in Poland, study of the antioxidant components of wood smoke used in meat curing, and the effects of methods of generation on the quantity and activity of the antioxidant components of the smoke; in Colombia, investigation of the stabilization of flavor concentrates of tropical fruits; and in the United Kingdom, investigations of the carbohydrase enzyme systems of alfalfa and their use in structural analysis of alfalfa polysaccharides.

#### Marketing Research Grants

In Finland, studies are under way on residues of insecticides and fungicides applied to different plant products after harvest, including stability of the residues during marketing, storage, food preservation, and the effects of pesticides on food quality; in Israel, development of a rapid, simple test for protein nutritive value of cereal grains and feeds; in Poland, flaxseed storage and chemical changes during storage; in Spain, basic studies on the constituents of rice influencing quality, and development of objective methods for measuring market quality of raw and precooked rice; and in Italy, determination of the persistence and fate of various insecticides in or on wheat during storage, milling, and baking or cooking of the products made from treated wheat.

Since the beginning of this program in 1958, the equivalent of somewhat more than \$50,000,000 in foreign currency has been made available to finance agricultural research abroad. About 500 research grants have been executed. Publication of research results is encouraged. Up to the present time more than 400 research articles have been published on grant results, most

of them in English. Reprints are available in the research divisions of the department sponsoring the research.

#### Results of Program

Many useful results have stemmed from this program. In the area of biological control of destructive insects, a great deal of progress has been made in finding predators for the balsam woolly aphid through grants in Pakistan and India. Several thousand of a dozen different parasites which are effective in parasitizing the balsam woolly aphid have been shipped to the United States and liberated in infested areas in the Pacific Northwest and in Southern Appalachia. The sugarcane borer is one of the worst insect enemies of sugarcane, corn, and sorghum along our Gulf Coast. Studies of several species of sugarcane borers in widely scattered areas of India resulted in the discovery of a number of parasites. Five species have been shipped to Florida for evaluation under our environmental conditions. Under a grant in Spain, two parasites for gypsy moths have been found and last year 30,000 were shipped to this country. This year we are obtaining 19,000 more for liberation in New Jersey.

African swine fever, a highly contagious disease of swine, has spread to Spain and Portugal in recent years and is a potential threat to our own hog industry. It is of special concern because of its resemblance to hog cholera, with which it may be confused. Under a Spanish grant, a rapid diagnostic test has been found for African swine fever, differentiating it readily from hog cholera. Under a grant in England on scrapie (a disease of sheep), the English investigators have been able for the first time to transmit the disease from sheep to goats and to confer it on mice. Since mice are more convenient test animals than sheep, this should

facilitate progress in studies on scrapie.

Through this research program we have been able to strengthen and broaden enormously our search for new supplemental crops through evaluation of wild plants. Grants in Spain, Yugoslavia, Turkey, Israel, Pakistan, India, Korea, and Uruguay have given us world-wide coverage in this search. About 3000 specimens of wild plants have been shipped to our plant exploration group in Beltsville for evaluation of agronomic characteristics and are being screened by the Regional Research Laboratories for chemical utility. A number of promising wild plants with unusual components have been found.

Under a grant in England, the antioxidants in oats have been isolated and characterized. In Finland we have a large grant under the guidance of Virtanen on the components of plants which confer undesirable flavor to milk. Members of the brassica family—such as turnips and cabbage, and seedlings of wheat, corn, and rye—have been studied. Several novel and unusual components and their enzymic conversion products have been identified, including organic sulfoxides, thiocyanates, isothiocyanates, and hydroxylamines.

In a world-wide research program such as this, there is a serious problem of communication in bringing the results directly to the attention of American scientists. This symposium provides an opportunity for American scientists to obtain detailed information on a few of these PL 480 grants. Following papers illustrate some of the progress under these grants.

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## WORLD-WIDE RESEARCH

### Immunochemical Study of Wheat, Barley, and Malt Proteins

IT is often difficult to define or isolate a protein from a mixture and to prove its purity or homogeneity. In most cases, physical-chemical methods are used, such as solubility, electrophoretic migration, sedimentation, and chromatography, but several proteins in a mixture may have identical or similar physical properties and therefore be difficult to distinguish.

To define proteins simultaneously by two completely distinct criteria, we established a method, which we call "immuno-electrophoretic analysis" (IEA) (15). This allows one to define every protein in a mixture by its electrophoretic mobility, which depends on the number and charge of ionizable groups on the molecule, and by its immunochemical specificity, which is based on the steric

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configuration of certain groups on the molecule called "antigenic determinants or sites." In some cases, when the protein has certain prosthetic groups or possesses an enzymatic activity, a third definition of a constituent in a mixture can be introduced by convenient color reactions performed in the same experiment (23).

The principle of this method is simple