

# Collection, Preservation and Utilization of Indigenous Strains of Maize

*The seed of more than 12,000 variations of Indian corn have been collected from many areas in the Western Hemisphere, and are preserved at regional centers to provide genetic factors in the future breeding of agronomically improved, disease-resistant and higher yielding varieties.*

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When the Americas were discovered at the end of the 15th century, corn (*Zea mays* L.), or maize, a crop new to Europeans and found to be indigenous to all of the Western Hemisphere, was being widely grown by the natives in many varieties. Its presence in the tombs of the Incas and in caves of Peru and other countries is evidence of its antiquity. For generation after generation Indian tribes maintained their own strains. Under the changing conditions of more recent years these old native strains have been gradually disappearing in many areas, but less in Latin American countries. There they are now being replaced by improved open-pollinated strains and to some extent by hybrids. New hybrid strains usually have a higher yield per acre, as well as other desirable characteristics. In the United States hybrid corns now occupy about 90 percent of the total corn acreage. In other countries new hybrids are being developed and distributed.

## Original Strains of Maize

Native strains, the original source of improved varieties, may be the product

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of hundreds or thousands of years of evolution under domestication. They represent one of the irreplaceable agricultural resources of this hemisphere. Their extinction would deprive the areas, where they are now indigenous, of genetic material of value in future programs of improvement and also deprive the rest of the world of genes of great potential importance. The indigenous races and early pioneer open-pollinated strains of corn may include genes producing disease resistance, high yield and possibly other desirable economic traits, among them high food and feed qualities.

## The Maize Committee

In order to prevent extinction of the desirable genes, a Committee on Preservation of Indigenous Strains of Maize was formed in the National Academy of Sciences-National Research Council to sponsor a project that would collect, preserve and study for future use as many varieties of native and pioneer corn as possible.

The committee is composed of leading corn breeders, geneticists, botanists and administrators concerned with the agricultural programs. The present roster is as follows:\*

\* Former members were: L. J. Stadler, John O. Brew, and Hugh C. Cutler.

- Ralph E. Cleland, *Chairman*, Head of Department of Botany and Dean of the Graduate School, Indiana University, Bloomington, Indiana
- J. Allen Clark, *Executive Secretary*, Division of Biology and Agriculture, National Research Council, Washington, D. C.
- Edgar Anderson, Director, Missouri Botanical Gardens, St. Louis, Missouri
- William L. Brown, Geneticist, Department of Plant Breeding, Pioneer Hi-Bred Corn Company, Johnston, Iowa
- C. O. Erlanson, Head of Plant Introduction Section, U. S. Department of Agriculture, Plant Industry Station, Beltsville, Maryland
- Claud Horn, Foreign Agricultural Service, U. S. Department of Agriculture, Washington, D. C.
- Merle T. Jenkins, Principal Agronomist, In charge Corn Investigations, U. S. Department of Agriculture, Plant Industry Station, Beltsville, Maryland
- Paul C. Mangelsdorf, Director, Botanical Museum, Harvard University, Cambridge, Massachusetts
- G. H. Stringfield, Senior Agronomist, Ohio Agricultural Experiment Station, Wooster, Ohio
- Paul A. Weatherwax, Professor of Botany, Indiana University, Bloomington, Indiana
- Mexican and Central American Areas  
Dr. E. J. Wellhausen  
The Rockefeller Foundation  
Calle Londres 45  
Mexico 6, D. F. Mexico
- Colombian-Andean Area  
Dr. L. M. Roberts  
The Rockefeller Foundation  
Apartado aero 58-13  
Bogota, Colombia
- Brazilian-Eastern South American Area  
Dr. F. G. Brieger  
Departamento de Genetica  
Escola Superior of Agricultura "Luiz Queiroz"  
Piracicaba, S. P. Brasil
- United States and Canada  
Mr. C. O. Erlanson, In charge  
Section of Plant Introduction  
U. S. Department of Agriculture  
Plant Industry Station  
Beltsville, Maryland

#### Collections of Original Strains

This Committee, in cooperation with the Rockefeller Foundation, has established Seed Centers in Mexico and Colombia at the Foundation's Agricultural Experiment Stations; it has received the cooperation of the University of Sao Paulo in the establishment of a Seed Center at Piracicaba in Brazil, and of the U. S. Department of Agriculture in the maintenance of a Seed Center in the United States. Collections originating in the United States and Canada are in active storage at the cooperative Regional Plant Introduction Station at Ames, Iowa. All requests for seed from the different collections should be made to the Directors of the Latin American Centers or to the Plant Introduction Section of the U. S. Department of Agriculture, Beltsville, Maryland.

#### Seed Center Directors

The names and addresses of the Directors of the Seed Centers are:

Throughout Latin America and other parts of the Western Hemisphere, several thousand collections of indigenous Indian and pioneer open-pollinated strains of maize have been assembled at these Centers. This collecting began in 1943 when The Rockefeller Foundation, in cooperation with the Mexican Ministry of Agriculture, began a program of practical maize improvement. It became evident at that time that a survey of the native maize varieties was needed. Varieties were collected from all parts of Mexico and, in controlled experiments, were compared for yield, disease resistance and other characteristics of agricultural importance. As the collections grew and the extraordinary diversity of maize in Mexico was revealed, the need for a taxonomic classification of the bewildering multiplicity of varieties became apparent. Botanical, genetic and cytological studies to supplement the agronomic investigation were begun. To make collections more complete, special efforts were made to obtain from remote localities most of the commonly grown varieties or strains, regardless of their

apparent agronomic value. This collection became known as the "germ plasm seed bank". These studies led to a classification and description of the principal races which was first published in Spanish and later in English (1).

In the United States, the Section of Plant Introduction of the U. S. Department of Agriculture has for many years collected corns from all parts of the world. With the rapid increase in the growing of hybrid corns in the United States, plus the apparent value of the Mexican collections, the importance of keeping these collections viable and of preserving the pioneer open-pollinated corns of the United States was obvious. Federal funds were made available to the States of Kansas, Missouri, Nebraska and North Dakota through Cooperative Regional Project NC-7 to bring together such pioneer varieties as existed in those States. This material is now largely held at the Regional Plant Introduction Station, Ames, Iowa.

The Committee for the Preservation of Indigenous Strains of Maize studied the problem in the whole Western Hemisphere. It obtained financial support from the United States Department of State, administered through the Office of Foreign Agricultural Relations, Department of Agriculture, and later through the Institute of Inter-American Affairs. Under an agreement with the Technical Cooperation Administration (Contract No. SEC 14029, dated June 28, 1951), the Committee has been sponsoring the collecting and preservation of as many varieties of native and pioneer corn as possible. One of its members collected and studied maize strains of the Caribbean area (1).

#### Cooperation

The NAS-NRC has had no formal agreements with governments of Latin-American countries, but the project has had enthusiastic support, both financial

and in personnel, of a number of governments and of their technical representatives. In order to give public credit, a partial list of those who have assisted in this collecting work in the Western Hemisphere follows. Without their work in field, laboratory and office, no collections would have been made.

- Mexican and Central American Areas  
 Mexico Seed Center at Chapingo  
 Mexico  
 Mexico City—E. J. Wellhausen, Director.  
 In charge of The Rockefeller Foundation Agricultural Program in Mexico  
 Sterling Wortman, Corn Project Leader and Co-Director of Seed Center  
 Chapingo—Hernandez Corzo, in charge of the storage and records  
 Lauro Bucio, in charge of collecting  
 Caribbean Area—William L. Brown, Maize Committee member  
 Cuba—C. G. delValle  
 Haiti—Claude Preval, Leon Pierre Louis  
 Martinique—George Mottard  
 Puerto Rico—J. Velez Fortuno  
 Trinidad—L. Johnson  
 Central America—Alfredo Carballo, in charge of collecting  
 Costa Rica—Mario Guittierez  
 El Salvador—Floyd Olive  
 Guatemala—Francis LeBeau  
 Honduras—Albert Miller  
 Nicaragua—S. C. Litzenberger  
 Colombian-Andean Area  
 Colombian Seed Center at Medellin  
 Colombia  
 Bogota—L. M. Roberts, Director. In charge of The Rockefeller Foundation Agricultural Program in Colombia  
 Emilio Yepes, Corn Project Leader  
 Medellin—Ulysses J. Grant, Co-Director, in charge of Station  
 Donald L. Smith, Corn Project Leader  
 Victor Patiño, in charge of collecting  
 P. E. Daza, in charge of storage and records  
 Palmira—Roberto Astralaga  
 Monteria—Climaco Cassalet

- Ecuador—Gaston Noroña, Luis A. Flor, Victor H. Alride, Napoleon Valdivieso, Ricardo Gellejos, S. Manuel Giler Honorio Moreno
- Peru—Alexander Grobman, Botanico Octovio Velarde
- Bolivia—Francisco Pulgarr, Alfonso Corrate V.
- Chile—Guillermo Crespo, Martin Gardenas, Leandro Rojo F., Alberto Ruiz S.
- Venezuela—Casa Briceno, Herman Oreopeza, Pedro Obregon
- Brazilian-Eastern South American Area  
Brazilian Seed Center at Piracicaba  
Brazil  
Piracicaba—F. G. Brieger, Director. In charge of Department of Genetics, College of Agriculture, University of Sao Paulo  
J. T. Cargel, Deputy Director of the Center  
E. Paterniani, Assistant to the Center  
W. E. Karr, Collecting
- Campinas—Glauco Viegas, Corn Breeding
- Paraguay—Charles Breitenbach
- Uruguay—Gustavo Fisher, V. Gheorghiano
- Argentina—J. M. Andres, Jose Vallega
- United States and Canada  
United States—U. S. Department of Agriculture  
Washington, D. C.—Claud Horn, Foreign Agricultural Service  
Beltsville, Maryland—C. O. Erlanson, Section of Plant Introduction  
Glenn Dale, Maryland—John L. Creech  
Ames, Iowa—Max M. Hoover  
Cooperators  
St. Louis, Missouri—Hugh C. Cutler, Collection in the Southwest  
Johnston, Iowa—William L. Brown, Central Area  
Bismarck,  
North Dakota—George F. Will, Northern Area  
Canada—University of Manitoba  
Winnipeg—S. B. Helgason, Corn Project Leader

The material collected is a part of the work of these governments and their technical staff aided by local assistants. The training of local personnel is one of the objectives of this project, and al-

ready a considerable number of young Latin Americans have received invaluable training in the technique of plant exploration, record keeping, agronomic experiments, botanical description and genetic analysis. Thus they have gained experience in research methods which makes them more competent and especially useful to use the material collected for conducting improvement breeding programs in their own countries.

### Collections

The collecting extended over a three-year period and came to an end arbitrarily set at June 30, 1954. Samples collected in the different countries were sent to the Centers where they were recorded and numbered. Many of the original ears were photographed and museum specimens kept. Grain was shelled, and moisture and germination tests were made before storage. Some samples were discarded, others had to be rejuvenated before storage. All samples stored were listed with the Center numbers, country, state, town or township of origin, local name, altitude, latitude, longitude, type, seed color, maturity, rainfall, and culture indicated.

Each of these factors has an important bearing on the identification, adaptation and plans for further field study necessary for classification of the more important varieties and races. For example, altitude has a most important effect upon corn-growing. The highest location found for corn-growing was by collectors of the Colombia Center above Lake Titicaca which lies between Peru and Bolivia at 12,500 feet. The lists reveal many other important factors and types of corn available.

These lists were sent from the Centers to the National Research Council, where NRC numbers were assigned as the lists were received. The lists were mimeographed, and processed reports entitled "Collections of Original Strains of Corn

I and II" (3), were made available to FOA and other government officials, to cooperators and interested corn workers on request.

The NRC numbers assigned to the Center lists and listed number of collections for each are as shown in Table I.

TABLE I

NRC Nos.	Centers and Number of Collections			
	Mexico	Colombia	Brazil	U. S.
1-925	....	925	....	....
926-1,171	....	246	....	....
1,172-1,998	827	....	....	....
1,999-2,611	....	....	613	....
2,612-4,534	1,923	....	....	....
4,535-5,140	....	606	....	....
5,141-5,386	....	....	....	246
5,387-6,987	1,601	....	....	....
6,988-7,155	....	....	168	....
7,156-8,442	....	1,286	....	....
8,443-9,715	....	....	1,273	....
9,716-10,596	....	881	....	....
10,597-10,922	....	....	326	....
Total 10,922	4,351	3,945	2,380	246

The first report of this collecting work, more extensive than the present brief article, was published by the National Research Council (2).

The number of collections received at the Centers has sometimes exceeded that listed. Some of these not already listed may be rejuvenated and listed later, while others may not have been viable or for other reasons were discarded. In order to show the magnitude of the collecting task, both the Reported and Listed numbers of collections from each Seed Center and country are listed.

The largest number of listed collections, 4,351, are at the Mexican Center; from Mexico, 2,750; from Guatemala, 1,054; and less numbers from six other Central American countries and from seven Caribbean Islands.

At the Colombian Center are 3,945 listed collections, 1,360 from Colombia

and other large numbers from five other western South American countries.

The Brazilian Center has listed 2,380 collections, while over 100 more are reported and may be listed later.

The following shows the reported and listed number of collections from each Center and country.

	Number of Collections	
	Reported	Listed
Mexican Center		
Mexico .....	2,761	2,750
Costa Rica .....	33	33
El Salvador .....	40	40
Guatemala .....	1,054	1,054
British Honduras .....	14	14
Honduras .....	30	30
Nicaragua .....	49	49
Panama .....	25	25
Cuba .....	70	70
Dominican Republic ..	235	235
Haiti .....	15	15
Virgin Islands .....	4	4
Jamaica .....	4	4
Martinique .....	10	10
Trinidad .....	18	18
Total .....	4,362	4,351
Colombian Center		
Colombia .....	1,666	1,360
Venezuela .....	586	586
Peru .....	735	646
Ecuador .....	555	555
Bolivia (western) ....	702	702
Chile .....	100	83
Others .....	....	13
Total .....	4,344	3,945
Brazilian Center		
Brazil .....	2,029	1,928
French Guiana .....	20	11
British Guiana .....	13	13
Surinam .....	16	11
Bolivia (eastern) ....	16	16
Paraguay .....	107	107
Uruguay .....	158	148
Argentina .....	136	133
Others .....	13	13
Total .....	2,508	2,380
United States Center		
United States .....	250	215
Canada .....	31	31
Total .....	281	246
Grand Total .....	11,353	10,922

In the Committee's program, only 246 listed collections went to storage at the United States Center; 31 of these came from Canada. However, there are also other collections in the United States. These include 833 introductions from 35 countries that have been collected and kept viable by the Section of Plant Introduction, USDA, and 163 samples by the Section of Cereal Crops and Diseases, USDA. The latter include 140 strains from Indians of the United States, 12 from Mexico, 3 from Guatemala and 8 from South America. Collections of a more local nature are in storage at several of the State Agricultural Experiment Stations. In all, this should make up a "World Collection" of more than 12,000 strains.

#### Preservation

Seed stored under ordinary conditions will not remain viable more than five years, but it will last for a much longer period under the conditions established by the Committee and provided at the Seed Centers. The seed is dried to 8-10% moisture content, sealed in airtight bottles, and stored at 25° to 30° F. Under these conditions it is thought that the seed will stay viable for ten to 25 years. Germination tests will be made from time to time and the strains rejuvenated when necessary.

Seed cabinets for storage of four-ounce seed samples of the original collection were furnished the Latin-American Centers through the Committee of the National Research Council, while larger working samples are also used at some of the Centers. Refrigeration equipment was furnished the Brazilian Center by the Committee, while the Rockefeller Foundation supplied that at the Mexican and Colombian Centers. Collections held in the United States are stored through the cooperation of State and Federal agencies.

#### Utilization

This material, collected throughout the Americas, will undoubtedly be of great value in the development of higher yielding, agronomically improved and disease-resistant varieties of maize in other parts of the world. Introduction of corn into other parts of the world is a relatively recent matter. One reason for the rapid spread is the increasing industrial importance of corn products—waxes, oils, glue, pastes and various forms of starch.

The value of the world maize collection has already been demonstrated. Collections have been sent from the Centers to plant breeders in Kenya, Ethiopia, Poland, Indonesia and about 35 other countries. A corn rust disease, caused by *Puccinia polyspora*, recently became extremely serious in West Africa, reducing yields as much as 50%. It was found that certain strains collected in the Caribbean area were either resistant or highly tolerant to this disease. Consequently, 125 strains of maize collected from the Caribbean were sent to the agronomists of West Africa. By proper crossing techniques they can now transfer to their strains the valuable resistant genes.

These extensive collections are expected to reveal other important pathologic, agronomic and industrial characteristics, including many which are new or which have not been described or have not as yet been available. New sources of corn germ plasm have thus been made permanently available for plant breeders to develop varieties, not only giving high yields of grain, but also having higher contents of vitamins, minerals, proteins and other substances.

The current expansion of industry in Latin America is in part dependent on corn, the principal crop, and there the industrial use of different types of corn is rapidly increasing. A search for de-

sirable high (70 percent or higher) amylose starch content corns has been started on broad types of the NRC collections in the United States by the Northern Regional Research Laboratory at Peoria, Illinois.

Another important use of the collection is that of providing materials for basic genetic research on corn. Already two eminent geneticists have canvassed a large part of the collections, searching for new characters or genes to be employed in such research. Additional knowledge concerning these collections should lead to the continued screening of this material for these and other uses.

#### Future Plans

The NRC maize collections, made possible by the original TCA (now ICA) grant, The Rockefeller Foundation, the U. S. Department of Agriculture, the University of Sao Paulo and cooperating Latin American governments, are nearing completion. Further financial support is being received from the International Cooperation Administration for a second part of the program to enable careful study of the Latin American collections of the different governments at the Seed Centers. The Center Directors and corn project leaders will select as assistants promising local personnel for the growing and study of the material. In order to promote coordination and integration of the program it is proposed to send to each Center a member of the Committee, or other North American experts on corn. They will go over the work being done and assist in the study of these collections for their

botanic, agronomic, pathologic and cytogenetic characteristics, classify key material and publish descriptions of the principal races. The composition or determination of the food, feed and industrial properties of the collections, varieties or races cannot be determined with these funds. However, they will be better known and made available to corn breeders and to industrial research workers as a result of the proposed studies and publications.

#### Summary

Native strains of corn may be the product of hundreds or thousands of years of evolution under domestication. To prevent extinction, a Committee on Preservation of Indigenous Strains of Maize was formed to sponsor a project that would collect and preserve as many varieties of native and pioneer corn as possible. This article summarizes the collecting work and plans for a study and classification of the principal races under a further grant from the International Cooperation Administration to the National Academy of Sciences-National Research Council.

#### Literature Cited

1. Brown, W. L. Maize of the West Indies. *Trop. Agr.* 30(7-9): 141-170. Illus. 1953.
2. Clark, J. A. Preventing extinction of original strains of corn. *Nat. Acad. Sci., Nat. Res. Coun. News Rep.* 4(5). 1954.
3. Report of the Maize Committee. Collections of original strains of corn. I. *Nat. Acad. Sci., Nat. Res. Coun.* [Processed]. 314 pp. 1954.
4. Wellhausen, E. J., Roberts, L. M., Hernandez, X. E., and Mangelsdorf, P. C. Races of maize in Mexico, their origin, characteristics, and distribution. 223 pp. Illus. *Bussey Inst. Harvard Univ.* 1952.