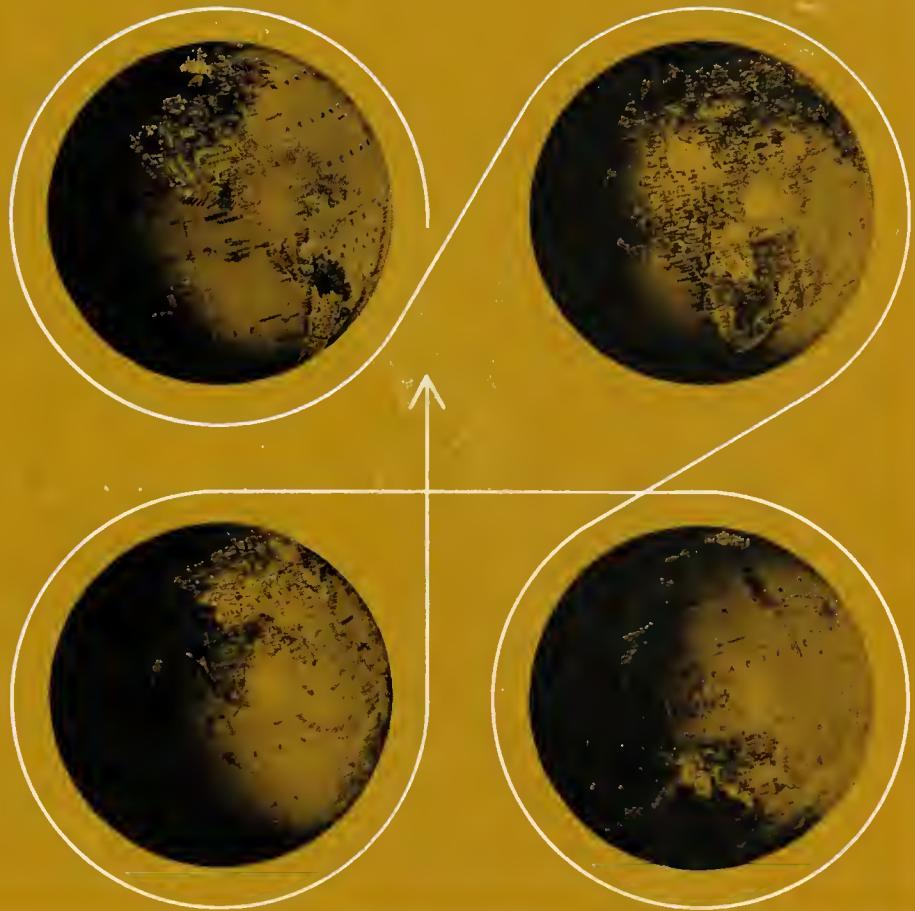


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Rural work-
China



The Cornell- Nanking Story

H. H. Love and John H. Reisner

NEW YORK STATE COLLEGE OF AGRICULTURE,
A CONTRACT COLLEGE OF THE STATE UNIVERSITY,
AT CORNELL UNIVERSITY, ITHACA, NEW YORK

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This publication is supported by a grant from the Ford Foundation

Single copy free • Additional copies 50¢ each • April 1964

Palm
Breeders
China

PREFACE

The College of Agriculture at Cornell University has had a history of working with scientists and students from many lands. Since opening its doors in 1867, the enrollment of foreign students to study agriculture has been encouraged, and travel to other countries has been an enlightening experience cherished by many of our faculty members.

It is our firm conviction that the College, the University, and the people have benefited from active participation in international agricultural development, and the College constantly is searching for more effective ways of working with agriculturists in foreign lands. Beginning in 1925, three professors in Cornell's Department of Plant Breeding agreed to cooperate with personnel at the University of Nanking in China. The program was based on the premise that a small number of highly qualified scientists, working with a larger number of Chinese, could bring about a marked improvement in crop production. The success of this modest program was phenomenal, and it has been regarded as an excellent model for more recent foreign assistance programs.

Two of the principal leaders of The Cornell-Nanking Program—Professor H. H. Love and Dean John H. Reisner—have kindly consented to share their experiences with others. It is a marvelous story of a successful international project, and the College is delighted to have the privilege of printing and distributing *The Cornell-Nanking Story*.



Charles E. Palm,
College of Agriculture



Dr. John H. Reisner, former Dean of the College of Agriculture and Forestry, University of Nanking, Nanking, China, and Dr. H. H. Love, former Head, Department of Plant Breeding, Professor Emeritus, College of Agriculture, Cornell University, Ithaca, New York.



Bailie Hall, named in honor of Joseph Bailie, founder and organizer of the College of Agriculture and Forestry, and its first Dean. Headquarters for The Cornell-Nanking Program.

AUTHORS' NOTE

The reader may be surprised at the omission of the names of most of the Chinese who rendered valuable service to the program, but this omission has been intentional on the advice of, and in several cases at, the request of those Chinese friends. The reason inheres in the political situation on the China mainland. Without the able and enthusiastic cooperation of many Chinese colleagues, this program could not have been carried out to such a successful conclusion. This fact will be evident throughout the report.

In the preparation of this manuscript, information and data have been taken freely from the unpublished reports of the Cornell University professors who participated in the program; reports from the College of Agriculture of the University of Nanking; Dr. C. H. Myers' report, written at the close of the cooperative program and published by the University of Nanking as Special Report No. 1, 1934; from the Agriculture and Forestry Notes of the College of Agriculture and Forestry of the University of Nanking; and from certain other reports, some of which were published and some unpublished. The authors appreciate having had access to these references.

A PIONEER PROGRAM

"The first notable example of international technical cooperation in agriculture was the Plant Improvement Program carried on from 1924 to 1931 by Cornell University and the University of Nanking with financial aid from the International Education Board. The success of this program in training Chinese scientists to carry on a program of Plant Breeding and Crop Improvement in China led to the great expansion of University contracts under the foreign aid program of the United States in recent years."*

Dean Myers reports another incident which shows the influence of The Cornell-Nanking Program. Referring to a visit with a member of the United States Department of State, in connection with the United States program of technical cooperation, he recalls, "The conversation occurred at a conference in the early days of this program and soon after President Truman's recommendation for a Point Four Program. This man told me that the success of The Cornell-Nanking Program was one of the basic reasons for the initiation of a more comprehensive program of cooperation between American colleges and their overseas counterparts as an important part of the technical aid program."

* From an address by Dean W. I. Myers, former Dean of the College of Agriculture and Professor Emeritus, Department of Agricultural Economics, March 22, 1962. "Agriculture at Cornell — The First Century."

THE CORNELL-NANKING STORY

**DEAN JOHN H. REISNER'S LETTER OF FEBRUARY 4, 1924,
TO PROFESSOR H. H. LOVE**

The Cooperative Crop Improvement Program between Cornell University, through the Department of Plant Breeding of the New York State College of Agriculture, and the University of Nanking, through its College of Agriculture and Forestry—with financial support from the International Education Board—had its origin in a letter to Professor H. H. Love at Cornell University from Dean John H. Reisner, College of Agriculture, under date of February 4, 1924, as follows:

“We are looking for a Plant Breeder—a man who is interested in the practical applications of the principles of plant breeding and in getting practical results as quickly as possible. As you probably know, the College of Agriculture and Forestry received a considerable sum from a balance of leftover funds in the hands of the American Famine Fund Committee which had been raised for famine relief in China. The sum given to us is for famine prevention, and one of the projects we are developing is the improvement of certain of the major crops, with the idea of increasing agricultural production and the food supply. Our experience so far has been that Chinese crops are very amenable to improvement. In fact, we have already done considerable work in the improvement of wheat, cotton, and corn with very excellent results. There is a tremendous field for this line of work.

“We would want a man who had specialized in the small grains. Personally, I feel that our more immediate plant breeding problem is one of selection rather than of hybridization. Another fact which makes the work attractive is that assistants are available, and one man is able to make his time go a very long way by careful and wise use of them. For instance, Mr. Griffing, who is in charge of our Cotton Improvement work, in three years time made and studied over 52,000 individual selections of cotton plants.

“Have you someone to suggest? I hope so and that I may have the privilege of hearing from you soon.”

FORMULATION OF PROGRAM

Dean Reisner's letter was discussed at length with members of the staff of the Department of Plant Breeding. Reactions were generally favorable. Several sabbatical leaves were due that might be used. However, it was early agreed that a worthwhile program could not be completely organized and placed on a permanent basis in one or two years. A program was drawn up requiring a period of five to ten years for its completion. President Livingston Farrand, Cornell University, and Dean A. R. Mann, College of Agriculture, gave their warm endorsement and approval to the plan.

Through correspondence, Dr. Love and Dean Reisner had reached agreement that the longer period of five to ten years would yield much better results and was therefore more desirable. But the proposal also meant that sabbatical leaves would not cover all the time the Cornell professors would be away from Cornell. The University of Nanking did not have funds to cover the added expense for this item. A request for financial aid was submitted to the International Education Board, through Dean Mann, who was on leave from the College and serving as the Board's Director of Agriculture. Fortunately for the program, the request was granted.

The program was formally approved by the Board of Trustees of Cornell University, by the authorities of the University of Nanking, and by the International Education Board late in 1924. Briefly summarized, the program involved the following:

1. The purpose of the program was two-fold, to organize and conduct a comprehensive crop improvement program, involving the principal food crops of the famine areas of central and northern China, and of equal importance, to train men in the principles, methods, application, and organization of crop improvement.
2. Each year, for a minimum period of five years beginning in 1925, a professor from the Department of Plant Breeding at Cornell would spend several months in Nanking, there to be associated with the Department of Agronomy of the College. Thus, he would have ample opportunity after his return to Cornell to discuss the program with the next visiting professor.
3. The University of Nanking assumed financial responsibility for the traveling expenses to and from China, and the maintenance and traveling expenses in China of the Cornell representatives.
4. Cornell University agreed to grant sabbatical leaves, when possible, to members of the staff of the Department of Plant Breeding for work in China, and to grant such other special leaves, without pay, as might be found feasible and necessary in the development of the program.
5. The International Education Board assumed the responsibility of providing salaries for the Cornell representatives when on leaves, without pay, from the University, and to aid financially in other ways as might be agreed upon during the progress of the work.

POLITICAL CONDITIONS IN CHINA

The Republic of China was 14 years old when this cooperative undertaking began. These were also the years of the war lords who had carved out spheres of influence for themselves. They were years of sporadic civil wars between the war lords.

On March 24, 1927, the Revolutionary Army, moving north from Canton, reached Nanking. The ensuing disturbances caused the evacuation of all Consular staffs and other foreign residents in Nanking, including the foreign members of the University faculty. Though intermittent civil wars continued, peace was generally restored in the lower Yangtze River Valley, and an era of reconstruction begun. In 1931, Japan moved into Manchuria, and in 1937 it attacked the mainland of China, driving the Government and many people and institutions to west China, among them the University of Nanking. The University returned to Nanking in 1946. The Communists took over the country in 1949, and the Nationalist Government established itself in Taiwan.

In spite of civil wars and the major military disturbances of 1927, no damage was done to the Crop Improvement Program, no plantings were harmed, and no seed was lost. Credit need be given to the Chinese associates for their dedication, courage, perseverance, and tact under extremely difficult circumstances.

THE COLLEGE OF AGRICULTURE AND FORESTRY

The College of Agriculture and Forestry of the University of Nanking, Nanking, China, began instruction in the summer of 1914, with a class of eight students. The College had been established to contribute to the prevention of famines in China through scientific agriculture and forestry. Its main protagonist and first Dean was Joseph Bailie, born in Ireland, educated there and in the United States, who went to China as a Presbyterian Missionary and later taught mathematics at the University. He had been granted leave from the University to take part in relief work in the disastrous famine in the Hwai River area in 1913. This was no new experience for him, but he was increasingly disturbed with each relief program. He concluded that the only answer to these perennial situations requiring relief in greater or lesser amounts and affecting tens of thousands of people, largely rural, was to attack the root causes, and that progress could only come as men trained in agriculture and forestry became available to the Nation. The College became the largest in the University.

The College operated on the philosophy that it should limit its operations and maintain high standards in what it undertook to do. In part, this was

necessitated by limited funds, but it was also a matter of policy. Departments listed in the annual report of the College for 1925 were: Agricultural Economics and Farm Management; Agronomy; Biology, including Bacteriology; Botany and Plant Pathology; Cotton Improvement; Extension; Forestry; Rural Education, and Sericulture. The Department of Forestry was for a number of years the only one in China. The College has to its credit; the first Farm Management survey, the first Crop Disease survey, the first Crop Reporting system, the first Department of Extension, and it pioneered in many other activities.

By 1931, the ratio of Chinese to foreign faculty was 64 to 4, compared with a ratio of 41 to 9 in 1925. One hundred and sixty-three students were registered in the College. By June, 1931, 215 men had been graduated, 151 in Agriculture and 64 in Forestry, with Bachelor of Science degrees respectively in Agriculture and Forestry, granted by the Board of Regents of the University of the State of New York. Forty of the college graduates went to foreign countries for graduate work, most of them to the United States. They became closely associated with the remarkable advances in agriculture and agricultural education that took place in China after 1930.

Instruction in the courses was in the English language. As a private institution, the University of Nanking was able, in spite of political disturbances, to maintain its program without serious interruption, an important factor in the success of a crop improvement program.

The College of Agriculture and Forestry was given official recognition by the Central Government of the Republic of China in 1925.

The Administration of the College of Agriculture was unique in that it had two Co-deans who were also Co-directors of the Experiment Station, one Chinese and one foreign, with a division of responsibility that was both natural and effective.

THE COOPERATING STATIONS

Before this Cooperative Crop Improvement Program had come to a close in 1931, 14 cooperating stations had become associated with it. These stations added greatly to the effectiveness of the work centered at Nanking. All but four were related to Mission stations, where there were agricultural missionaries or others interested in local agricultural conditions. There was land available at each station for experimental purposes. Stations were located in areas representative of the major crops of north, central, and east China. As private organizations, they continued to function for the most part in spite of civil disorders. They were centers from which large selections from the major crops could be made, first for local testing and later for exchange with the other cropping stations for advanced testing. Since the

experimental methods in use were common to all stations, as well as to the Nanking station, comparable data could be obtained.

The following is a list of the cooperating stations operating in 1931. Among the directors, seven were graduates in Plant Breeding of the College of Nanking, and all had received training in the Summer Institutes of Plant Breeding as part of the Cooperative Crop Improvement Program.

Anhwei Provincial Agricultural Experiment Station, Anking, Anhwei.

Central China Teachers College, Wuchang, Hupeh.

College of Agriculture, Central University, Nanking, Kiangsu.

Jefferson Academy, Tunghsien, Hopeh.

Kaifeng Baptist School, Kaifeng, Honan.

Kiangsu Wheat Experiment Station, Hsuchowfu, Kiangsu.

Nanhsuchow Station, Presbyterian Mission, North, Nanhsuchow, Anhwei.

Oberlin Shansi Memorial Schools, Taiku, Shansi.

Shantung Agricultural and Industrial School, Yihsiien, Shantung.

St. Paul's Hospital, Canadian Church Mission, Kweiteh, Honan.

Tsangchow London Mission, Tsangchow, Hopeh.

Weihsien Station, Presbyterian Mission, North, Weihsien, Shantung.

Yenching University Agricultural Experiment Station, Peiping, Hopeh.

PARTICIPATING CORNELL PROFESSORS

As plans developed, it was agreed that Professors H. H. Love, C. H. Myers, and R. G. Wiggans, of the Department of Plant Breeding at Cornell University, would participate in the program. It was possible to arrange more easily for the continuation of their research work while they were absent in China, than it would be with staff members engaged in full-time teaching.

Dr. Love had specialized in small grains and biological statistics, Dr. Wiggans in open-pollinated crops, such as corn, and also in forage crops, and Dr. Myers in vegetable and forage crops. Each had experience with other crops and was fully acquainted with the experimental methods and techniques in use at Cornell and many other experiment stations. Each had received the Doctor's degree from Cornell and worked together for a number of years.

Due to unsettled political conditions, the participation of the Cornell representatives was interrupted partially in 1927 and completely in 1928. Each professor made two trips to China as follows: Professor H. H. Love—1925 and 1929; Professor C. H. Myers—1926 and 1931; and Professor R. G. Wiggans—1927 and 1930.

THE PROGRAM

The program had two main objectives. One was to develop by appropriate methods better varieties of the important field crops of China. The other was to train, during the course of the experimental work, a large number of Chinese who would be capable of continuing the investigations after The Cornell-Nanking Program was officially concluded.

Crop Improvement

High yields and the quality of all crops were important considerations in the crop improvement program. There were other characteristics of plants, such as a stiff straw or stalk and disease resistance, needing evaluations, and did receive attention as the program progressed.

The first phase of the program was to make a large number of individual plant or head selections from farmers' fields as the basis of the first work in crop improvement. One might ask why concentrate on selection rather than engage upon a program of hybridization or crossing the varieties that were already available?

When beginning a program of crop improvement in a new area or region where the varieties of different crops have not been studied and compared by yield tests as to their ability to yield, it is better to begin by making selections rather than to embark upon a hybridization program. If a study covering several years had not been made in variety evaluation of the many different varieties of a particular crop, then it would be unwise to begin a crop program without more knowledge as to which varieties were actually the best for the given area and the best sorts to be used in a hybridization program.

It is also important to have information on types or kinds of varieties that would be more desirable for the general area under consideration. So when entering upon a crop improvement program where such information is not available, it is best to start with a selection program, and a variety evaluation program may be conducted along with the selection program. Naturally, as a selection program is carried out, it also gives information on variety evaluation.

Another reason for beginning a program by selection is that it is the cheapest and quickest way to find some good varieties. Selection enables the plant breeder to pick out from a field a lot of different plants and then by appropriate field tests find the best lines from any particular lot of selections.

Value of Selection

What does selection do? Selection with crops such as wheat, barley, rice, and certain other crops does not create anything new. But, with corn and

other naturally cross-fertilized plants, continued selection toward a definite goal will change the type of plant. In this respect, it differs decidedly from a hybridization program. When one observes a field of wheat, barley, rice, or other similar crop, one is inclined to look at the entire field and sees a lot of plants growing together, and does not observe closely the individual plants unless one is trained in plant improvement and is looking for variations.

Where a good agricultural program has not been conducted in an area, a field of grain being observed will contain hundreds, and even thousands, of different types of plants. Some of them may be shorter than others; some may yield more grain than others. The yield of such a field is made up of the individual yields of all the plants in the field. If it were possible to go into a field and pick the best plant, it might be possible to obtain a new high-yielding sort by keeping the seed of this plant separate from all others and multiplying it. This sort might produce as much as 30 to 40 percent more than the average a grower would harvest by continuing to sow the seed of the crop from which this selection was made. Unfortunately, it is not possible for even the best-trained plant breeder to determine by observation the most outstanding plant in the field.

Plants vary in yield when a lot of them are grown together due to the environment or nurture in which each plant grows and to the plant's nature or heredity factors that it possesses. Thus, nurture and nature or environment and heredity are the factors which cause variation in yield. When the plant breeder makes selections in the field, there is nothing to indicate whether a vigorous, high-yielding plant is the result of nurture or heredity, and both work together to produce this particular plant. It is important to make a large number of selections and test them out by appropriate methods so that the seed from each head is grown in a separate row and grown under as nearly identical conditions as possible. For these comparisons, it is desirable to have check rows spaced about every 10th row in the field. These check rows are sown from seed of a variety that is recognized as the best for a given area. These rows enable one to note the good and poor spots in the field.

Training of Men

An equally, if not even more, important purpose of the program was to leave in China a group of well-trained men who could carry on and expand the work after the Cornell representatives had left. Training was carried on by formal lectures in the College and by Summer Institutes. Informal training was a continuous process, whether in the office, laboratory, or field. By the close of the program, all personnel believed that this training program was Cornell's most important contribution. Therefore, the training program is described separately and at some length under The Training Program.

However, it is appropriate to mention the training of one Chinese student

who was to play a key role in the developing program at Nanking. Mr. T. H. Shen, after receiving a Master's degree at the University of Georgia, came to Cornell University in 1924 to complete work for a Doctor's degree in Plant Breeding and Genetics.

Soon after arriving in China in 1925, Dr. Love suggested to Dr. Myers that it would be extremely valuable if Mr. Shen could come to China with him in 1926. This proposal was approved by Dr. Myers and presented to the International Education Board. The Board concurred in the plan. It agreed to provide a fellowship for Mr. Shen and to furnish travel expenses from Ithaca, New York, to Nanking, and return. Mr. Shen joined Dr. Myers in March, 1926, returning to Cornell in the fall to continue graduate studies.

In his report for 1926, Dr. Myers states, "This report would be incomplete without especial mention of the services of Mr. T. H. Shen. In a preliminary report sent to the International Education Board, the writer has already mentioned the excellent work done by Mr. Shen. As a matter of formal record, he desires to repeat here that any contribution he himself was able to make to this important work was due in no small measure to the very able assistance of Mr. Shen. His knowledge of China and his acquaintanceship with educational leaders everywhere made possible many contacts that would otherwise not have been made. It is gratifying to be able to state that before leaving Nanking, Mr. Shen was appointed to a professorship in the Department of Agronomy, to which he will return when he completes his graduate work."

The International Education Board continued Mr. Shen's fellowship until he completed the work for his degree and then made a grant to cover his return to China, where he continued as a professor in the College of Agriculture at the University of Nanking for a number of years. It may be added that time has demonstrated that the training made possible for Dr. Shen, along with his experience, has enabled him to make outstanding contributions to the agriculture of his country. He is, at present, one of the five Commissioners of the Joint Commission on Rural Reconstruction in China, and has served in this capacity since 1948, when the Commission was established.

DR. H. H. LOVE'S FIRST TRIP — 1925

Dr. Love arrived in Nanking on April 11, 1925. He became acquainted with the faculty, especially those with whom he would be working in developing the program. Individual and group conferences were held.

Facilities for the Program at the College of Agriculture

The facilities for plant breeding work at Nanking were simple but adequate. An area of 220 acres of good land on three farms outside the city of Nanking was available and used entirely for experiments and seed increase purposes. Paper bags, envelopes, and tags were made to order by the ambulatory patients in the University hospital. Stakes for marking rows were made of bamboo.

The field house, at the experiment station, furnished a hanging capacity for some 8,000 head and rod rows. It was equipped with storage and fumigation rooms, animal and tool sheds, kitchen, and quarters for the permanent working force. Close by was the school that was provided by the College for the children of neighboring villages; it served as a night school for adults.

The threshing and winnowing of experimental materials were done by hand by neighboring village women and were put into properly numbered paper bags. A large concrete drying floor provided space for sunning and drying the experimental materials and the reserves of seed. Storage space for experimental materials was available at the College where final weighings and checkings were made. Materials were moved between the experiment station and the College by horse cart. Fumigation facilities were added in 1925. In 1931, two greenhouses with a floor space of 3,750 square feet, and head house providing space for two offices and two small fumigation rooms, and a wire cage covering a fifth of an acre for growing experimental plants were constructed on the University campus. This construction added materially to the crop improvement facilities.

Following consultations with the staff and a study of the available equipment, the current projects in crop improvement work were reviewed; some were rewritten, and others covering the new lines of work to be undertaken were written. These projects are important as guides for those doing the experimental work, otherwise some investigators may have been inclined to undertake lines of work that were not contemplated in the project. It is important in all programs to review the projects frequently.

Reorganization of Program

The reorganization of the program at the Nanking station, and later at the cooperative stations, involved a process of education that was continuous,

whether in the field making selections, at work on the experimental plots, in the laboratory, or in the formal lectures in the classroom. By the close of the cooperative program, it was agreed that the training provided the Chinese staff by the Cornell professors was their most important contribution to China.

To standardize the crop improvement methods to be used, Dr. Love prepared two detailed memorandums. The first was "General Suggestions for Methods of Selecting and Testing to be Followed in Crop Improvement Work by the Department of Agronomy and Cooperating Organizations." The second was "Methods for Rod Row Testing." These detailed instructions were translated into Chinese and widely used. This was the beginning of a program leading to the adoption of standardized methods of crop improvement for practically all of China.

A first pressing need was preparation for an expanded program for wheat and barley. On May 18, Mr. G. E. Ritchey and Dr. Love left Nanking for Yihsien, Shantung. Here they inspected the work that had been started by Mr. K. M. Gordon. Altogether, 134 selections were made from head rows planted the previous fall. The trip continued to Kaifeng, Honan, where three days were spent with Mr. G. K. Middleton inspecting his wheat and other crop experiments. Over 2,000 head selections of wheat were ready for inspection and for selections. Selection of 208 rows was made from the lot. Rod rows were inspected, indicating the strains that were to be continued in the test for 1925-26. Observations were recorded on cooperative flag smut tests that had been arranged by Professor R. H. Porter, Plant Pathologist of the College of Agriculture and Forestry.

Leaving Kaifeng, Mr. Ritchey and Dr. Love returned to Nanking, stopping enroute at Hsuchowfu. Dr. Love continued on to Nanhsuchow, N. Anhewi, to review the wheat work at that station with Mr. H. H. White. Plans were made for a considerable expansion of the program.

First Conference with Cooperators

Toward the close of the summer season, cooperators from the different stations were asked to come to Nanking for a conference at which time questions on methods and procedures would be raised and answers given as far as possible. Condensed plans of procedure were to be discussed so that those men who were working with wheat and barley would have detailed plans for their work with these crops in the fall of 1925. On September 25 and 26, the conference was held at the University of Nanking.

In the conference, it was agreed that each station would grow a winter crop and a major and minor summer crop. The following plan resulted:

COOPERATIVE CROP IMPROVEMENT PROGRAM-DISTRIBUTION OF CROPS

Station	Winter Crop	Major Summer Crop	Minor Summer Crop
Kaifeng	Wheat	Kaoliang	Beans (Millet)
Nanhsuchow	Wheat	Beans	Kaoliang
Yihsien	Wheat	Kaoliang	Beans
Weihsien	Wheat	Kaoliang	Beans
Wuchang	Wheat		
Kweiteh	Wheat	Kaoliang	Beans
Nanking	Wheat Barley	Cotton Corn	Beans Rice

It was agreed:

- that the crop improvement in China would proceed more satisfactorily if the interested agencies would join together in one large plan of co-operation rather than for each individual or station to work separately;
- that the same plans for selecting and testing the various crops would be used at each station so that the results would be comparable;
- that the improvement work would be closely associated with the diseases of the crops studied.

Professor Porter was in charge of this work, and several cooperative projects on disease resistance were already underway.

At the conference, a memorandum of understanding for cooperative work and crop improvement between the College of Agriculture and Forestry of the University of Nanking and cooperating agencies was discussed. It covered such items as crops to be investigated, methods of work, records, seed storage and handling, reports, personnel, furloughs, expenses, supplies, conferences, and termination of cooperation. Agreement was reached on all topics, and copies of the memorandum were made available to cooperators.

At the close of the 1925 season, and after part of the wheat experiments had been sown, Dr. Love returned to Cornell University and completed his report, copies of which were made available to Drs. Myers and Wiggans.

DR. C. H. MYERS' FIRST TRIP — 1926

Dr. Myers was the second representative from Cornell University to go to China, arriving in Nanking March 24, 1926. As mentioned earlier, a fellowship was granted to Mr. Shen, who arrived in Nanking a few days before Dr. Myers.

The first few days were used for conferences with members of the staff who would be associated with the work, and to check the available facilities. Dr. Myers reported on the construction of a fumigation room on the first floor of the storage building at the Tai-ping-men Farm. This was a valuable additional facility.

In May, Dr. Myers and Mr. Shen visited most of the cooperating stations. Provision was made for other members of the University of Nanking staff to observe those stations that were not visited by Dr. Myers and Mr. Shen.

About 8,000 head rows of wheat were grown at the Nanking Station and at several cooperating stations. After studying these selections carefully, 2,000 rows were selected for further tests. Dr. Myers and Mr. Shen arranged for additional head selections to be made from farmers' fields at Wusih, Soochow, Nanhsuchow, and Kaifeng.

Barley matures at about the same time as does wheat. There were 2,400 head rows, the seed of which had been inoculated with smut before sowing. (Inoculation of the seed was through the cooperation of Professor Porter.) From these 2,400 rows, 230 were selected which showed no trace of smut.

Some 10,000 selections of soybeans had been made. These were divided and grown at several stations. Dr. Myers and Mr. Shen assisted in the soybean planting at some of the stations. Since planting time came about the same date at each station, they were unable to assist at all of them, but the planting was done by experienced personnel. They assisted with the selection of the plant rows of soybeans (at the end of the season) at Nanking, but since their time to leave China was close at hand, they were unable to help with all selections.

Recommendations were made to include some vegetables in the program. The Division of Vegetable Gardening, University of Nanking, had been growing vegetable seeds to sell to growers, and it was thought wise to begin work that would lead to better sorts of these crops. Dr. Myers suggested that millet be added to the program. It was, and continues to be, an important crop in China.

DR. R. G. WIGGANS' FIRST TRIP — 1927

Dr. Wiggans, the third member of the Cornell University scientific team to go to China, left Ithaca in the spring of 1927. At this time, the Chinese Army was on the move from south China to central and north China. It was assumed that the troops nearest Nanking would pass the city without disturbance, but by the time Dr. Wiggans arrived in Shanghai, conditions around Nanking had changed radically, forcing foreigners to leave Nanking. This affected his plans, and he remained in Shanghai, but the Chinese staff, responsible for the crop improvement work, could travel to Shanghai for conferences.

Plans for crop experiments were discussed, and planting plans were outlined. The fact that the plans were well laid and the experiments at all stations were conducted according to arrangements made in Shanghai is evidence of the interest in the program by the Chinese staff.

Dr. Wiggans' shortened visit was disappointing, but his encouragement given to the Chinese staff and the conferences held with them were beneficial to the advancement of the program. After one month in Shanghai, he returned to Cornell University.

The University of Nanking authorities believed it unwise for a Cornell representative to come to China in 1928. Even so, it is important to note that the planning for the crops to be planted in the fall of 1928 and the plans for 1929 were carried forward in a highly satisfactory manner.

DR. H. H. LOVE'S SECOND TRIP — 1929

Dr. Love made his second trip to China in 1929, arriving in Shanghai April 19. He was advised that the experimental work had neither been interfered with at the University nor at any of the cooperating stations.

Remnants of the seed had been divided into two lots and were hidden so that sufficient seed of the samples would have been saved in the event of loss. Records on experiments at the Nanking Station had been well kept; the same being true at the cooperating stations visited by Dr. Love. It was evident from the records of the other cooperating stations that the work was being conducted with extreme care.

Wheat — Nanking No. 2905

Since the wheat crop was first to mature, trips were taken to several stations to study the experiments and to make selections of the lines to be continued in further tests in 1929 and 1930. From 10,400 head rows grown at Nanking, 2,300 were selected for further observation.

Some fields had been sown at Nanking to increase the seed of certain varieties. The one that had been most promising was Nanking No. 26. This variety had been distributed quite widely near Nanking and its adjacent territory. It was decided that a new lot of pure seed was needed, and to accomplish this, a number of bundles had been harvested from this variety. Only those heads that seemed to possess the exact characteristics of Nanking No. 26 were saved to sow small increase plots for the 1929-1930 season.

While inspecting farmers' fields at Nanhsuchow, it was observed that barley was heavily infected with smut. Counts were made, and in one field, 45 percent of the plants were taken by smut. Since smut could be controlled by a simple chemical treatment, it was regrettable that a larger staff was not available so that extension work could be done to control the disease.

By 1929, it was evident that seed distribution might well be expanded to include some of the newer selections. From field tests that had been con-

ducted and from observations in the field, it was demonstrated that the wheat selection Nanking No. 2905 appeared to be an improvement over the farmers' varieties. One of the soybean selections, Nanking No. 332, was also giving considerable increases in yield over local varieties that were being grown.

The Nanking No. 2905 wheat is a selection which was made a short distance southeast of the city of Nanking by one of the staff of the College of Agriculture and Dr. Love in 1925, while driving through the country for the purpose of making head selections. One field was so different from any others yet seen, they were at once attracted to it and were sure that some selections should be made. The owner was contacted. The program was explained to him, and how they planned to do the work and that they would like to make some head selections from his wheat field. A fair sum was offered for the heads taken. He readily gave his consent, and Dr. Love and his associate selected more than 100 heads. The farmer watched; he did not ask them not to take more heads, but he suggested that his neighbor, a short distance away, had a better field of wheat than did he. Both men grasped his meaning, and made no further selections. The farmer refused to accept any payment for the wheat heads selected.

From these selections, there were several heads that were almost as good as the Nanking No. 2905. This wheat, together with Nanking No. 26 wheat and some other selections, was sown to increase the supply of seed for distribution to farmers when the supply was sufficient.

By 1931, a fair amount of seed of Nanking No. 2905 was available. That year witnessed one of the most serious floods China had had in modern times, and many of the farmers who had lost their wheat seed needed more seed for sowing. It was possible to supply a number of the farmers near Nanking with seed of this new variety. Reports from several of them after the 1932 harvest indicated that they had harvested yields at least 40 percent higher per unit of land than they had been able to harvest before. This variety had demonstrated its ability to yield well in the experiments and again proved that it was worthy of further extension.

The program received benefit from the cooperation of Professor Porter and his staff of Plant Pathologists, and their help was appreciated. What they had time to do along with their other duties indicated how much more could have been done if additional well-trained men were added to the staff of the Division of Plant Pathology. This was emphasized by Dr. Love in discussing the further expansion of crop improvement investigations.

Grain Sorghum — Kaoliang

Kaoliang, grain sorghum, is an important crop for northcentral and northwestern China. It withstands drought better than other grain crops. While the presently developed varieties of Kaoliang are somewhat resistant to drought, it would be beneficial if varieties could be found or produced which would be even more resistant than those now available.

During a visit to Peking in August, 1929, Drs. Shen and Love were advised of a plan to grow imported drought resistant grain sorghums. They were informed of pending purchases of large amounts of this seed from the United States. No adequate experimental evidence had been obtained to prove whether these imported strains were equal to or superior to the native sorts. Drs. Shen and Love raised the question of whether a mistake was being made in obtaining large quantities of untried strains. Since the seed had been ordered there was nothing to do but await results. Conclusions on imported grain sorghums are reported under "Dr. Wiggans' Second Trip—1930," page 21.

Soybeans

Experimental work with soybeans was continued and expanded in 1929, but the tests at the Nanking Station were almost a total failure that season due to the unusually dry weather. Most of the flowers dropped from the plants; only a small amount of seed was obtained, and seed for sowing in 1930 was from the remnant seed that had been saved. This emphasizes the importance of saving remnant seed each year.

Millet

Millet was another crop to receive greater attention in the Crop Improvement Program. For best results, it was necessary to bag the heads of some plants before flowering to avoid natural crossing, and thus obtain pure seed for further testing.

The results from experiments showed that new selections from certain crops were definitely superior in yield to the varieties commonly grown by the farmers. The ultimate goal of crop improvement and breeding research is to make available to growers seed of these better sorts so they may obtain better yields from their land without changing their cultural methods. Dr. Love emphasized the need to give more consideration to the problems that would arise in multiplication and distribution of good seed.

Drs. Shen and Love visited north China and studied experiments at the Tungchow Station. Experimental crops included corn, wheat, kaoliang, and millet. The work on kaoliang and millet was observed in the field. Some

promising selections and varieties of these crops were noted, and from the wide differences in yield, it was evident that some good yielding sorts should be obtained after further tests.

The Chinese Science Society

From Tungchow, Drs. Shen and Love went to Peking, where the Chinese Science Society was holding a meeting. Dr. Love spoke at one of the sessions. This Society has a close association with Cornell University. Several Chinese students studying at Cornell had learned from their professors of the American Association for the Advancement of Science and other organizations in the United States that had been established for special fields of research. These students met in one of the entomology laboratories on the Cornell Campus and considered the need for a Chinese organization to further the interest of science in their country. They agreed that such an organization was desirable, and after returning to China, efforts would be made to interest other scientists in the proposal. Thus, the Chinese Science Society was born, and in a few years it had developed into a useful organization.

DR. R. G. WIGGANS' SECOND TRIP — 1930

Dr. Wiggans arrived in Nanking March 29, 1930, and remained until October 29 of that year. In his report, he said:

"As stated in previous reports, it seemed doubtful in 1927 that the Crop Improvement Program could be carried on successfully as a result of the political conditions then existing. It is, however, a great satisfaction to report that during those trying times of changing and reorganizing governments, when all foreigners were forced to evacuate Nanking as well as a very large part of the interior where cooperative work was established, when institutions were in a state of upheaval, and when individuals were unable to plan for the future with any degree of certainty, that not a single loss of any of the crop improvement material occurred. The personnel in charge were so thoroughly interested in the work and impressed with its importance that no sacrifice was too great in order to prevent loss."

Open-fertilized Crop — Corn

Dr. Wiggans placed emphasis on the breeding of an open-fertilized crop such as corn. This was desirable, and it was time to emphasize not only corn as a crop, but to illustrate the methods for breeding an open-fertilized crop. These methods enlarged the program of training for individuals working in the program and for the students and staff members who attended the short-course lectures.

As mentioned earlier, corn improvement was begun by Dean Reisner when he first went to the College of Agriculture and Forestry in 1914. He followed the ear-row method, used at that time at most experiment stations in the United States, by the selection of individual plants and continuing the selection process. The Nanking Yellow developed by this method proved to be a good variety, especially in the area of the Yangtze River; it did well in some more distant areas. Changes in breeding methods were being made which focused the attention on the importance of producing crosses from inbred lines and double crosses.

Quoting from Dr. Wiggans' report:

"The experiments for 1930 included: (1) the establishing of a large number of lines of corn by the inbreeding method from 868 individual ears of corn collected from many localities in China and from many varieties and strains introduced from the United States; (2) the testing of 35 varieties, 30 double crosses, 11 single crosses, and 6 varietal crosses from the United States for their adaptation to Chinese conditions; and (3) the testing of F₁'s of native strains.

"The results are not available except for Nanking Yellow, but it is interesting to note that only two of the introduced sorts yielded as much, or more, than Nanking Yellow. Results from farther north will probably show the foreign sorts to better advantage. In the test were cross-bred combinations of inbred strains of native stock which out-yielded Nanking Yellow by large margins. This statement is made to show that there are limitations in favorable results that can be expected by the introduction of high-yielding varieties of an open-fertilized crop into an entirely new and different environment."

Soybeans

Dr. Wiggans emphasized the importance of conducting an adequate soybean program, since the soybean is one of the main food crops of China. He mentions the fact that until the beginning of the work at Nanking, the many varieties of this crop had never been scientifically studied in China. He reports that larger collections had been made by representatives of the United States for tests in the United States than had been made for China. The results of a test for three years comparing the new selection No. 332 with a check variety was reported by Dr. Wiggans. The selection showed an increase in yield of 52 percent over the check, which was a substantial gain.

Doctors Shen and Wiggans visited north China to (1) conduct an Institute of Crop Improvement for the Nanking University cooperators; (2) study the needs for crop improvement in north China; and (3) make a special study of the recent introductions of foreign sorghum seeds into the famine areas of north China.

It was a good plan to hold the Institute in north China, since it was possible for a number of men to attend from that area who had been unable to come to Nanking for previous Institutes.

It was concluded that the areas visited in north China were in need of careful and consistent crop improvement work. The varieties and types of crops were numerous and mixtures almost universal. There was little doubt but that material increases in production could be made by an application of the present knowledge of inheritance in plants.

Conclusions by Drs. Wiggans and Shen on the value of the imported sorghum seed were:

(1) A considerable amount of the seed was of low vitality; in some cases the seedlings were so weak that they were unable to survive the adverse conditions.

(2) There was no significant evidence of greater adaptation or yield of foreign sorghums over native sorghums, either from the observations made or from the reports of careful experimental work except in Suiyuan, where the evidence was very strong to the effect that all introductions were entirely too late.

(3) There was need for careful experimental tests in representative localities in the areas, including both dry and irrigated land, over a series of years, before the facts of the comparative merits of the various types and varieties could be known.

(4) That large expenditures for recently introduced and comparatively untried crops, regardless of the kind, should be made with extreme caution. This statement was made due to observation and statements reported above and the fact that there are few examples in the history of crop improvement where new introductions that have been made on a wholesale plan have proven successful from the start.

DR. C. H. MYERS' SECOND TRIP — 1931

In the autumn of 1930, the President of Yenching University asked the University of Nanking, through its College of Agriculture and Forestry, to take over the work of its Department of Agriculture with the understanding that the future work would be confined to a Crop Improvement Program.

By mutual agreement of both Universities, Dr. Myers, who was to return to China in 1931, was asked to arrive as early as possible at Yenching University to study the situation and make recommendations. He arrived in Nanking on February 20, 1931, and stayed until October 2 of that year. He went to Yenching on March 18 and began his study of the proposal made by Yenching University. On the basis of his consultations with members of both Universities and his own investigations, he recommended that the agri-

cultural operations be limited to one major Crop Improvement Program, and that it be conducted by the University of Nanking on behalf of, and in the name of, Yenching University with complete control of its Agricultural Experiment Station land, financial resources, and other pertinent assets. His report, dated May 26, 1931, was approved by the two Universities and the China Famine Fund Committee, and the College of Agriculture and Forestry, University of Nanking, took over the work in April, 1931.

General recommendations agreed upon covered the responsibility of the University of Nanking in the use of land, finances, and other details. The University of Nanking agreed to secure the approval of the President of Yenching University before making final decisions affecting the property interests of Yenching University. Staff appointments for temporary or permanent residence at Yenching University were to be made by the University of Nanking and such appointments should be considered by Yenching University as visiting staff members. It was stipulated that the Agreement by the two institutions might be terminated by either of the two upon previous notice of 12 months and by a satisfactory adjustment of property and other issues involved.

Recommendations made by Dr. Myers were well received by the officials of Yenching University and approved in principle by the China Famine Fund Committee, and later approved by the Board of Managers of Yenching University and the Board of Directors of the University of Nanking.

Dr. Myers' first association with the Crop Improvement Program was in 1926. While a substantial beginning had been made at that time, there was much to be desired in organization, equipment, and trained personnel. On his second visit, he noted improvements in the organization of the Department of Agronomy in the College of Agriculture and Forestry. The Department was staffed by 18 men who were functioning efficiently in conducting the projects. There was more land for experimental work, and there was additional laboratory and office space. Work at the cooperating stations was progressing satisfactorily.

Since Dr. Myers was the last representative from Cornell University to go to China, he carefully studied experiments underway, and made recommendations from his observations for improvement and extension of the general program. The following paragraphs on a Revised Memorandum of Agreement and a Revision of Projects are from Dr. Myers' Report of March, 1934.

Revised Memorandum of Agreement

The Memorandum of Agreement formulated in 1925 to cover the work with the cooperating stations was designed to meet different conditions than those prevailing in 1931. In 1925, there were but a few well-trained plant breeders available for the stations. It was necessary, therefore, for the Memorandum to be specific and exacting with respect to procedure, and the work entailed close checking and supervision by the Department of Agronomy at Nanking, where details of the work were centered. The wisdom of this strong centralization of responsibility had been established.

In 1931, conditions were different. The training of men, one of the two important aims of the Crop Improvement Program, had progressed to where its effectiveness was noticeable. No longer was it necessary to exercise such close supervision of the work. By their contacts with the program and by their studies in the Summer Institutes, the men originally on the staffs of the cooperative stations in 1925 had become capable of working more independently. The more recent graduates in Agriculture from the University of Nanking were better trained in genetics and plant breeding than were the earlier graduates, this being a direct effect of the Nanking Program. Some of these graduates had become associated with the cooperative stations.

In view of these changed conditions, it was desirable to revise the Memorandum of Agreement to provide more flexibility and freedom of action without losing the advantage to be derived from a correlated effort, an important advantage in crop improvement. The new Memorandum of Agreement provided for careful scrutiny and consideration of details of the projects, but it permitted more freedom and individual responsibility for the project leader. The new Memorandum of Agreement was approved. The group of cooperating stations functioning under this agreement was a strong one. The work started in 1925 was beginning to produce worthwhile results.

Revision of Projects

Dr. Myers reviewed the projects of the Agronomy Department and made changes and rewrote a number of them. At the beginning of the program, it seemed desirable to have a project drawn up covering each line of work even though some projects were closely related. As the projects were revised, it was desirable to include closely related lines of work within one project. This made it easier for those handling the work of the projects, and an improvement from the standpoint of the administration. It was recognized that it would be advantageous to have projects covering all types of investigation; therefore, a project committee of the College was formed with the Dean as an ex-officio member. A standard form sheet was adopted by each department of the College.

The Flood of 1931

China experienced one of its most serious floods in 1931. Dr. Myers comments on this as follows:

"In July and August came the disastrous flood of 1931, one of the major calamities of China, which disrupted a rural population estimated at 25,000,000 in the Yangtze and Yellow River basins, and which caused an enormous loss of life and property. Nanking and its environs did not escape the ravages of this flood. Many parts of the city were under water to a depth of three feet, and thousands of acres of fertile land outside the city were completely submerged for months. Not only were growing crops destroyed, but it was impossible on many farms to make the usual fall seeding of wheat, which is one of the important food crops of that region.

"The lower lying parts of the University of Nanking's experimental farm were also submerged. Fortunately, however, no serious losses of experimental material occurred. Some of the rice experiments for that year were lost, but reserve supplies of seed were available for renewing the work as soon as conditions permitted. The experiments with other crops were not seriously damaged. Wuchang, near Hankow, was the only one of the cooperative stations which suffered material injury from the flood. Here the damage was very severe, and plant breeding projects were entirely disrupted for the growing season of 1931. The reserve supplies of seed, however, were not lost and the work was fully renewed in 1932. The fact that the Crop Improvement Program was relatively so little permanently affected by the flood is evidence of its stability and the loyalty and efficiency of the trained Chinese associates responsible for its execution."

It was impossible for Dr. Myers to visit all cooperating stations in 1931, but during the Summer Institute of that year, he held special conferences with representatives of those stations he did not visit and with representatives of the other stations. Members of the Department of Agronomy at Nanking took an important part in these conferences. Projects were reviewed, and special problems, both administrative and technical, were discussed.

Knowing that he would be the last Cornell University representative to participate in the program, Dr. Myers used his time to the greatest possible advantage. He knew that plans for the future needed careful consideration, and he discussed a number of these during conferences with the staff members at Nanking and with those in charge of the crop improvement work at the cooperating stations who were to be responsible for the program in the future. He was aware of his responsibility in doing everything possible to leave complete plans, recommendations, and directives covering the many details that would arise as the Crop Improvement Program continued to grow and expand. *It did just that.*

RESULTS FROM EXPERIMENTAL WORK

Space does not permit the presentation of results with all crops. Gains made by the new strains or varieties may appear somewhat high. This is not surprising since the experimental work was being done in a new agricultural area from the standpoint of crop improvement. There had been no extensive experiments to improve crops other than those made by Dean Reisner and his associates.

Data on the several crops on which work was being conducted and the number of cooperating stations are presented in Table 1. "Head rows" and "plant rows" include those crops planted from the various selections made from farmers' fields. "Rod rows" are small plots that are used by most plant breeders in conducting similar tests. Plants from 8 different crops were grown at 13 different stations. Total plantings for the tests for 1929-1930 are given. In 1927-1928, there were but 8 stations, with 46,229 plantings. The number of stations increased from 8 to 13, and the total plantings increased to 96,799, or more than double those of 1927-1928. This represented rapid expansion in the program.

The results of yield comparisons for one experiment with wheat and one for soybeans will now be presented. Yields of Nanking No. 2905 wheat compared with Nanking No. 26 are listed in Table 2. Using the data for the years in which the comparisons may be fairly made, the average yield for five years is 30 bushels per acre and the gain over the check averages 6 bushels per acre, or 25 percent. Since it is known by numerous tests that Nanking No. 26 yields about 7 percent more than the farmers' varieties, it is apparent that the new selection No. 2905 wheat, grown under similar conditions, would yield about 32 percent more than the farmers' varieties.

Selection work with soybeans was begun at the Nanking station in 1924, when a Chinese associate made individual plant selections from the University Farm and from farmers' fields near Nanking. Among these selections was one named Nanksoy No. 332, which proved to be a most valuable type as its performance in yield indicates. The results for five-years' tests are given in the upper part of Table 3. As a result of the five-years' tests, average gain over the check is 5.46 bushels per acre. Subtracting this figure from the average yield of Nanksoy No. 332, 17.68, the average yield of the check is 12.22 bushels. Using this figure as a basis, Nanksoy No. 332 shows a gain of 44.7 percent. The results obtained when comparing Nanksoy No. 332 with a farmer's variety in two tests are given in the lower part of Table 3. The gain of the new variety over the farmer's sort in the first test is about 83 percent, and in the second one, it is over 90 percent. Thus, the value of selection for improvement of crop yields is substantiated.

TABLE I. PLANTINGS FOR 1929-1930 SEASON

STATIONS	An- king	Hsu- chowfu	Hwang- tu	Kai- feng	Kwei- teh	Nanhsu- ehow	Nan- king	Taiku	Tsang chow	Tung- hsien	Weih- sien	Wu- chang	Yih- sien	Total
CROPS														
Barley	Genetic Study	.....	.....	.....	.....	.....	974	.....	.....	.....	.....	.....	.....	974
	Head Rows	.....	.....	300	50	3,332	.....	.....	.....	.....	.....	.....	.....	3,332
	Rod Rows	.....	.....	300	50	1,035	.....	.....	.....	.....	.....	.....	.....	1,385
	Total	.....	.....	.....	.....	5,341	.....	.....	.....	.....	.....	.....	.....	5,691
Corn	Selfing	.....	.....	.....	.....	928	150	418	.....	.....	.....	.....	.....	1,496
	Yield Test	.....	.....	.....	.....	385	.....	98	277	.....	.....	.....	.....	385
	Introduced	.....	.....	.....	.....	.....	.....	440	.....	.....	.....	.....	.....	375
	Ear-to-Row	.....	.....	.....	.....	.....	1,313	688	695	.....	.....	.....	.....	440
	Total	.....	.....	.....	.....	.....	3,405	.....	.....	.....	.....	.....	.....	2,696
Cotton	Rod Rows	396	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3,801
	Sulfuric Acid Treatment	.....	.....	.....	.....	.....	146	.....	.....	.....	.....	.....	.....	146
	Blank Test	396	.....	.....	.....	.....	200	.....	.....	.....	.....	.....	.....	200
	Total	396	2,010	.....	.....	.....	3,751	.....	.....	.....	.....	.....	.....	4,147
Kaoliang	Head Rows	.....	1,955	431	3,800	530	.....	457	520	.....	.....	.....	.....	2,540
	Rod Rows	.....	.....	.....	.....	452	.....	.....	.....	.....	.....	.....	.....	9,613
	Selfing	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	452
	Multiplication	.....	1,955	431	3,800	982	.....	457	240	.....	.....	.....	.....	240
	Total	2,010	.....	1,955	431	3,800	982	.....	760	.....	.....	2,450	.....	12,845
Millet	Head Rows	.....	.....	1,280	.....	1,760	270	.....	205	.....	.....	.....	.....	1,965
	Rod Rows	.....	.....	.....	.....	.....	241	.....	410	.....	.....	.....	.....	1,960
	Selfing	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	241
	Blank Test	.....	.....	1,280	.....	1,760	300	.....	615	.....	.....	.....	.....	300
	Total	.....	.....	20,000	.....	.....	1,367	.....	.....	.....	.....	.....	.....	4,466
Rice	Head Rows	20,000	.....	.....	.....	.....	1,645	.....	.....	.....	649	.....	.....	21,367
	Rod Rows	342	.....	.....	.....	.....	800	.....	.....	.....	.....	.....	.....	2,636
	Blank Test	600	.....	.....	.....	.....	180	.....	.....	.....	.....	.....	.....	1,400
	Transplanting	270	.....	.....	.....	.....	3,992	.....	.....	.....	649	.....	.....	450
	Total	21,212	.....	.....	.....	1,740	570	.....	.....	.....	.....	.....	.....	25,853
Soybean	Plant Rows	.....	405	78	1,084	1,936	.....	.....	1,060	.....	.....	.....	.....	5,043
	Rod Rows	.....	.....	.....	.....	300	.....	.....	.....	.....	.....	.....	.....	300
	Blank Test	.....	.....	.....	.....	200	.....	.....	.....	.....	.....	.....	.....	200
	Multiplication	.....	.....	405	78	2,824	3,006	.....	1,060	.....	.....	480	.....	7,853
	Total	.....	2,825	200	4,723	2,255	1,632	1,403	.....	.....	.....	.....	.....	10,013
Wheat	Head Rows	.....	1,875	330	3,315	9,068	637	595	740	.....	.....	.....	.....	20,538
	Row Rows	.....	.....	.....	.....	2,697	14,020	1,632	2,040	595	740	953	953	2,697
	Genetic Study	.....	2,825	200	6,598	330	3,315	.....	.....	.....	.....	.....	.....	33,248
	Total	.....	2,825	200	10,538	839	11,749	33,216	1,632	688	3,807	2,415	1,389	96,799
Grand Total	.....	21,608	4,835	200	10,538	839	11,749	33,216	1,632	688	3,807	2,415	1,389	96,799

Note 1.—The numbers in the above table show the exact number of rows planted as the omitted row numbers after each series are not counted.

Note 2.—The number of rows in the above table includes both strains or varieties, and check rows.

TABLE 2. THE YIELD COMPARISON OF NANKING NO. 2905 WHEAT WITH NANKING NO. 26 IN BUSHELS PER ACRE

Year	Actual yield +	Gain over No. 26
1927*	(42.8)	(19.8)
1928	29.4	8.8
1929*	(53.3)	(26.9)
1930	40.8	9.7
1931	23.4	—.5
1932	28.1	7.7
1933	28.3	4.3
Average	30.0	6.0 = 25.0%

* The average yield for Nanking No. 2905 is based on the data of 1928, 1930, 1931, 1932, and 1933. The yield data in 1927 and 1929 are excluded because that from 1927 was based on the two-rod row test, which is only preliminary, and in 1929 the yield of Nanking No. 26 was unusually low, owing to a poor stand, and it should not be compared with Nanking No. 2905 for that year. Excluding these two highest yields for Nanking No. 2905, the average yield is 30 bushels per acre, which is a gain of 6 bushels, or 25 percent, over Nanking No. 26.

+ The reader may question why the actual yield of the variety is not higher. This is because the soil of the experimental field is typical of the Nanking region and its fertility is slightly lower than that of the normal field, and high amounts of fertilizer were not used.

TABLE 3. YIELD OF NANKSOY NO. 332 COMPARED WITH THE CHECK VARIETY

Year	Yield in Bushels Per Acre	
	Actual Yield of Nanksoy No. 332	Gain Over Check
1926	20.3	9.6
1927	24.3	6.7
1928	15.4	4.1
1930	13.8	5.0
1931	14.6	1.9
Average	17.68	5.46 44.68%

Two tests comparing Nanksoy No. 332 with a farmers' variety expressed in bushels per acre and percent.

Variety	Seed	Variety	Seed		
Farmers' Nanksoy No. 332	20.7 37.9	83.1%	Farmers' Nanksoy No. 332	12.1 23 1	90.9%



Harvesting test plots of wheat used for comparing yields of varieties and selections.



Carrying the bundles of wheat to the storage building.



The bundles are hung up for drying. After drying, the grain is threshed out by hand and placed in paper bags as shown in the picture. Bags are properly labeled for storage of the seed until it is needed to prepare the seed for the next crop.



Wheat of one of the good varieties that has been grown on a field to increase the amount of seed for distribution to growers now spread out on a large concrete floor for a good sunning. This helps prevent mold and also helps control insects.

SUMMARY OF EXPERIMENTAL WORK

Wheat

Wheat data comparing Nanking No. 2905 for five years with other selections and one foreign variety show that Nanking No. 2905 yielded 51.7 percent more than the check, Nanking No. 26. Other selections made from the same field from which Nanking No. 2905 was obtained showed large gains. At Kaifeng, the station developed a new variety of high quality Kaifeng No. 124. It showed an increase of 12.4 percent gain over the standard use for comparison. At Nanhsuchow, the station developed a new variety, Nanhsuchow No. 61. Comparing this variety for seven years with an imported variety, known as Nanhsuchow No. 6, from the United States, which had been doing well in the Nanhsuchow area, there was a gain of 11.75 percent in yield. When this selection was compared with farmers' varieties for three years, it showed an average gain of 27.83 percent.

Barley

The Kaifeng station developed a new barley selection, Kaifeng No. 313. A five-year test showed an average gain of 7.27 percent over the check variety. When this selection was compared with farmers' varieties, it showed a gain of 21.28 percent.

Rice

Selection work with rice conducted at Nanking produced several sorts which gave increases ranging from 14.6 to 29.6 percent over a good farmers' variety.

Kaoliang

Selection work with Kaoliang was conducted at the Nanhsuchow station. In a four-year test, these selections ranged from 28 to 48 percent more than farmers' varieties grown in the same tests. The two leading selections gave 47 to 48 percent increases.

Cotton Improvement Work

Cotton improvement work was begun by J. B. Griffing when he made selections from Chinese cotton. This was before the expanded Crop Improvement Program. In his studies, Mr. Griffing made over 50,000 selections. One seemed to be superior to others from the standpoint of yielding ability and quality of lint. This was named Million Dollar, and it was accepted by many farmers as being an improvement over the common variety they had been growing.

Seeds of this variety were multiplied and distributed to many growers, especially along the seacoast from Shanghai, south to Ningpo, as well as for some distance inland from the seacoast. It was grown north of the Yangtze River above Shanghai. Its quality, measured by spinning tests, was judged equal to the American cotton. Experiments were conducted with seed of the Acala variety from the United States; in some areas this variety was giving satisfactory results.

Later, cotton production work was included as part of the Crop Improvement Program. Variety trials were made in the northern part of China. Here it was determined that some varieties from the United States gave good results. Trice cotton was one that was doing fairly well, but Stoneville No. 4 seemed to be more popular in the general area of Peking and in an area southwest of that city. More extensive variety tests were planned to determine the best varieties for the important cotton producing areas of China. These experiments indicated in which areas the Chinese type of cotton would be expected to be more satisfactory than the foreign varieties, mainly American. The latter were better adapted to the north-central and northern cotton-growing regions. A new selection program was begun, and studies on the disease resistance of the different types were included in the program.

In the later years of the Crop Improvement Program, more consideration was given to the multiplication and distribution of pure seeds of the varieties in which field experiments had demonstrated their capabilities of producing superior yields in a large number of different areas.

The data which have been presented here illustrate that under conditions existing in China when the program began, the field selection of plants, conducted on a large scale, made it possible to obtain new strains of plants that would produce larger yields than the varieties commonly grown by the farmers, and that the results of the experimentations were obtained in a short time.

SEED MULTIPLICATION AND DISTRIBUTION

The goal of a crop improvement program is to produce varieties of crops that are an improvement over those grown by the farmers and to make available to them seed of these better sorts so they may obtain higher yields from their land without changing appreciably their cultural methods. In some ways this is the most difficult part of a crop improvement program.

In former days it was common belief that it was much easier to produce an improved variety than it was to introduce it to the growers and have it produced successfully.

Unless the seed from an improved variety is accepted by the growers and

maintained in its purity, the entire effort in producing the new sort ends in failure. This was realized in the crop improvement program, and plans were made to enable the Chinese farmers to do their part in the multiplication of the new sorts.

Some distribution of good strains of wheat, cotton, and corn was made in China before 1925. As previously mentioned, Dean Reisner had produced the Nanking No. 26 Wheat and the Nanking Yellow Corn. Both were superior to the native varieties being grown by farmers; these were from selections of local varieties. Selected strains of cotton were also distributed. Mr. Griffing made many selections from Chinese cotton, and one of these named Million Dollar gave an increase in yield and produced high quality lint. Selections were made from the American cotton varieties, Trice and Acala, and the seed was distributed.

When considering the crop improvement work that was done in China, this question is frequently raised: "Was the Chinese farmer so conservative that he would not wish to cooperate with the program and try out seed of some new variety, or a method for seed treatment?" The Chinese farmer is no more conservative by nature than was the farmer of the United States 50 to 60 years ago. The chief difference was one of economy. Since many of the farms were less than an acre in size, and the average size of a farm was about 3.5 acres, the farmer was not willing to set aside a small part of his field to try something new; if good results were not obtained, he would have less food than if he had used all of his land for his own crops. With the American farmer, it was different; since his farm was larger, he could usually spare a strip of land for some experiment without seriously affecting his income. When the Chinese farmer could see an experiment demonstrated in his neighborhood, then he was eager to apply the new practices to his own farm.

In the early days of seed multiplication by the College of Agriculture, farmers in the region of Nanking came to the College to obtain small amounts of wheat and corn which were made available for growing on their farms. This resulted in a greater spread of the better varieties farther and farther from Nanking. Some cotton seed was distributed in the vicinity of Nanking, but most of the distribution was nearer Shanghai and on the sea-coast, above and below Shanghai. Some of the distribution was aided by Agricultural Missionaries who were working at different localities, but as the Crop Improvement Program developed, it was evident that more definite plans should be made for the extension of good seed.

In lectures to the Summer Institute in 1931, Dr. Myers outlined a program for seed multiplication and distribution. He stated that it would be neither necessary nor desirable for a large number of new varieties to be put into multiplication and distribution at the same time. That is, it would not

be necessary to have several different strains of wheat or other crops put into distribution for use in a certain general area. Rather than distribute small amounts of seed over a large area, he recommended that it would be better at first to select certain areas where the farmers had indicated a willingness to cooperate in a good seed program and where the users of the seed would be interested in taking part in this movement. Seed would be distributed to a large number of farmers, if there were a sufficient amount of the new seed. If results were satisfactory, the plan would be to move out in a more-or-less general circle surrounding the area where the seed was first distributed, and continue on in this way until an entire area, or at least the majority of the farmers of the area, were growing the new variety. This plan was generally followed as the program continued and expanded during the years, even during the war years, with the result that many farmers benefited by the use of good seed.

Plans were made to instruct growers on the importance of keeping seed of the new variety pure. Fields were to be inspected by men trained for this work, and the farmers who received the new seed were asked to make the seed from their farms available to their neighbors through a cash sale or some kind of barter system.

For an improved seed program to be complete, it is desirable to have a system for the registration of new varieties. It was not possible to develop all of these details during the period devoted to this Crop Improvement Program, but sufficient information was made available so that seed multiplication and distribution continued to expand rapidly in many different parts of China, with continued expansion during the war years.

Seed multiplication continued to expand rapidly after the program was officially closed in 1931, and during the time that the University of Nanking was forced to leave its campus and move to the campus of West China University in Chengtu, Szechwan.

Some interesting information on the program is presented in the Agriculture and Forestry Notes of the College of Agriculture and Forestry, University of Nanking, under date of May, 1939. This was over seven years after the last Cornell representative had returned from China. One statement reads: "Since 1924, the Crop Improvement Program on a large scale has been well under way. Considering the population and area of China, and the fact that 85 percent of the population is rural and hence directly connected with agricultural production, crop improvement may well be considered of the utmost importance to the economic and physical well-being of the people."

The names of the improved varieties of crops and some of their characteristics are given in Table 4. There are 37 strains or varieties listed, and 27 of these, as indicated, were already being distributed to farmers and

TABLE 4. IMPROVED CROP VARIETIES — 1938

From the University of Nanking and Cooperating Agricultural Experiment Stations

Improved Varieties	Yield in Catties Per Mow §	Gain Over Check (%)	Gain Over Farmers' Varieties (%)	Remarks
WHEAT				
*U.N. 2905	226.0	25.0	32.0	Early, stiff straw, smut resistant
*U.N. 26	208.1	7.0	7.0	Early, good stooling power
*U.N. Kaifeng	238.6	12.5	17.7	Stiff straw, good quality
*U.N. Nanhsuchow 61	284.0	33.9	34.0	Early, resistant to nematode
†U.N. Nanhsuchow 1419	264.0	23.0	56.9	Stiff straw, good quality
*U.N. Yenching Standard . . . . .	....	....	19.0	White kernel, resistant to cold
*U.N. N-W Blue-awn	185.0	....	19.0	
*Oberlin 169—dry land	370.0	13.5	....	White kernel
“ “ —irrigated	226.0	9.2	....	White kernel
*Tinghsien 72	267.5	15.0	....	White kernel
*Tinghsien 73914	255.8	18.3	....	Good quality
*Hsuehchow 1438	245.9	16.5	22.5	Resistant to cold and drought
*Hsuehchow 1405	251.9	21.2	27.2	Resistant to cold and drought
†Tsinan 1195	303.5	32.4	....	Resistant to flag smut
COTTON				
*U.N. Trice	180.0	....	....	Wide adaptation
*U.N. Acala	180.0	....	....	Fine fiber
*U.N. Million Dollar	150.0	....	....
†U.N. Acala 481	187.0	8.5	....
†U.N. Acala 949	220.0	18.5	....
†Stoneville 4	200.0	....	....	Early maturity
*Delfos 531	200.0	35.5	....
RICE				
†U.N. 1386—direct planting	361.2	9.0	....	Stem borer resistance
“ “ —transplanting	394.8	12.9	....	Stem borer resistance
SOYBEAN				
*U.N. 332	133.0	44.9	82.7	High yield
	....	....	90.8	High yield
MILLET				
*U.N. Yenching 811	303.0	26.8	17.8	Resistant to downy mildew
*U.N. Nanhsuchow 373	353.0	13.0	50.0	
*U.N. Kaifeng 48	370.5	31.0	....
*U.N.C.H. Millet	424.3	34.9	....	Somewhat resistant to kernel smut and downy mildew
*Tinghsien-Yenching 22	417.0	7.8	....
†Tsinan U.N. Path. 8	479.7	53.4	....	Resistant to kernel smut
KAOLIANG				
*U.N. Kaifeng 2612	284.1	21.2	13.4	
*U.N. Nanhsuchow 2624	328.0	18.0	39.0	
*Tinghsien 33	250.9	28.0	....
BARLEY				
*U.N. 99	211.8	17.9	17.9	Resistant to covered smut
†U.N. Kaifeng 313	266.6	7.3	21.9	
†U.N. Nanhsuchow 1963	358.0	18.0	....
†U.N. Nanhsuchow 718	224.0	13.0	....
CORN				
*Nanking Yellow . . . . .	....	....	....
*Oberlin Golden Queen	554.0	21.0	....	Fairly resistant to corn borer

* Seeds under extension.

† Seeds being multiplied for extension.

‡ See text, page 37.

§ One catty equals 1.33 pounds; one mow equals one-sixth of an acre.

some were grown on a fairly large acreage. The above number should be 28 rather than 27 because, although this table does not indicate that any seed of Stoneville No. 4 was being distributed, other available records indicate that a large amount of seed of this variety was being distributed. In 1939, enough seed of this sort was made available by the Sian Station to plant 5,000 acres. The other nine varieties were being multiplied for distribution. All selections were made from Chinese crops, except those made from Trice, Acala, and Delfos cotton. These varieties were grown in China, and the selections were made from these fields.

All the sorts that would be available to farmers for the program are not listed in Table 4, since crop improvement is a continuing program, and new lines are developed from time to time. When found worthy, the seed was multiplied and made available to the farmers. For example, Table 4 was completed early in 1939, and by November 1939, a new variety of barley was ready for distribution.

What better evidence can be had to show the importance of the training of staff members which was stressed during the time spent in China than to review the results presented in Table 4? No one can doubt the importance of the training given Chinese staff members when it is realized that over seven years following the last visit to China of a Cornell staff member, and with the troubled times for China, that the program of crop improvement was going forward on an ever-widening scale. This fact is of the greatest importance.

It is worthwhile at this point to relate an experience of a friend of the University of Nanking at New Delhi, India, while he was attending the Industrial Fair in 1960. While looking over the exhibit from Communist China, he observed a bottle of wheat seed labeled "Nanking 2905." It may be assumed that this sample was from the crop of 1959, indicating that 28 years after the close of the formal cooperation on the Crop Improvement Program, this variety was still being grown by Chinese farmers.

THE TRAINING PROGRAM

The training of men proved to be the most important element in the Crop Improvement Program. Evidence for this lies in the fact that after the Cornell representatives had completed their assignments in China, the crop improvement work continued to expand, even during the war years, and the program of seed multiplication was developed rapidly. This would not have been possible if during the early years of this cooperative effort special plans to train men to continue this kind of work had not been an important phase of the program. When considering the program before the first Cornell representatives went to China, it was agreed that efforts to produce better



Showing method of threshing by flailing. These flails are made with a long bamboo handle with several short pieces of bamboo or other wood. When the flail is lifted and given a forward push, it falls on the grain with considerable force. The grain is placed on a threshing floor made by tamping down a part of the area near the house or farm buildings. Sometimes the soil may be wet down before the tamping begins. These floors are prepared sometime before needed and may be wet down and worked over several times.



Another method of threshing is by use of a corrugated roller pulled by a water buffalo or other animal. These rollers are made by taking a large stone and cutting out grooves lengthwise and then constructing the necessary frame work so that as the animal pulls it along the roller revolves. This same type of roller may be used by the farmers when preparing their soil for planting in breaking up large clods of soil. The corrugated type works better than the roller that is smooth all around.



Another method for threshing is that of making a slatted frame. The frame is made from any kind of available wood. The slats are often made from bamboo. The bundle of grain is then beaten over this frame by a workman, and the grain and chaff fall to the ground. With all these three methods, the grain is separated from the chaff by tossing it into the air when a breeze is blowing and a good separation is obtained.



This picture does not show the threshing machine too well, but it is a small type of modern (for those days) machine made for small farm operations in the United States. It was used at the Nanking Station for threshing grain from fields where a good variety was being multiplied for distribution to farmers, and when time permitted to thresh grain for the farmers living near the Tai-Ping-Men Experimental farm. Another reason for using this picture is to show the large number of experimental fields at the Tai-Ping-Men farm used in the program.

crops would be of little value unless well-trained men who could work independently would continue the program after the last Cornell professor had returned home.

The training was carried out through a series of Summer Institutes of three weeks' duration, formal lectures in the College, field observation trips, and informal discussions and conferences.

One purpose of the Summer Institutes was to provide intensive courses of instruction in Genetics and Plant Breeding and related subjects for the Chinese associates who had little or no training in them. Although the instruction was intended primarily for the staff of the cooperating stations, representatives from government institutions and experiment stations were invited to attend; and by 1931, they comprised the majority of those registered. Another purpose of the Summer Institutes was to bring the Nanking cooperators together to discuss problems arising at their stations and to check on methods being used and results obtained.

On Dr. Love's first trip to Nanking in 1925, reorganization of the plant breeding program at the College and the cooperating stations was accompanied by detailed instructions covering aspects of the work, such as preparation of planting plans, weighing of seeds, planting, observations to be made during the growing season, selection of strains for further trials, harvesting, threshing, weighing, storage, keeping records, and interpretations of data. Detailed instructions for making head and plant selections and for rod row testing were prepared and translated into Chinese. For members of the College staff, Dr. Love gave a series of evening lectures on Biological Statistics, and during the summer he offered a course in Experimental Methods. For advanced students and the younger staff members, he gave a course in Plant Breeding.

First Summer Institute

In 1926, the first Summer Institute of Crop Improvement was held at Nanking under the direction of Dr. Myers. Twenty-three students and experiment station associates were registered, with 16 visitors representing the major crop improvement organizations in central and east China. Lectures and laboratory practice were given in Genetics, in Plant Breeding, and in Plant Pathology. Field observations were arranged. Dr. Myers gave a course of 20 lectures on Plant Breeding, attended by about 50 upperclassmen and members of the College faculty.

Second Summer Institute

In 1929, following an interruption of two years due to political disturbances, the second Summer Institute of Crop Improvement was held at Nanking under the direction of Dr. Love. There were 52 registered students, an

average attendance of 65, with similar representation as in 1926, and with the same general program of instruction. Dr. Love also gave a course in Biometrical Methods to advanced students and members of the faculty.

Third Summer Institute

The third Summer Institute was held from July 18 to August 5, 1930, at Yenching University, Peiping, under the direction of Dr. Wiggans, with the University as host. Twenty-five persons attended. The enrollment included directors of provincial experiment stations, representatives from provincial governments, and plant breeders from the cooperative stations in north China. This Institute differed from those previously held in that (1) emphasis was placed on the improvement of open-fertilized crops, and (2) it was held in north China and provided special help to those who had been unable to make the long trip to Nanking in previous years.

Dr. Wiggans offered a course in Breeding Methods, with emphasis on open-fertilized crops. Dr. Shen gave a course in Genetic Principles as applied to crop improvement. The Division of Plant Pathology of Nanking provided a course in Crop Diseases. Laboratory exercises, field trips, and conferences completed the program. At Nanking, Dr. Wiggans gave a series of lectures for advanced students and staff members of the College and National Central University; attendance varied from 33 to 50.

Fourth Summer Institute

The fourth and final Summer Institute was held at Nanking, July 6 to 24, 1931, under the direction of Dr. Myers and reflected the progress that had been made in the years since the cooperative program began. Ninety-one persons were registered, with 20 regular visitors from the staff of the College of Agriculture and Forestry, mostly from the Plant Science departments. Thirty-two institutions were represented, 17 of which were governmental and 15 private from nine provinces, mostly in north-central and East China. Courses offered were:

- A. Elementary Plant Breeding was given by Dr. Shen in Chinese. There were 51 regularly registered, and six visitors.
- B. The Division of Plant Pathology offered a course in Plant Diseases. There were 91 who registered, and six visitors.
- C. A course in Advanced Plant Breeding was given by Dr. Myers. There were 40 regularly registered, and 14 visitors who attended only lectures.
- D. A course in Biometry was given by Dr. Love, who had returned to Nanking in March, 1931, as Agricultural Advisor to the National Agricultural Research Bureau. There were 40 students regularly registered, and six visitors attending the lectures.

Of special significance was the academic standing of the student group. Sixty-six were graduates of recognized colleges. Twenty-four were upper-classmen in the College of Agriculture and Forestry, and 21 were graduates of its Short Course in Agriculture. With the exception of the upperclassmen, all students were engaged in experimental work or in teaching. As Dr. Myers pointed out in his final report, the instruction given was of the same grade and covered the same ground as that offered by the three Cornell professors in their teaching at Cornell University.

Again, many individual conferences were held during the Institute on special problems that were being faced at the institutions represented. The Institute provided opportunity for a general conference of the representatives of all cooperating stations.

By the end of the formal cooperation between Cornell and Nanking, it was estimated that over 125 men, who had little or no previous experience, had been trained to where they were independently able to conduct crop improvement experiments.

The close of the formal cooperation marked the beginning of another training program, when the College of Agriculture and Forestry was designated as the center for Crop Breeding training in connection with the Government-organized Crop Breeding Program at Nanking, in which Dr. Love was to play an important part. (See Government Cooperation, page 43)

CHINESE GRADUATE STUDENTS IN PLANT BREEDING AT CORNELL UNIVERSITY

Between 1909 and 1961, according to the records of the Department of Plant Breeding, 82 Chinese graduate students have studied Plant Breeding at Cornell University.

Seventeen Ph.D. degrees, 19 M.S. degrees, and five M.S.A. degrees have been granted. Between 1926, the second year of the cooperative program, and 1946, 62 Chinese graduate students were registered for work in the Department.

Personal contacts with the visiting Cornell professors at Nanking stimulated the desires of many Chinese students for additional professional training in plant breeding and genetics. Beginning with Dr. Shen, who had received his Ph.D. degree in 1928, and succeeding students at Cornell, the influences in favor of study at Cornell increased. This influence carried over into the early years after the Government of the Republic of China had moved to Taiwan. It is not suggested that the direct and indirect influence of Cornell accounted for all the 62 students who studied in Taiwan between 1926 and 1946, but it was certainly the major factor. That Cornell Uni-

versity has played the dominant role in plant breeding work in China and later in Taiwan is not open to question.

GOVERNMENT COOPERATION

Reference has been made to local government experiment stations that were cooperating with the College in the Crop Improvement Program. In 1930, discussions were held by government officials and representatives of the Colleges of Agriculture of Central University and the University of Nanking. Discussions related to the fact that after one more year the Cooperative Crop Improvement Program would officially come to a close, and they believed it desirable that the work should be continued. As a result, the Ministry of Agriculture and Mining of the Central Government, the Kiangsu Provincial Government through its Bureau of Agriculture, and the Chekiang Provincial Government, established a Crop Improvement Program that would serve both provinces. An invitation was extended to Dr. Love to become its first advisor which he accepted. He arrived in Nanking in April, 1931, and served three and one-half years.

The several governments concerned with this new development made certain agencies responsible for the program, and among themselves they developed a working plan that was agreeable to all. The main points agreed upon related to the responsibilities of the Governments of Kiangsu and Chekiang for crop improvement in their respective provinces. The training of students was to be an important part of the duties of Dr. Love. The College of Agriculture and Forestry, University of Nanking, agreed to provide necessary facilities and to serve as headquarters for the training.

Some time before leaving for China, Dr. Love received word from the Ministry of Industries stating that the Government was interested in organizing a unit that would lay plans for a general agricultural program. This was an important action, and it indicated the desire of the National Government for improving agriculture for all of China.

Soon after arriving in China, Dr. Love and interested Chinese considered the Government's plan for a research program. It was agreed that a call would be made on the Minister of Industries to present the need for a committee to study the plan and make recommendations to the Minister for his consideration. The Committee chosen by the Minister consisted of men well-informed on the recent efforts that had been made to improve the agriculture of China.

The Committee proposed the name, *The National Agricultural Research Bureau*, with its location at Nanking. Its program was to develop research in all the important phases of Chinese agriculture as rapidly as a trained staff and facilities would permit. Three divisions were established;

namely, Crop Production, Animal Production, and Agricultural Economics and Marketing.

The Committee completed its work in the early fall of 1931. Plans were made to implement its recommendations, and sufficient land for buildings and experimental fields was obtained. Next came plans for buildings, greenhouses, and other construction work. The land was purchased in small parcels from individual farmers. Construction of the first large building was begun early in 1934.

By November, 1937, only six years after the first committee meetings were held, the land area had increased to 428 acres; five laboratory buildings, one administration building, more than 10 staff dormitories, greenhouses, wire cages to protect plants from birds, cold storage rooms, and a high temperature room had been constructed. The technical staff included over 100 persons in addition to farm laborers and servants. The research was expanding rapidly, and aid was made available to many of the provinces. Some extension work was added to take the research to farmers for their benefits. About that time, because of the Japanese invasion, it was necessary for the Bureau to move to west China where it continued to function. At the close of the war, the Bureau returned to Nanking where it continued its program until shortly before the take over by the Communists. There is no information available to indicate whether the projects were immediately dropped or continued in part.

CHINA FOUNDATION COOPERATION

As a result of the progress made in the Crop Improvement Program, Nanking University was granted aid for the first time in 1930 by the China Foundation for the Promotion of Education and Culture. Upon presentation of well-outlined projects on breeding and disease resistance work by the Departments of Agronomy and Pathology, the University was granted \$10,000 a year for a period of three years. This material aid made it possible to inaugurate and carry to completion some phases of the crop improvement work which could not otherwise have been done. Available records indicate that the China Foundation continued its support of this work for at least 10 years, even after the College had moved to Chengtu because of the Japanese invasion.

THE INTERNATIONAL EDUCATION BOARD

The International Education Board, founded in 1923 by John D. Rockefeller, Jr., contributed greatly to the success of the program by providing funds to cover the salaries of the Cornell University professors that were not

covered by the University. In addition, a grant was made in 1925 for a fellowship to Mr. Shen to cover his expenses in traveling to China and working there with Dr. Myers in 1926. A further appropriation provided Mr. Shen with a fellowship to complete work for a Ph.D. degree in Plant Breeding at Cornell University and to provide return travel to Nanking. Appropriation by the International Education Board for all purposes indicated above was \$14,000 for the period of cooperation.

REASONS FOR THE SUCCESS OF THE PROGRAM

Many factors entered into the success of this program. It is difficult to assign priorities to them.

First, consideration should be given to the people involved, in this case, Chinese and American. The specialists were Americans. They had knowledge, techniques, and experiences that were greatly needed in China, but for the most part were lacking. Their task was to transfer these qualities to their Chinese associates, if their efforts were to be successful. Moreover, it was imperative that they be personally accepted by their new Chinese associates and the community in which they were to work. It was a situation wherein personal relationships determined to a large degree the atmosphere and spirit of the cooperative effort. It was a "learning" situation, both for the Cornell professors and the Chinese staff, and while the Chinese may have had more to learn, the quest for new knowledge was mutual.

It must be remembered that scientific agricultural education and agricultural improvement were in a pioneer stage of development for the Chinese. There was a heavy national deficit in terms of trained men, educational institutions, and governmental interest and support. To these pioneer Chinese, the improvement of agriculture was a pressing necessity, and a patriotic cause.

The Chinese staff with whom the Cornell representatives were associated sensed the importance of the work in which they were engaged and took pride in their share in doing it. What they lacked in training was made up by their eagerness to learn and their desire to cooperate. Finally, and expressed without bias, it would be difficult to find anywhere in the world a finer group of people with whom to work. Ten-hour days in the field or in the office were not unusual.

A second major factor in the success of the program was the emphasis on training Chinese personnel. This was both formal and informal, and with the staff at Nanking it was a continuous process, whether in the office or in the field. Had the program failed to provide opportunities for formal training, or had it not persisted in its opportunities for informal training, the results of the program would have been seriously vitiated.

Another factor in the success and influence of the program was that of cooperation with both missionary and government agencies. Before the conclusion of the program, formal cooperative relationships had been developed at 14 stations in the Yangtze Valley and the provinces north of Nanking. These provided opportunity to deal with crops important to the areas concerned. Uniform methods were used throughout, making possible comparable results.

The fact that the Department of Agronomy was one of the strongest in the College, that it was fairly well staffed, that it had a field program in operation producing practical results, and that it was fairly well financed had an important bearing on the results achieved. This department was in a position to make maximum use of the contributions of the Cornell professors.

Another factor in the success of the program was continuity, especially necessary in crop improvement work. As previously reported, no experiment was destroyed, and there were no seeds lost because of the serious military disorders during these years.

Another contributing factor in the success of the program was that those individuals who were responsible for it knew the kind of results they were seeking and knew how to attain them. The broad outline of the program had been established in the beginning. Enough time had been allotted to secure results, and adequately trained men had been developed to carry on into the future when the Cornell representatives were no longer available. To a large extent, the Cornell team members had worked themselves out of the job. They left the program in efficient hands.

SIGNIFICANCE OF THE PROGRAM

I. In the field of Crop Improvement

- (1) Higher yielding strains of wheat, barley, kaoliang, rice, corn, soybeans, cotton, and millet were developed and distributed to farmers.
- (2) Crop improvement methods were standardized throughout the area and later adopted throughout most of China.
- (3) The plant breeding work at the University of Nanking was reorganized, and cooperative relationships were established with 14 private and government stations.
- (4) Government activities in this field were greatly stimulated.

II. In the field of Training in China

As a result of the formal and informal training provided throughout the program, it is safe to say that no branch of agriculture in China had available to it as many well-trained men as did plant breeding.

III. In the field of Training at Cornell University

Resulting chiefly from the contacts made with the Cornell representatives in China, many Chinese students took graduate work in Plant Breeding and Genetics at Cornell University. (See page 42)

IV. In the field of International Education

- (1) The Cornell professors were agreed that their work in China had broadened their own technical training and experience.
- (2) The general experience of the Cornell professors in agricultural education, administration, and research work resulted in incidental but important contributions to other departments of the College at Nanking.
- (3) Dr. W. I. Myers, former Dean of the College of Agriculture at Cornell University, states in a letter: "The successful results of The Cornell-Nanking Program were certainly one of the major factors that encouraged us to undertake a similar but more comprehensive contract with the University of the Philippines, College of Agriculture, at Los Banos. I am sure this project was helpful in strengthening the agriculture and the economy of the Philippines, and I am equally confident of its benefits to the College of Agriculture and to Cornell."

V. In stimulating Governmental Activities

It was generally recognized that the extent and success of the program stimulated government activities in China. (See page 43)

VI. As a Continuing Program

The Crop Improvement Program continued to expand after 1931 when the formal cooperation with Cornell came to a close. All experimental material at Nanking was moved to Chengtu in 1937 following the Japanese invasion of the mainland, and a successful Crop Improvement Program was started immediately. During these war years, the stations at Nanking and some of the cooperating stations continued to function and to produce seed of the superior varieties for local distribution.

VII. Of benefit to the Agriculture of New York State and Neighboring States

The introduction by Dr. Love of four heads of barley from the experimental fields of the College of Agriculture and Forestry into the breeding program of the New York State College of Agriculture enhanced winter barley growing in New York State and the neighboring states. It continues to do so. (See page 49)

VIII. In Modern Terms

At the time of this program, the term, "Technical Assistance," had not come into prominence. Viewed in modern terms—namely,

- the development of international understanding and good will;
 - the transfer of technical knowledge to a host country;
 - the establishment of an ongoing program definitely related to a pressing national need;
 - the creation of a reservoir of well-trained nationals capable of moving forward when the "technicians" departed
- this program must be rated as "technical assistance" at its best. With the results obtained and in terms of its low cost, it probably set some kind of a record.

THE INFLUENCE ON OTHER COUNTRIES

It is a satisfaction to note that a number of Chinese directly or indirectly related to the Crop Improvement Program, and now in Taiwan, are aiding in the improvement of agriculture in other countries. Dr. Shen and a group of specialists at the request of the Thai Government made a study of the agricultural problems of Thailand. Dr. P. C. Ma, Dean of the College of Agriculture, University of Taiwan, at the request of the Government of Vietnam, headed a Technical Mission of 11 specialists and instituted a program of research on agricultural problems. Later, through the Food and Agriculture Organization of the United Nations, he was invited by the Government of Liberia to help develop its College of Agriculture. Another Chinese has made notable contribution to rice culture through the Foreign Agricultural Organization. These activities of Chinese technical experts illustrate the influence of the methods and ideals developed during the Cornell-Nanking cooperative program.

THE WONG BARLEY STORY

Many people are inclined to believe that when a staff member of one of the Colleges or Universities in the United States is invited to go to some foreign country to participate in a program in that country that the staff member gives out information and helps the local institution and country but does not gain information that will be of value to him or to his institution when he returns. Dr. Love was asked by one of the administrative officers at Cornell when he returned from China the first time whether it was not a situation of "all give and no return." He answered definitely "that it was not." Often new experiences that are gained from spending time with college men in another country add to the information the visiting staff member needs for his program at home. Then, if one is interested in some phase of plant life, he may find plants that will be useful to his investigations when he returns to his special work after completing service abroad.

Dr. Love states that he gained much from the new experiences, and especially from some new plant types. He had been conducting genetic studies with oats, and there was one type of plant he had been seeking for some time. When looking over a field of wheat at Nanking, he was suddenly surprised to see this type "looking right at him." It was a mixture that had become mixed with the wheat. Another time he was observing a field of hybrid barley plants and noted some that were bearing their heads erect, even when the plants were nearly ripe. This was most unusual, as practically all of the United States varieties have a weak straw. These new plants stood so erect that there was no bend in the stem. These plants are the basis of the Wong Barley Story.

Dr. Love asked the Chinese investigator, who was a member of the staff of the College of Agriculture, Nanking University, and a member of the team working on the Crop Improvement Program, if it would be possible to have a few seeds of some of these special plants. Only a few seeds were needed. Four heads were obtained. Dr. Love had in mind using these to cross with spring barley to obtain stiffer straw. When he returned to Cornell, he found that spring barley was not grown as much as formerly, but interest was developing in winter barley. The seeds he had obtained in China were from winter types, but the winters where these were growing were less severe than those in New York State.

Seeds from each of the four heads were grown in the Plant Breeding garden to see if the plants produced could withstand the winter in New York State. Some plants from each head did survive the winter, but those from two heads made much better growth. These were grown in other winters, and finally the plants from one line did much better, and this line was kept; the seed was multiplied further, and the variety named Wong. This new sort was grown by a number of farmers of New York State, and was the

stiffest-strawed type then available to United States growers. It yielded well compared with the other varieties then grown in New York State. The average yields in bushels per acre for four varieties grown in 14 yield tests for 1939–1942 in New York State were:

Variety	Bushels per Acre
Wong	50.0
Kentucky No. 1	47.8
Michigan Wonder	46.0
Poland	45.6

Professor N. F. Jensen, of the Plant Breeding Department at Cornell University, who is in charge of the Small Grain Breeding Program, has assembled some facts and figures on Wong barley, and we thank him for making these available for this story. He has also made a number of crosses between Wong and other winter barley varieties. Three of these, Hudson, Dutchess, and Catskill, have replaced Wong in New York State due to their higher yields, greater winter hardiness, and scald resistance. In a number of adjacent states, Wong continues to be grown extensively.

Seven or eight states produce certified seed of Wong. The larger producers of certified seed are the states of Virginia that for 14 years has had an average acreage of 1,404 acres, and Pennsylvania with an average acreage of 1,522 acres. For 13 years, Maryland produced an average of 769 acres, and New Jersey, 349 acres. Certified seed of Wong barley has been offered to the farmers for 21 years, which is an unusual record for a grain variety to be popular.

Quoting from Professor Jensen's statement: "Wong must be almost unique in the history of crop varieties. After more than 20 years of production, *there is more Wong grown today than in any previous year* (last year of complete data: 1960). Certified seed production of this variety in 1960 was 15 percent greater than the highest previous figure. Furthermore, for the 14 years for which data are available, Wong production (total bushels) averaged 40.9 percent of all certified winter barley seed production in the United States (and 41.5 percent of all acreage). In 1960, Wong produced 40.3 percent of the total certified bushels on 34.4 percent of the total certified acreage; therefore, it would appear that the trend is not downward. New varieties do not seem to offer competition. A total of 28 winter barley varieties were involved in 1960 production of certified seed in the United States. Dayton, with a production of 102,700 bushels, was second to Wong, with 241,700 bushels. Hudson was grown on 991 acres to produce 32,500 bushels. For 14 years the average production of certified Wong seed was 150,885 bushels."

"Taking into account the usage of certified seed, it is assumed that certified Wong seed planted 25 percent of the total acreage of Wong, therefore, 603,540 bushels of Wong would be needed to plant all Wong acreage each year. At a 2 bushels-per-acre seeding rate, this would indicate 301,770 acres annually. Roughly 300,000 acres, at 35 bushels-per-acre yield, would amount to 10,500,000 bushels per year. At \$1.00 per bushel, this gives an estimated value of \$10,500,000 per year."

It is interesting to note that one handler of certified seeds made an independent estimate, based on knowledge of seed sales and related information, of the value of Wong. This estimate was \$200,000,000 over a period of 21 years, or \$9,500,000 annually. From these two estimates it seems reasonable to conclude that Wong has been worth \$10,000,000 a year to eastern United States agriculture. This is an important gain coming from one little barley head, or back one generation, just one seed.

"Wong apparently has extraordinarily good parental qualities. In the 1961 U.S.D.A. Uniform Winter Barley Nursery test of about 30 varieties, the first seven, and nine of the top 10 in yield rank had Wong as a parent."

The result obtained from the Wong barley is definite proof that when staff members go from their institutions abroad it is not always "a give, no take effort," especially if the visiting staff member is a keen observer.

EVALUATIONS OF THE PROGRAM

The following statement by Dr. Shen dated Taipei, Taiwan, October 12, 1962, was written at the request of the authors. Dr. Shen's relation to the program has been mentioned several times in this story.

"1. *Influence of the Nanking-Cornell-International Education Board Program on Chinese Agriculture on the Mainland China.*

"The most significant results of the Nanking-Cornell-International Education Board Program for Crop Improvement in China were:

(1) training a group of Chinese plant breeders to carry on a national program of crop improvement; (2) developing better varieties of wheat, barley, kaoliang, millet, rice, soybeans, and other crops showing increased yields from 10 to 20 percent more than the native varieties; and (3) stimulating the Chinese government to establish the National Agricultural Research Bureau of the Ministry of Industry in 1931 which made great improvements in agricultural production in China through scientific research and agricultural extension services.

"2. *Influence of the Program Carried Over to Taiwan.*

"The influence is indirect and through the 12 men of the National Agricultural Research Bureau who formed an important part of the staff of the Joint Commission on Rural Reconstruction in Taiwan. They include Com-

missioners: T. H. Chien in 1952-61; Y. S. Tsiang since 1961; and T. H. Shen since 1948. Dr. Love served as consultant of J.C.R.R. in 1949. An important part of the program of J.C.R.R. is to assist cooperating agencies in training and developing leaders and developing better (crop) varieties, which are much the same as the objectives of the Nanking-Cornell-International Education Board Program.

"I should also like to express my gratitude and pleasure in having been privileged to take part in the program. The International Education Board granted a research fellowship to me in 1926-27 on the recommendation of Professors H. H. Love and C. H. Myers. While on the faculty of the University of Nanking, 1927-37, I had the rare opportunity to acquire valuable experience from the visiting Cornell University professors.

"With confidence in the international cooperation built up from my early association with this triangular cooperative program, I have enjoyed working, since 1948, in my present position with the China-United States Joint Commission on Rural Reconstruction in China.

"As a trustee of the International Rice Research Institute, Manila, I met Mr. John D. Rockefeller, III at the opening ceremonies of the Institute on February 7, 1962. I expressed my gratitude to him for my research fellowship from his father's foundation, the International Education Board, and commented on this triangular cooperative program as the earliest and also the best example of technical assistance by American institutions to foreign countries."

The following evaluation is by one who had observed the progress of the Crop Improvement Program and one who was in a position to give a fair estimate of the program:

- "(1) This project was a forerunner of the present technical assistance program of the United Nations, and for the present University contract arrangement by the A.I.D. of the U. S. Department of State.
- "(2) The project was located at a training institution, where a large number of people could be trained. We, the counterpart, were not just one person, but a group of people working with the visiting professors.
- "(3) There was a real desire to learn from the expert on the part of the recipient institution.
- "(4) There was an element of continuity and stability, which helped to carry the project to a successful result."

A publication of the
New York State College of Agriculture,
A Contract College of the State University,
at Cornell University,
Ithaca, New York

4-64-3M