CHINESE-AMERICAN

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CROP AND SEED IMPROVEMENT IN TAIWAN, REPUBLIC OF CHINA

June 1956 - April 1959

TAIPEI, TAIWAN, CHINA

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FOREWORD

This report contains 15 papers presented by the Delegation of the Republic of China to the Second Far East Seed Improvement Workshop held at Tokyo, Japan, from May 11 to 30, 1959, under the sponsorship of the International Cooperation Administration of the United States Government. The First Far East Seed Improvement Conference was held from June 25 to July 14, 1956, at Taipei, Taiwan, China.

Recent progress of the seed improvement work on sugarcane, tea and fiber crops in Taiwan is not included in this report for the reason that these crops were not on the agenda of the Workshop.

Since the first presentation of this report in May 1959, in mimeographed form, demand for copies from both within the country and abroad has made a second printing necessary. Contents of this issue are the same as those in the original mimeographed issue.

H. T. Chang, Chief
Plant Industry Division

November 1960

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SUMMARY REPORT ON CROP AND SEED IMPROVEMENT IN FREE CHINA, 1956-1959

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When the First Far East Seed Improvement Conference was held in the summer of 1956 at Taipei, the Chinese Delegation had the honor of presenting to the Conference reports on the seed improvement work carried out in Taiwan since the end of the Second World War. Coming to the Second FE Seed Improvement Workshop (Conference), we are keenly interested in learning the advancement of other countries in the field of seed improvement, and happy to report to you once more the progress made in Taiwan during the past three years.

I. Establishment of Seed Certification System for Major Crops

In 1956, we reported that, up to that time, most of the major crops in Taiwan had fairly efficient seed multiplication and distribution systems, which, as a rule, were consisted of three levels of seed farms: the foundation, the stock and the extension seed farms. We further explained that we did not call the 2nd and 3rd level seed farms "registered" and "certified" seed farms, because in the past the seed farms in Taiwan were inspected only in the field for purity and general seed quality, but the seeds multiplied were not inspected in laboratories. We had no seed laboratory then, nor were there standards for laboratory seed inspection.

The honorable delegates will recall that one of the resolutions adopted by the First Conference is for the member countries to establish seed laboratories and strengthen the work of seed inspection as a means to strengthen the overall crop improvement program. Since then, the following work have been in progress in Taiwan:

A. Two seed laboratories have been established, one under the Taiwan Provincial Department of Agriculture & Forestry for handling the routine inspection of seeds multiplied by the various seed farms every year, and the other under the

College of Agriculture, National Taiwan University, for conducting researches and training on seed technology. The equipment for the two laboratories have arrived. The NTU Seed Laboratory has been operating since October 1957, and the one under the Taiwan Provincial Department of Agriculture & Forestry will be formally inaugurated as soon as the construction of the laboratory building is completed in July 1959.

B. Procedures and standards for seed certification for rice, sweet potato, peanut, soybean, wheat and grain sorghum were carefully drafted by specialists concerned after many meetings, and have been officially promulgated by the Taiwan Provincial Department of Agriculture & Forestry.

C. A total of 1,088 technicians have received training on the methods and procedures of field and laboratory inspection of seeds in short courses lasting from one to three days conducted by the Taiwan Provincial Department of Agriculture & Forestry and the National Taiwan University. Three technicians have been sent to the United States under the ICA TA-Program to receive specialized training in seed technology.

D. Actual inspection of seeds according to the procedures and standards established was started for Ponlai rice in the fall of 1957 and for five upland food crops in the fall of 1958. The laboratory inspection of the foundation, stock and extension seeds for the time being has been conducted separately by the seven District Agricultural Improvement Stations. When the PDAF Laboratory is established, it will be responsible for doing the inspection with the assistance of the stations.

II. International Seed Exchange

Another resolution adopted by the First Conference has to do with the promotion of seed exchange among countries of this area. After the Conference, we compiled a "List of Plant Materials in Taiwan Available for International Exchange", copies of which have been sent to all delegates and observers who attended the last Conference and to relevant government organizations of the participating countries for their reference in November 1956. The list has recently been up-dated for distribution in this Workshop.

During the past three years, the Joint Commission on Rural Reconstruction has sent out on request seeds of a total of 179 varieties belonging to 58 kinds of crops to 17 countries in the world. In return, we have requested and received from 17 countries seeds of 379 varieties belonging to 67 kinds of crops. A number of the introduced varieties have already been extended for commercial planting or used to good advantage in our breeding programs. We wish to take this opportunity to express our deep appreciation to all countries from which we have obtained these excellent new varieties. In turn, we will be pleased to learn the performance of Taiwan crop varieties in other countries.

III. Varietal Improvement

During the past three years, the breeding program for all major crops has also made notable progress.

A. Rice

Since 1956, five new promising rice varieties have been released for extension. The new emphasis placed on the rice breeding work by all experiment stations is to obtain varieties resistant to rice blast disease and lodging, and of early maturity. The former two characters will enable us to elevate the rate of fertilizer application so as to further bring up the rice yield per hectare; while the latter will facilitate the extension of winter crops following the two rice crops on the same piece of land.

B. Sweet Potato

The highlight of the sweet potato improvement program is the selection through hybridization of high yielding and nutritious red or yellow sweet potato varieties which are expected to gradually replace the white varieties in many parts of the Island. Since 1956, 11 new varieties, 8 white and 3 red ones, have been released for extension.

C. Sugarcane

In the First Conference, we had stressed the rapid expansion of the sugarcane variety NCo-310 in Taiwan since its initial extension in 1952. The acreage planted to this variety reported then for the crop year of 1955-56 was 81.62 percent of the total sugarcane acreage of Taiwan. For crop year 1956-57, its acreage had reached 91.54 percent of the total. For 1957-58 crop, the percentage further climbed to 94. As said in a Chinese proverb, having too much is as bad as not having enough, the Taiwan Sugar Corporation began to feel the need of having other better varieties to provide a proper degree of diversification. During 1957 and 1958, a total of eight varieties, i. e., F137, F138, F139, F140, F141, F142, F143 and F144, were released for extension. However, none of these varieties have the wide adaptability of NCo-310 to the varying cane growing conditions in different parts of Taiwan. The sugar breeders are continuing their effort to select still better varieties from their extensive breeding material on hand.

D. Corn

We are happy to report that by 1958, we successfully produced our own double cross hybrid corn varieties, using combinations of introduced U. S. inbred lines and local inbreds obtained through the selfing of local varieties grown by the aboriginal farmers on mountains. Being significantly higher in yield and about three weeks earlier in maturity than the native open pollinated varieties, these new hybrid corn are expected to steadily replace not only the native corn but also sweet potatoes to a considerable extent as the staple livestock feed in the near future.

E. Soybean

Another crop which has made rapid progress is soybean. Three new varieties, two introduced from Japan and one from the U. S. A., were released for extension during the past three years. In 1958, out of the total soybean acreage of 45,031 hectares, 18,030 hectares were planted of these new varieties. It is estimated that 28,300 hectares of new varieties will be planted in 1959. They are not only replacing the native varieties in old producing areas in the southern Taiwan, but are rapidly expanding into northern, eastern and central Taiwan where soybean was only occasionally grown as a green manure crop in the past or not grown at all.

F. Peanut

The prominent feature of the present breeding program of peanut is the selection of varieties resistant to *Sclerotium* wilt, *Cercospora* leaf spot and rosette diseases. Two approaches have been made in recent years. One is to make crosses between the Spanish and Virginia types of varieties, hoping to transfer the disease resistance of the latter to the former which are desirable in other respects. The second is to treat the peanut seeds of our leading extension varieties with X-ray and thermal neutron and select disease resistant mutants from the irradiated generations. Both projects are in progress.

G. Vegetables and Fruits

The vegetable seed improvement program has, in the past three years, yielded a significant impact on the increase of quantity and varieties of vegetables produced in Taiwan, as well as the local production of vegetable seed. The amount of vegetable seeds imported has been steadily reduced. Aside from continuing the improvement work on the existing fruit crops such as citrus, pineapple and banana, the introduction, selection, multiplication and extension of new fruit crops, i.e., coffee, mango, Litchi, nut crops and deciduous fruit crops, have been promoted in recent years for fuller utilization of the slope land and diversification of supply of fruits.

H. Pasture Crops

Since the First Conference, the grassland improvement program has been greatly expanded in Taiwan, from mere observation of the adaptability of native and introduced forage crops to (1) systematic research on the adaptability, performance and productivity of various forage crops; (2) development of feed and forage crops on dryland and mountainous areas, government livestock farms and research stations, small scale community dryland grazing areas and individual small farms; and (3) multiplication and distribution of forage crop seeds and plant materials.

IV. Coordination of Crop and Seed Improvement Programs

During the past three years, serious efforts have been made to strengthen the coordination of the crop and seed improvement work conducted by all experiment stations and colleges, so that (1) duplication may be avoided and the limited personnel, fund and facilities utilized to the best advantage, (2) each station would know better what other stations are doing and what breeding material they have, and (3) all work are concerted to meet the need of the country. The coordination is achieved through the initiation of two levels of conferences as follows:

A. Research Council of the Taiwan Provincial Department of Agriculture & Forestry

An Agricultural Research Council was organized by the Department in 1956 composed of members who are either professors of agricultural colleges, specialists of the Joint Commission on Rural Reconstruction, or other prominent agriculturists.

Once a year, the Department would call a two-day conference of the Council which is presided by the Commissioner of the Department and attended by the directors and division heads of all research and experiment stations, and the Council members. In the conference, each station would (1) report orally the highlights of the experimental results obtained during the passing year and present a full report in written form thereof and (2) present in written form the project proposals and budget for the new fiscal year, copies of which, together with those of the written reports are sent to the Council members by the Department beforehand for reviewing. In screening the projects and budgets, the Council members are divided into sections. Projects concerning food crops and special crops (including horticultural crops, fiber crops, beverage crops, etc.) are screened by separate sections. The chairman of each section would report the result of screening to the conference.

Through this conference, the Department and all its stations are benefitted by the opinions of the leading agriculturists outside of the Department; and the annual work progress of all stations are made known to one another.

B. Crop Improvement Conferences

1. Rice conference—In 1956, the Department also organized a rice conference, which meets twice a year, once for each rice crop. The rice conference is attended by rice breeders of all stations and the high level extension men of all prefectures and municipalities. The breeders, based on results of advanced tests, regional tests and demonstrations, would recommend the rice varieties to be included in regional tests, demonstrations, and seed multiplication system in each prefecture and municipality for the next crop season. The extension men, based on observations made on demonstration plots and opinions of the farmers, would comment on the breeders' proposals as to the varieties for demonstration, multiplication and extension. The result of seed certification is reported by the Department and discussed by all participants. The Department would then finalize the lists of varieties for the above mentioned purposes according to decisions arrived at during the conference. Actual field projects are implemented accordingly by organizations concerned.

2. Upland food crop conference and vegetable conference—Conferences of nature similar to the rice conference were organized by the Department in 1957 for upland food crops and in 1958 for vegetable crops. These conferences are held once or twice a year.

3. Sugarcane and tobacco research and extension conferences—The conferences for screening the research projects and varieties for demonstration, multiplication and extension of sugarcane and tobacco are conducted annually, not by the Taiwan Provincial Department of Agriculture & Forestry, but respectively by the Taiwan Sugar Corporation and the Taiwan Tobacco & Wine Monopoly Bureau which are in direct charge of the production and improvement of these two important crops.

The Commissioner of the Taiwan Provincial Department of Agriculture & Forestry, the Director of the Taiwan Agricultural Research Institute and the specialists concerned of the Joint Commission on Rural Reconstruction, however, are invited to be the members of the research or extension committee for these two crops.

Such conferences as described above have been highly successful in coordinating the crop improvement work conducted by various stations. They give the breeders and extension men a clear vision of the program ahead and the part in which each of them plays, stimulate healthy competition among stations and boost the morale of all concerned.

V. Crop Improvement in Relation to Overall Agricultural Development of Taiwan

In view of the limited arable land and dense population, the basic approach of our agricultural development plan is to increase the total crop yield per hectare per year as much as possible, and to put the arable land, both on the plains and on hillside slopes, to best economic production.

Following this concept, the crop varietal improvement programs are being developed along the following directions: (1) In all cases, varieties with high yield are constantly sought. However, in order to obtain high yield, the breeding project for each crop has its specific aim and employs different technics. (2) In order that a winter dryland crop may be grown after two rice crops on the same piece of land in one year, it is necessary to select very early maturing varieties for both the rice and winter crops. (3) For both rice and dryland crops, varieties non-sensitive to photoperiod are preferred so that the same varieties may be grown in both spring and fall, or even winter. (4) Crop varieties adaptable to intercropping are favored for increasing the total crop yield per hectare. (5) New crops of economic value adaptable to winter planting on the low land or culture on slope land at higher altitude are sought to make fuller utilization of all land. (6) Feed and forage crops are developed to support an expanding livestock industry and to make profitable use of the land unfit for the production of ordinary crops.

To achieve the goals of the overall agricultural development plan, the seed improvement program is implemented in close coordination with the programs on uses of fertilizers and manures, pest control, improvement of cultural methods, farm implements and farm machinery, and soil conservation.

THE RICE BREEDING PROGRAM AND ITS RECENT DEVELOPMENT IN TAIWAN

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I. Introduction

In the early days of Taiwan, the rice varieties were mostly of ***indica*** type. During the Japanese occupation, efforts had been made by the Japanese agriculturists to improve the local rice varieties. Japanese rice varieties were then introduced to Taiwan for planting. These introduced rice varieties of the ***japonica*** type are locally known as Ponlai rice. Owing to its better quality, higher yield, shorter growing period, and non-sensitive to photoperiod, the Ponlai rice began to gain a firm footing on the Island. Among the early introduced Ponlai rice, Nakamaru was the leading variety. Its acreage in Taiwan once reached 106,689 ha. before 1926. Through local hybridization work, new varieties gradually came into being, among which "Taichung 65" has been the most prominent one ever produced. It is an offspring of a cross between Kameji and Shinriki, developed by the Taichung District Agricultural Improvement Station in 1929. Because of its good quality, high yield and wide adaptability, it replaced Nakamaru as well as the native ***indica*** type of varieties rapidly to become the most widely planted rice variety in Taiwan.

In postwar years, rice breeding work has been carried out by all the district agricultural improvement stations and considerable progress has been made especially on Ponlai rice, including round glutinous rice. New varieties have been released from all district stations and are favorably accepted by farmers in their respective area. Meanwhile, new varieties better adaptable to localized areas have gradually replaced the acreage originally planted to Taichung 65. In 1941, the acreage of Taichung 65 was 118,692 ha. (or 69.45% of the total acreage) in the first rice crop or spring crop and 119,704 ha. (65.5% of the total acreage) in the second rice crop or fall crop, while in 1958, it dropped to 48,681 ha. and 48,834 ha., being 21.1% and 18.86% respectively of the total Ponlai rice acreage. Among the existing Ponlai rice varieties, 20 varieties are being most widely planted by farmers.

The postwar government policy, until recently, has been one to extend the acreage of Ponlai rice at the expense of native rice because the former is of better quality, higher yield and greater export value. For this reason, rice improvement work and seed multiplication have been concentrated on Ponlai rice, while such work on the native and upland rice have been rather neglected.

II. Rice Breeding Program in Taiwan

A. Breeding Stations

Rice breeding work is carried out by the Taiwan Agricultural Research Institute and all seven district agricultural improvement stations. The names and locations of the organizations engaged in rice improvement program are listed as follows:

Organization	Location	Breeding programs conducted
1. Taipei District Agricultural Improvement Station (Taipei DAIS)	Taipei (Northern Taiwan)	Ponlai rice
2. Hsinchu DAIS	Hsinchu (Northern Taiwan)	Ponlai rice
3. Taichung DAIS	Taichung (Central Taiwan)	Ponlai rice, native rice, glutinous rice, blast resistance
4. Tainan DAIS	Tainan (Southern Taiwan)	Ponlai rice, upland rice
5. Kaohsiung DAIS	Pingtung (Southern Taiwan)	Ponlai rice
6. Taitung DAIS	Taitung (Eastern Taiwan)	Ponlai rice
7. Hualien DAIS	Hualien (Eastern Taiwan)	Ponlai rice
8. Taiwan Agricultural Research Institute (TARI)	Taipei (Northern Taiwan)	Ponlai rice, inter species cross between *japonica* and *indica* rices, genetic and cytogenetic studies
9. Chiayi Agricultural Experiment Station, TARI	Chiayi (Central southern Taiwan)	Blast resistance of Ponlai rice

B. Purposes of Rice Breeding in Taiwan

The main purposes of rice breeding in Taiwan may be summarized as follows:

1. To breed blast resistant varieties: Rice blast is one of the main diseases which annually cause considerable losses in Taiwan. Particularly in the 1st rice crop, the disease is very prevalent in Ilan, Chiayi, Kaohsiung and East Taiwan areas. The breeding of blast resistant variety, therefore, is one of the most primary aims in rice breeding.

2. To breed varieties with high yielding capacity: Breeding of varieties with high yield is the universal aim of all breeding programs. Under the circumstance

of limited arable land and steadily increasing population in Taiwan, it has special practical significance.

3. To breed varieties with good milling and table quality: The bulk of rice produced here in Taiwan is for domestic consumption, but about 10% of it is exported to other countries, chiefly, Japan. In recent years, the competition in the world rice market has become much keener than a few years ago, and the need for Taiwan to produce rice of high quality is more pressing. So the factor of good milling and table quality becomes an important aim of the future rice breeding program.

4. To breed varieties of wide adaptability: Wide adaptability is a very important character to be taken account of in rice varieties. Among the rice varieties now being grown in Taiwan, "Taichung 65" is so far still the most widely adaptable one. Although some of the new varieties released in recent years have proven superior to "Taichung 65" in yield, yet their superiority occurs each in given districts. The extension of these varieties has been effective in raising the yield of rice, but has also resulted in a larger number of extension varieties than before, each covering a smaller area. Emphasis is therefore to be placed on wide adaptability in rice breeding, with the hope that the varieties under extension may be reduced.

5. To breed varieties of shorter growing period: One of the superiorities of the Ponlai rice lies in its shorter growing period. In recent years, more and more farmers have adopted cropping system under which a summer crop, a winter crop or both are planted in between the spring (or the 1st) and the fall (or the 2nd) rice crops in order to get more out of the limited acreage of arable land. This could be illustrated by the winter soybean crop, which is planted after the 2nd rice crop in Kaohsiung area and the summer planting of melons and winter planting of wheat in Taichung area, both of which are planted in between the two rice crops. With this extremely tight cropping system, rice varieties of shorter growing period naturally have definite advantages.

6. To breed varieties with stiff straw and responsive to heavy fertilization: In the last ten years, the rate of fertilizer application on rice crop has been increasing considerably. The rate of fertilizer application in 1958 was N-90 kg., P_2O_5-35 kg. and K_2O-18.6 kg. per hectare. To apply more nitrogen fertilizer would induce the plant to lodge or an increased infestation of rice blast disease, so to breed new varieties which could tolerate heavy application of fertilizer without succumbing to

lodging and rice blast becomes one of the most important aims in the rice breeding program in Taiwan.

C. Materials for Rice Breeding in Taiwan

The breeding materials commonly used in Taiwan are the native *indica* type varieties, the local rice varieties grown by the aborigines in mountain area, the Japanese rice varieties and the locally bred Ponlai rice varieties. In recent years, rice varieties introduced from the China mainland and those from southeastern Asian countries are added to the breeding stock for making crosses. In some stations, rice varieties brought from the United States are also being used as breeding material.

D. Procedures of Rice Improvement in Taiwan

The breeding of rice varieties is usually carried out in two ways:

1. Hybridization—commonly used for Ponlai, native and upland rice breeding.
2. Pure line selection—inclusively used for improving native rice and upland rice.

The procedures of which are summarized as follows:

1. Hybridization:

a. Crossing is usually made between native and Ponlai rice varieties and in most instances, multiple cross is used. The F_1 plants of the crosses are mostly sterile so only the fertile plants are selected. The F_2 and F_3 strains possessing desirable characters of both parental materials are selected. From F_4 to F_5, selection is continued to discard all segregated plants. Fixed strains will be chosen from F_6 for the preliminary yield test.

b. Preliminary yield test—The preliminary yield test is divided into two groups. One group is applied with a normal rate of fertilization while the other is treated with a double rate of fertilization. The field layout is in 2- to 3-row-plot, randomized block with two to three replications. Field notes on the following will be taken: heading, maturity, degree of infection of blast and other diseases, height of plant, tillering, length of head, awn, shape of kernel and number of kernels per head. The preliminary yield test will be continued for four crop seasons. The offspring from a cross is sometimes crossed with other varieties, so in many cases, the parent stock consists of more than two varieties.

c. Advanced test—The strains selected from the preliminary test are put into the advanced test, in which 5-row-plot of randomized arrangement with 4 replications is adopted. After 4 crop seasons in the advanced test, the desirable strains will be selected by the breeding station for entering into either one of the following two tests.

d. District regional test—The strains released from the advanced test of the breeding station will be recommended by the station to the Rice Improvement Conference called semi-annually by the Provincial Department of Agriculture & Forestry (PDAF). The function of the conference is to determine the varieties to be included in the district regional test, provincial regional test, demonstration farms and the foundation seed farms. After the varieties are approved by the said meeting, they will be included in the district regional test in which 5-row-plot, randomized block with 4 replications, will be followed. The number of varieties in the district regional test does not usually exceed 16 in number.

The number of tests within each district is to be decided and recommended by the respective district agricultural improvement station and approved by the Rice Improvement Conference, but the total number of places of the district regional test in the whole province of Taiwan stays around 50.

Every two years, considerations will be made to replace partly or wholly the varieties used in the district regional tests.

e. Provincial regional test—From the advanced test, promising varieties which show possibilities of wide adaptability may be picked out for provincial regional test which is conducted by the Taiwan Agricultural Research Institute to find out their adaptability on a province-wide basis. The recommendation is to be made by the breeding station and approved by the Rice Improvement Conference of PDAF. Under the provincial regional test, 5-row-plot, randomized arrangement with 5 replications, will be used. The varieties in the provincial regional test are usually from 16 to 20. The test should be couducted at not more than 10 places scattered in the whole province. Consideration should be made to replace the varieties with newer and promising varieties partly or wholly in every three years.

The varieties bred by other stations but showing superiority in the provincial regional test at any station should be included into the district regional test carried on by the district agricultural improvement stations along with varieties selected from their own advanced tests as described in the foregoing paragraph.

f. Demonstration—Promising varieties come out from the district regional test will be put into the demonstration farms within the district for demonstration purpose before starting seed multiplication and extension.

g. Multiplication—Varieties after being demonstrated in demonstration plots for a year may be multiplied through the three levels of seed farms, i. e., the foundation seed, stock seed and extension seed farms, to produce seeds for extension.

2. Pure line selection:

This is carried out among adaptable varieties. In the beginning, head selection is practised. The heads selected will be put into the head row test, in which each head is planted in a row of 1 meter long. Direct sowing method is used. The selected rows will be put into the 2-rod-row test for further screening and selection. In 2-rod-row test, the plants will be spaced 25 cm. and 20 cm. between rows and hills. Each row is 4 m. long consisting of 20 hills. Five plants will be planted in a hill. Every fifth row is a check. The strains selected from 2-rod-row test will be further screened in the 5-rod-row and 10-rod-row test, in both of which the same design as in 2-rod-row test is used. Strains chosen from 10-rod-row test will be tested in the advanced test. In the advanced test, 5-row-plot, randomized arrangement with 6 replications, will be used. The spacing and length of row are the same as that in 2-rod-row test. The test will usually be continued for two years, and the desirable strains will be released for district regional test, demonstration, seed multiplication and extension.

It is to be noted that breeding procedures used are conventional. Only the coordination between the district regional tests and the provincial regional test is a special feature adapted to the organizational relationship of the district agricultural improvement stations and the Taiwan Agricultural Research Institute. This coordination system was established by organizing a Rice Improvement Conference under Provincial Department of Agriculture & Forestry since the spring of 1956. In this meeting, all plant breeders in the various district stations are invited to attend for exchange of information on breeding materials, discussion of breeding results and screening of the recommended varieties to be included into the district regional test, provincial regional test, demonstration farm and foundation seed farms. Under this closely coordinated plan, the promising varieties emerged from the advanced tests of the various breeding stations may be included for further test (either in district or in provincial regional test) and the less desirable varieties will be discarded. Furthermore, a unified breeding program may be obtained.

Aside from the hybridization and pure line selection method described above, backcross method is frequently used in the course of breeding of disease resistant varieties, particularly in rice blast resistance.

In addition to the conventional breeding methods described in the foregoing paragraph, the application of irradiation on rice seeds for induced mutation has also been applied since 1955 as a new tool in the rice breeding program in Taiwan.

E. Recent Development of Rice Breeding in Taiwan

1. Breeding for blast resistance:

As the blast disease is the most persistent and destructive disease of rice in Taiwan particularly in the first rice crop, causing an annual loss estimated not less than 5% of total production, emphasis has been placed on the breeding of blast resistant varieties in rice varietal improvement program. Furthermore, the susceptibility of the existing Ponlai rice varieties to this disease is limiting the expansion of Ponlai rice acreage and the increased application of N fertilizer on rice.

Systematic breeding work for blast resistance has been started since 1950. Crosses have been made between Ponlai rice varieties (*japonica* type), Ponlai rice and native rice varieties (*indica* type), Ponlai rice and mountain varieties originally introduced from Malaya and Philippines and also between Ponlai rice and glutinous rice varieties at various agricultural stations in Taiwan. The varieties selected to make crosses possess either desirable agronomic characters or resistant character to blast. The "Taichung 65", being the most popular variety in Taiwan, noted as a high yielder of wide adaptability and producing grains of good quality, was, therefore, most extensively chosen as parental material in making crosses.

In the methods of breeding, pedigree, bulk and backcross are employed. Two or all three methods may be used in different generations after a cross is made. Furthermore, backcrosses are frequently made with Taichung 65 as recurrent parent. In inducing the infestation of blast disease on the progenies, at first, only artificial inoculation method was used during the seedling stage. Later, it was found that the response of the variety to blast in growing season differed from that in the seedling stage. Therefore, from 1952 to 1954, certain spots near the hillside of Tungshih, Taichung Prefecture, where development of blast disease is very favorable, were chosen to set up experiment fields on which the progenies were planted for the observation of resistance to blast. Besides the favorable natural environment to the blast infestation, very heavy applications of nitrogenous fertilizer (160 kg. of nitrogen per hectare) was made to the experimental plots to make the condition even more favorable to blast development.

In making observation of the leaf blast, 12 classes of disease development in leaf blast phase are established, varying from "no diseased leaf surface" to complete succumb of the entire plant. These standards are being used to rate the degree of leaf blast development on rice plant.

Since the 1st crop of 1956, a number of established varieties were planted in blast disease prevalent areas in 4 localities of Taiwan to observe the reaction from blast disease. The results obtained from 1956–1958 revealed that rice varieties show great deal of difference in resistance with respect to variety, locality and year.

The physiological strains of the causal organism has been studied since 1957 for determining the presence of such strains.

Irradiation of Ponlai rice seeds with X-ray, Cobalt 60 and thermal neutrons have also been made to induce mutants which may be resistant to rice blast. Among the treated progenies, a few are found to be quite resistant. The preliminary results are encouraging and observation and further tests are still under-way.

The varieties relatively resistant to blast disease developed in Taiwan are listed as follows:

Relatively Blast Resistant Rice Varieties Developed in Taiwan

Variety	Parental stock	Degree of resistance to blast[1]
Chianung 242	(Hsinchu 4×Taichung 150) ×(Taipei 7×Tainung 45)	0.2–5%
Taichung 178	Taichung Glu. 46×Yoshino	11%
Taichung 179	Kwangfu 401×Kwangfu 1	5%
Kaohsiung-yu 71	(Chianan 2×Ladang Paeboeboe) ×Kaohsiung 18	5%

1. Percentage indicates diseased leaf surface.

2. Application of irradiation treatment for induced mutants:

Irradiation of rice seeds with X-ray and Cobalt 60 for induced mutation was started from 1955 in Taiwan. Again in 1957, seeds of five Ponlai rice varieties were sent to the Brookhaven National Laboratory, Long Island, New York, USA, for irradiation treatment by X-ray (20,000 *r* and 25,000 *r*) and thermal neutrons (15 hours and 20 hours). Treated seeds were sent back to Taiwan for experimentation. Among the treated progenies, disease resistant (several are found resistant to blast, two strains are resistant to Helminthosporium and a few others resistant to Corticium sheath rot), early maturing (five to ten days earlier than the untreated varieties), stiff strawed and large panicle strains are found.

To acquire induced desirable mutants by applying irradiation seems to be quite encouraging, particularly in the breeding for disease resistant strains, although the results are not yet conclusive.

3. Breeding of promising native (*indica*) rice varieties:

The improvement work on native rice was started from 1949. Five crosses were made between the local breeding stocks by the Taichung District Agricultural Improvement Station. In 1957, a new promising rice variety, Taichung Native No. 1, was developed. This variety, though an *indica* rice, has many desirable characters. Differing from other *indica* varieties in Taiwan, it is non-sensitive to photoperiod so it can be successfully planted in both the spring and the fall crops. It is of stiff straw, responsive to fertilizer application and also a good yielder. Its agronomic characters may be summarized as follows:

The Agronomic Characters of Taichung Native No. 1

Parentage	Presence of awn	Days from transplanting to heading	No. of ears	Height of culm (cm.)	No. of kernels per panicle	Paddy yield (kg.)
Dwarf Wu-jin × Tsai Yuan Chung	Awnless	91 (spring crop)	19.0	83.8	85.9	5,645
		67 (fall crop)	18.6	84.3	84.3	4,997

It is predicted that this variety will become more and more popular in regions where native rice is being grown.

III. Conclusion

In summarizing the recent progress of rice breeding made in Taiwan, it may be stated that the popular Ponlai rice varieties released in the earlier period have been largely replaced by varieties bred in the postwar period. The acreage of "Taichung 65" in the 1st and 2nd crop of the past few years dropped considerably. Among the new varieties recently developed, Chianung 242, a cross of Chianung-yu 65 and Chianung-yu 123, released by the Chiayi Agricultural Experiment Station has been found rather promising in Taichung, Tainan and East Taiwan areas for its blast resistance, high yield and wide adaptability. Kaohsiung 45 and Kaohsiung 53 have made very good performance in the Kaohsiung area, while Hsinchu 55 and Hsinchu 56 have shown good results in the Hsinchu area, and Taipei 127, Taipei 177 in the Taipei area. These varieties are being planted in the demonstration farms in various districts for demonstration and extension.

The new varieties to be developed in the future would be of early maturing, good quality, highly resistant to blast and tolerant to heavy fertilization without lodging, and of good yielding capacity so that it would be able to fit into the tight cropping schedule now being practised in Taiwan. With the recent development of breeding technique as well as the application of irradiation treatment on crop seeds together with the more thorough genetic studies on rice and expansion of breeding stock, new varieties bearing the desirable characters will be developed in the future.

A table shown in the following pages gives the varieties released from various stations and approved by the Rice Improvement Conference of Provincial Department of Agriculture & Forestry for seed production in 1958-1959.

The Characteristics of the Ponlai Rice Varieties Multiplied on Foundation Seed Farms in Taiwan during 1959

Name of variety	Breeding station	Year cross made	Year selected	Parental material	Days from transplanting to heading and (yield) 1st crop	2nd crop	Distinct characters
Taipei 127	Taipei DAIS[1]	II[2] 1936	II 1941	Taichung 65 × Tsing-kao-an[3]	85 (3,561)[4]	65 (3,402)	Adaptable to heavy fertilization; fairly resistant to diseases; medium bearing; apicule pale brown in color.
Taipei 177	-ditto-	II 1936	II 1941	Hwang-chien[3] × Asahi	86 (3,216)	63 (3,369)	Fairly susceptible to diseases; apicule pale brown.
Taipei 301	-ditto-	II 1936	I 1941	Taichung 65 × Tsing-kao-an	87 (3,004)	64 (3,372)	Adaptable to heavy fertilization; fairly resistant to diseases; apicule pale brown in color.
Hsinchu 55	Hsinchu DAIS	I 1939	I 1943	Tainung 44 × Chianan 2	89 (3,567)	68 (3,345)	Resistant to diseases; good table quality; heavy bearing; awnless; short grain; stiff straw.
Hsinchu 56	-ditto-	I 1939	I 1943	Tainung 44 × Chianan 2	89 (3,561)	69 (3,135)	Fairly resistant to diseases; medium quality; medium bearing; awnless; stiff straw.
Taichung 65	Taichung DAIS	II 1923	1929	Kameji × Shinriki	79 (4,665)	68 (3,976)	Medium stalk; stiff straw; large head; heavy bearing; yellow glume; apicule dark brown color; medium maturing; good table quality with wide adaptability.
Taichung 150	-ditto-	1930	1938	[(NC4 × Japanese sp.) × Italian sp.] × Taichung 65	75 (4,508)	63 (3,792)	High stalk; medium tillering; large head; early maturing; green apicule; fairly resistant to diseases.

(To be continued)

(Cont'd)

Name of variety	Breeding station	Year cross made		Year selected		Parental material	Days from transplanting to heading and (yield)		Distinct characters
							1st crop	2nd crop	
Taichung 155	Taichung DAIS	II	1935	II	1939	Taichung 115 × Taichung 121	76 (4,643)	63 (3,675)	Fairly resistant to diseases; good yield.
Taichung 160	-ditto-	I	1938	II	1941	Taichung 114 × Kinkoho	84 (4,674)	67 (3,800)	Apicule dark purple; short grain; awnless; growing better in the 1st crop.
Taichung 162	-ditto-	I	1936	II	1941	Kameji × Taichung special 6	87 (4,506)	64 (3,998)	Adaptable to heavy fertilization; susceptible to disease; long head; awnless; dark purple apicule.
Taichung 170	-ditto-	II	1943	I	1946	Taichung 150 × Nungling 1	85 (4,528)	78 (3,911)	Apicule colorless; long grain; awnless; growing better in the 2nd crop.
Chianan 2	Tainan DAIS	II	1935	I	1938	(Uluan glutinous × Mitsi) × Taichung 65	85 (4,494)	77 (3,564)	Adaptable to heavy fertilization; resistant to diseases; heavy bearing; good table quality.
Chianan 8	-ditto-	II	1935	I	1938	-ditto-	82 (5,178)	74 (4,215)	Medium stalk, head and tillering; heavy bearing; good quality; fairly resistant to diseases; pale purple apicule.
Chianung 242	Chiayi Expt. Sta., TARI[5]	I	1946	II	1948	Chianung-yu 65 × Chianung-yu 63	82 (5,029)	62 (3,556)	Strongly resistant to blast; adaptable to heavy fertilization; heavy bearing; awnless; long head.
Kaohsiung 10	Kaohsiung DAIS	I	1930	I	1933	Kaielou Iikoku × Kaohsiung 6	95 (4,020)	68 (3,157)	Adaptable to heavy fertilization; resistant to diseases; long head; heavy bearing; reddish brown apicule; short awn.

(To be continued)

(Cont'd)

Name of variety	Breeding station	Year cross made	Year selected	Parental material	Days from transplanting to heading and (yield)		Distinct characters
					1st crop	2nd crop	
Kaohsiung 18	Kaohsiung DAIS	I 1939	II 1941	Kaohsiung 10× Taichung 114	95 (4,780)	68 (3,850)	High stalk; medium tillering; green apicule; long head; medium bearing; short awn.
Kaohsiung 22	-ditto-	II 1946	I 1949	Kaohsiung 18× Taichung 158	93 (4,476)	69 (4,246)	Very long head; heavy bearing; resistant to diseases; growing well on fertile soil; stiff straw; broad leaf blade.
Kaohsiung 24	-ditto-	II 1946	I 1949	-ditto-	94 (4,884)	69 (4,210)	Very resistant to blast; very long head; heavy bearing; resistant to diseases; growing well on fertile soil; stiff straw; broad leaf blade.
Kaohsiung 27	-ditto-	II 1946	I 1949	Chianan 3× Kaohsiung 18	94 (4,931)	69 (3,957)	Resistant to diseases; rather long head; heavy bearing.
Kaohsiung 53	-ditto-	I 1949	II 1951	*Kwangfu 401*× Taichung 65	93 (4,927)	60 (4,024)	Resistant to blast; apicule reddish brown; awnless; round kernel; good quality; wide adaptability.

1. DAIS—District Agricutural Improvement Station
2. I—Spring crop; II—Fall crop
3. Native rice (*indica* type)
4. Figure in bracket—Yield of paddy in kg./ha.
5. Taiwan Agricultural Research Institute

PRODUCTION, CERTIFICATION AND DISTRIBUTION OF PONLAI RICE SEEDS IN TAIWAN

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Introduction

In Taiwan, there are two main paddy rice groups under cultivation, i. e., the Ponlai rice group (*japonica* type) and the native rice group (*indica* type). The Ponlai rice is a common name for the improved varieties of the *japonica* type including both the pure-bred varieties introduced from Japan and the offsprings from the inter-crossing of the introduced Japanese varieties or from their crossing with the native rice in Taiwan. The Ponlai rice is of stiff straw, short and round kernel, non-sensitive to day length, responsive to fertilizer, early maturing and a high yielder, so it is favorably accepted by the farmers.

Although there are 127 established Ponlai rice varieties for the spring crop (or 1st rice crop) and 131 varieties for the fall crop (or the 2nd rice crop), only 20 varieties are being widely planted in both spring and fall crops. It has been the policy of the Government to encourage the farmers to plant Ponlai rice in place of the native rice. The extension of irrigation facilities, chemical fertilizers and pesticides to farmers has decisively helped the expansion of its acreage in recent years. In 1958, the Ponlai rice acreage was 460,596 hectares, being 59.2% of the total rice acreage (778,189 ha.). Its production reached 1,185,342 metric tons of hulled rice (brown rice) which was 62.6% of the total production (1,894,127 M. T. of brown rice). The acreage and production of the *indica* rice in the same year were 274,508 ha. (35.3% of total) and 644,262 metric tons (34% of the total) respectively.

In Taiwan, the rice seed multiplication system was established before the Second World War. Since 1945, efforts have constantly been made firstly to rehabilitate and then to strengthen the system of rice seed production and distribution which was largely broken down towards the end of the War. The more recent improvement covers: (1). the reduction of the number of extension seed farms (certified seed farms) from 7,000 to less than 3,000 for better management;

(2) the provision of needy facilities for all seed farms; (3) a more adequate supervision over the multiplication of pure seeds; (4) the establishment of a system in approving new varieties for multiplications and distribution; and (5) the adoption of a rice seed certification system.

I. Present Seed Production System

A. Kinds of Seed Farms

The production of pure rice seeds in Taiwan follows the normal pattern adopted by most other nations. It consists of three levels, i. e., the foundation seeds, the stock seeds (equivalent to the registered seeds) and the extension seeds (equivalent to certified seeds). The seeds are raised on the respective seed farms as follows:

1. The Rice Improvement Conference: The Rice Improvement Conference (RIC) convenes once or twice a year. The RIC is a working party under the Provincial Department of Agriculture & Forestry (PDAF). In the conference, the rice breeding program, the varieties for regional test, for demonstration and for extension,. and other important problems on rice varietal improvement will be discussed and decided. All the rice breeders in various experiment stations will attend. The resolution reached in the conference will be carried out by various stations and local governments and farmers' associations accordingly. The rice varieties approved by RIC for multiplication and extension will be included in the seed production plan of the ensuing season.

2. Foundation seed farm: Following the resolution of RIC, the foundation seed farms will receive the breeders' seeds of the approved rice varieties from the breeding stations. In order to maintain the genetic identity and purity of the variety, the foundation seed farm is managed with utmost care. The seedbed is observed carefully. Any off-type or plant in question is rogued. In transplanting, only one seedling is transplanted into each hill for the convenience of close field observation. As the purpose of the foundation seed farm is to produce seed of high purity and quality, the projected yield is set at a fairly low level, 1,500 kg./ha. (The average yield of rice crop in 1958 was 3,158 kg. of paddy per hectare.) Under the normal rate of seeding (60 kg./ha.), this amount of seed produced will be enough for planting 25 hectares of stock seed farms (registered seed farms) the following season. Since the management of the foundation seed farms requires intimate knowledge of the genetic characters of the varieties under multiplication, the seven district agricultural improvement stations under the administration of the PDAF

on the island are charged with the responsibility. The foundation seeds are supplied free of charge to the stock seed farms.

3. Stock seed farm (registered seed farm): The foundation seed is used for seeding the stock seed farms at a rate of 60 kg. per hectare. The operation of the stock seed farm is also carefully managed. But in line with the farmers' practice, 4–6 seedlings are transplanted to a hill, instead of one seedling transplanting as used for foundation seed farms. The projected average yield of a stock seed farm is 2,400 kg./ha., an amount enough to plant 40 ha. of extension seed farms. The stock seed farms may be operated by the local prefectural government, farmers' association or contracted farmers under their supervision. The stock seeds produced are bought up by the prefectural government and given, without charge, to the extension seed farms for further multiplication.

4. Extension seed farm (certified seed farm): The extension seed farms, the third step of the seed production system, receive their seed supply from the stock seed farm. The extension seed farms should also be well managed. Roguing should be done four times in the first crop and three times in the second crop, to eliminate barnyard grasses, off-types and other mixtures that may be present. The size of extension seed farms, which are scattered in all rice growing townships, should not be smaller than half a hectare. The projected yield of an extension seed farm is the same as that of a stock seed farm. This amount, 2,400 kg. per hectare, is enough to plant 40 ha. of farmers' paddy field. The extension seed farms are operated mostly by contracted farmers.

The pure seeds produced from the extension seed farms may be obtained by the rice farmers by exchanging with their own seed either at the rate of one to one or at a premium of not more than 20 percent. This exchange usually takes places at the extension seed farms.

A summary table showing the system of rice seed production now being practised in Taiwan is given as follows:

Seed Farm	Source of seed supply	No. of plants per hill	Projected yield	Operated by	Location
			(kg./ha.)		
Foundation seed farm	Breeder's seed plot	Single plant	1,500	District Agricultural Improvement Station	District level
Stock seed farm	Foundation seed farm	5 plants	2,400	Gov't agencies and farmers' associations	Prefectural level
Extension seed farm	Stock seed farm	5 plants	2,400	Contracted farmers	Township and village level

B. Number of Seed Farms and Amount of Seeds Produced

There are 12 foundation seed farms, 184 stock seed farms and 5,112 extension seed farms for two rice crop seasons in Taiwan. The amount of foundation seeds, stock seeds and extension seeds produced in 1957 was 14,816.6 kg., 267,420 kg. and 9,747,922 kg. respectively. Every year in the fall season the PDAF will set the projected goal of seed production for the following year. This goal is so adjusted that enough pure seeds will be multiplied to supply at least 1/6 of the total Ponlai rice acreage. As the total Ponlai rice acreage in Taiwan is around 450,000 ha., the projected acreage is set to produce 5,700,000 kg. of pure seeds which is enough to supply 95,000 ha. of paddy field. Under the double cropping system, most of the paddy field is planted to rice crop twice a year so each field will have the chance to receive pure seeds once every three years. The number of seed farms and projected amount of pure seeds to be produced in 1959 are listed in the following table:

Level of seed farms	First crop			Second crop			Total		
	Number	Acreage (ha.)	Projected amount (kg.)	Number	Acreage (ha.)	Projected amount (kg.)	Number	Acreage (ha.)	Projected amount (kg.)
Foundation seed farm	5	1.3	1,950	7	3.02	4,530	12	4.32	6,480
Stock seed farm	73	42.81	102,744	111	47.11	113,064	184	89.92	215,808
Extension seed farm	2,160	802.75	1,926,600	2,952	1,572.25	3,773,400	5,112	2,375.00	5,700,000

II. Seed Certification

The Ponlai Rice Seed Certification System was inaugurated in Taiwan in 1957. The year before, when the First Far East Seed Improvement Conference (FESIC) sponsored by the International Cooperation Administration (ICA) was held in Taipei, Taiwan, much discussions were made on how to develop the seed technology (seed processing, seed analysis, seed storage and seed marketing) in the Far East Asian countries. The resolutions made in the FESIC may be summarized as follows:

A. ICA/Washington be requested to make arrangement with some leading organizations on seed technology to offer special courses on seed technology to trainees from FESIC countries.

B. FESIC countries should take necessary action toward the establishment of seed laboratory as the first step in the development of seed technology.

C. ICA/Washington be requested, at appropriate time, to set up seed technology training centre in FESIC area to offer training courses, to conduct research and to furnish information and services toward seed technology.

Pursuant to the seed conference, the Chineses Government in Taiwan has approved the recommendations made by the Agricultural Association of China (an organization of Chinese agricultural research workers and educationists) to establish the seed certification system of rice and other farm crops and to set up two seed laboratories in Taiwan, one in the National Taiwan University for research and training purposes and another under the PDAF to handle actual seed certification program.

Subsequently with technical and financial assistance from the Joint Commission on Rural Reconstruction (JCRR), seed standards and procedures were prepared and adopted by the PDAF and the Ponlai Rice Seed Certification System was inaugurated in Taiwan in 1957.

A. Ponlai Rice Seed Certification Standards

The certification standards of Ponlai rice seed consist of field standards which are to be followed in field inspection and seed standards to be followed in laboratory analysis. The field and laboratory certifying standards for different seed farms are listed in the following table:

Ponlai Rice Seed Certification Standards

1. Field Standards:

Factor	Maximum permitted in each level of seed farm		
	Foundation	Stock	Extension
Other varieties	None	None	None
Barnyard grass	None	None	None
Objectionable weeds	None	None	10 plants per 1,000 sq. m.
Disease affecting quality of seed or transmissible through planting stock	None	None	None

2. Laboratory Standards:

Factor	Standards for each level of seed farm		
	Foundation	Stock	Extension
Pure seeds (minimum)	99.8%	99.5%	99%
Inert matter (maximum)	0.2%	0.5%	1%
Other varieties (maximum)	None	None	25 seeds per kilo.
Barnyard grass (maximum)	None	None	5 seeds per kilo.
Weed seeds	None	None	2 seeds per kilo.
Germination (minimum)	90% (1st crop) 85% (2nd crop)	90% (1st crop) 85% (2nd crop) 80% (Intermediate crop)	90% (1st crop) 85% (2nd crop) 80% (Intermediate crop)
Moisture content (maximum)	13%	13%	13%
Weight of 1,000 kernels (minimum)	(See the following table)		

The weight of 1,000 kernels will be determined in all three levels of seed farms according to varieties and localities. The following table gives the standard weight of 1,000 kernels of different varieties under seed production at different localities:

Locality	Variety	Weight of 1,000 kernels (gm.)
Taipei area	Taipei 127	24.5
	Taipei 177	26.1
	Taipei 301	24.7
	Taichung 65	25.9
Hsinchu area	Hsinchu 55	22.0
	Hsinchu 56	22.5
	Taichung 65	25.0
	Taichung 155	24.0
	Kaohsiung 24	25.0
Taichung area	Taichung 65	25.2
	Taichung 150	25.1
	Taichung 155	28.2
	Taichung 160	25.9
	Taichung 162	24.6
	Taichung 170	23.5
Tainan area	Chianan 2	23.8
	Chianan 8	25.0
	Taichung 65	26.3
	Kaohsiung 24	26.6
Kaohsiung area	Kaohsiung 10	25.8
	Kaohsiung 18	25.0
	Kaohsiung 22	26.2
	Kaohsiung 27	25.1
	Kaohsiung 53	24.7
	Chianan 8	24.9
	Taichung 65	26.7
Taitung area	Chianan 2	24.0
	Chianan 8	24.7
	Chianung 242	25.3
Hualien area	Chianan 8	24.0
	Kaohsiung 24	24.0

In addition to field inspection and laboratory analysis, the storage inspection is also needed to determine: (1) whether the storage facilities are available; (2) has proper care been taken to clean the storage before seeds are stored; (3) whether the storage facilities are adequate to prevent rats and insects; (4) whether the storage facilities are affected by outside humidity; and (5) whether the germination percentage is affected by long period of storage, etc.

B. Operation of the Seed Certification System

The certification of rice seeds includes the field inspection, storage inspection and laboratory analysis. The field inspection covers all levels of seed farms whereas the storage inspection and laboratory analysis cover all the foundation seed farms, stock seed farms and so far only a part of the extension seed farms. In 1957, only 113 extension seed farms were sampled at random to undergo laboratory analysis. From 1958 to 1959, one third of the extension seed farms have been scheduled to undergo laboratory analysis.

In making field inspection, inspectors will be dispatched to the seed farm from full heading stage to dough stage to carry out field inspection work. The foundation seed farms will be inspected by inspectors from the Taiwan Agricultural Research Institute (TARI). The stock seed farms will be inspected by inspectors dispatched from District Agricultural Improvement Stations (DAIS) and prefectural governments. The extension seed farms will be inspected by inspectors from the township offices with the assistance of DAIS.

In making laboratory analysis, the TARI will dispatch personnel to the DAIS to take seed samples (2 kg. each) from foundation seed farms and bring them back to its laboratory for seed analysis. For the stock seeds, the DAIS will dispatch personnel to take seed samples and bring them back to the station for seed analysis. If a sample is found up to the standard, the respective seed farm will be informed and tags will be issued (white tags for foundation seed farm and purple tags for stock seed farm) to indicate these seeds are certified according to government regulations. For the extension seeds, no tags will be issued to the operators. Instead, a certificate notice, on which the name of the operators, name of the variety, amount of seeds produced and quality of seeds shall be written, will be posted at some public place in the township.

The results of seed certification of the three levels of seed farms in the 1st and 2nd crops of 1958 are given as follows:

Level of seed farms	Field inspection		Laboratory analysis		Storage inspection	
	1st crop	2nd crop	1st crop	2nd crop	1st crop	2nd crop
Foundation seed farm						
No. of seed farm inspected	6	7	6	7	6	7
No. of seed farm complying with the standards	6	7	5	6	6	7
No. of seed farm disqualified (see note)	0	0	1	1	0	0
Stock seed farm						
No. of seed farm inspected	73	111	46	95	57	95
No. of seed farm complying with the standards	57	95	33	73	57	95
No. of seed farm disqualified	16	16	13	22	0	0
Extension seed farm						
No. of seed farm inspected	2,160	2,952	520	1,560	0	0
No. of seed farm complying with the standards	1,863	2,496	264	998	0	0
No. of seed farm disqualified	297	456	256	562	0	0

Note: In the 1st crop, 24 varieties were examined, 2 were found disqualified.
In the 2nd crop, 30 varieties were examined, 1 was found disqualified.

IV. Storage and Distribution of Pure Rice Seeds

The methods of storage and distribution of rice seeds vary with the levels of seed multiplication and also the length of time of storage required.

A. Storage and Distribution of Foundation Seeds

The foundation seeds, after being properly sun-dried to a moisture content not higher than 13%, are generally stored in wooden bins, installed in storage house of the district agricultural improvement stations. Each wooden bin is 2.4 meters long, 1.06 meters wide and 2.7 meters high and is lined inside with galvanized iron sheet to keep the seed dry and to prevent damage from rats. The wooden bin has a lid on its top for loading seed and an outlet near the base at the front for unloading. It is installed 30 cm. above the floor in order to prevent moisture. Each wooden bin has a storage capacity of 2,400 kg. of rice seeds. Usually a series of wooden bins is installed in the same house for storing seeds of different varieties.

Before the planting season begins, the prefectural farmers' association will take delivery of the foundation seeds by bringing empty jute bags to the DAIS and will take back a certain amount of seeds according to the acreage of stock seed farm for planting. In Taipei area, the stock seed farm itself takes delivery of the foundation seeds directly from the Taipei DAIS. Locally produced jute bag is also used as the container for shipping.

B. Storage and Distribution of Stock Seeds

After being properly sun-dried to 13% moisture, the stock seed is kept either in wooden bins, as described above, or in smaller metal bins. The metal bin is either made of galvanized iron or aluminum sheet and has a capacity of 150 kg. The bin is 90 cm. high with a diameter of 66 cm. and a rubber lined metal lid. The metal bin has several advantages, i. e., (1) it can be moved easily from place to place; (2) due to its smallness, it can be installed easily; (3) it is light in weight, rat-proof, and good for keeping seeds in relatively small amounts. Because of these reasons, it is popularly used in rural Taiwan not only for storing rice seeds but also for other crop seeds.

Stock seeds, after being certified and found up to the seed standards, will be bought up by the prefectural government. In taking delivery of the stock seeds, the prefectural farmers' association or the township office will bring empty jute bags to the seed farm to collect the seeds and then haul the seeds by truck either to the township farmers' association or to the township office. The extension seed farm operator will take delivery of the stock seeds from farmers' association or from township office.

C. Storage and Distribution of Extension Seeds

The extension seed is kept mostly in jute bags. As the Ponlai rice varieties are generally non-sensitive to day length, they are planted both in the spring (1st crop) and fall (2nd crop) seasons. The seed produced by the spring crop will be planted in the following fall, and vice versa, so the storage period is comparatively short.

In the southern and central Taiwan (Yunlin, Chiayi and Tainan Prefectures), due to the insufficiency of irrigation water, rice is planted only once a year, at the time between the spring and the fall crop. Such rice crop is termed as intermediate rice crop. The seed for intermediate rice crop will be stored for at least six months so a bowl-typed storage hut has been used by farmers for the purpose. Split bamboo strips are woven into a bowl shaped container which is seated on a heavy wooden base. The bamboo frame is then plastered, both inside and outside, with a mixture of lime, sand and mud. On one side of the storage, there is a small opening for loading and unloading the seed. Over the top there is a thatched roof. This construction will prevent the penetration of moisture, reduce the fluctuation of temperature and also keep out the rats. This storage hut usually has a capacity to store 3,000 kg. of seed and can be erected by the farmers themselves in their yards.

In obtaining extension seeds, rice farmers bring in their own rice seeds to the seed farm operator in exchange of pure seeds. Sometimes farmer brings back pure seeds first from the extension seed farm and then bring in his own seeds at a later date. The seed exchange rate will be 1:1 or 1:1.1 depending on the discretion of the operator. The seeds exchanged will be hauled on a bicycle or on an ox-cart depending on whichever is available.

IV. Concluding Remarks

The production and distribution of pure Ponlai rice seeds have been implemented quite smoothly in Taiwan. The certification of rice seeds has been started only from 1957. From then to date, the field inspection and storage inspection are carried out to cover all three levels of seed farms. Laboratory analysis is conducted on all foundation and stock seeds but only on one third of the extension seeds. The seed laboratory of the National Taiwan University is already under operation. The one of PDAF is under construction and expected to be completed in June 1959. After its completion, with the assistance of the seven district agricultural improvement stations, the certification work may be expanded to cover all the extension seed farms in Taiwan.

It may be stated that the success of this program lies in (1) the applicability of the system; (2) the careful selection of seed farm operators; (3) the provision of necessary physical facilities; (4) supervision of the management of the seed farms by the government; (5) incentives of farmers to use pure rice seeds. Lack of any of these factors will make the program less successful.

SEED MULTIPLICATION, DISTRIBUTION AND CERTIFICATION OF SWEET POTATO IN TAIWAN

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I. Introduction

Sweet potato (*Ipomoea batatas* Lam.) is a common food and feed crop grown in Taiwan. In acreage and production, it ranks only next to rice. Every year, over 220,000 hectares are planted with an annual production of approximately 2,600,000 metric tons. The main sweet potato growing regions are in Tainan, Yunlin and Changhwa in the southern and central parts of the Island, although potato fields may be seen almost everywhere from north to south and from west to east. Planting may be made in the spring, in the fall or in the winter.

Recently, with the expansion of the soybean and peanut acreages, more and more sweet potatoes are being planted as a winter crop to paddy fields prior to the harvesting of the second rice crop in October or November. A rough estimate shows that about 74 percent of sweet potatoes now in Taiwan are planted in the months between August and December, while the spring and early fall plantings occupy about 13 and 14 percent respectively. Except those planted on the paddy field as a winter crop, sweet potatoes are still the main upland food crop in Taiwan for dryland area.

The common sweet potato varieties grown at present are Tainung 10, 17, 31 and 45 of the improved varieties and Red-tuber-tail, Green-tuber-tail, Iron-wire-vine and 70-day Early of the native varieties. The native varieties are poor in quality, but they stand up better under adverse conditions especially in northern districts. In recent years, through the work of the Taiwan Agricultural Research Institute (TARI), its Chiayi Agricultural Experiment Station (Chiayi Station, TARI) and the Hsinchu District Agricultural Improvement Station (Hsinchu DAIS), several new improved varieties have been produced, which give better yield and quality at some localities tested. Of these new varieties, Tainung 58 is produced by TARI, Tainung

48, 51, 53, 54, 55, 56 and 57 by the Chiayi Station and Hsinchu 1 and 2 by the Hsinchu DAIS. Tainung 54, 55 and 57 are colored sweet potato varieties, having very high nutritive value and good for table use, and obtained from the crosses between Tainung 27 and Nancy Hall. Through the seed multiplication and extension system, the improved varieties occupy at present about 70 percent of the total acreage, while the native varieties take up the remaining 30 percent.

II. Method of Seed Multiplication

The operation of the sweet potato seed multiplication system may be briefly outlined in the following:

A. Recommendation of Sweet Potato Varieties for Seed Multiplication and Extension

This recommendation is usually made at the mid-year meeting of the Provincial Upland Food Crop Improvement Conference called by the Taiwan Provincial Department of Agriculture & Forestry (PDAF). At this meeting, with the attendance of all crop men from PDAF, research experiment stations, district agricultural improvement stations and JCRR, a careful review will be made on the performance of different varieties tested at different districts. The best ones and those specifically demanded by farmers will be recommended for seed multiplication and extension. The recommended varieties for different districts during the past two years are shown in the following:

District	Varieties
Taipei & Ilan	Tainung 45 Tainung 58
Hsinchu	Tainung 58 Hsinchu 1 Hsinchu 2
Taichung	Tainung 31 Tainung 45
Tainan	Tainung 31 Tainung 45 Tainung 57
Kaohsiung	Tainung 45 Tainung 51 Tainung 53
Taitung	Tainung 44 Tainung 53
Hwalien	Tainung 44 Tainung 58

A list of seed multiplication with the name of the varieties, acreage to be planted and amount of seed material to be multiplied at each district is prepared by PDAF after the meeting and later announced at the Provincial Food Production Conference.

B. The Seed Multiplication System and Its Operation

Under the present seed multiplication system, seed material of sweet potato is multiplied under three levels of seed farms, i. e., foundation seed farms, stock seed farms and extension seed farms. These farms are established and operated in the following manner:

1. The foundation seed farms: These seed farms are established at and operated by seven district agricultural improvement stations, one located at each of seven food districts where sweet potato is grown. Seed potatoes for the foundation seed farms are usually supplied by the breeding stations. Each foundation seed farm is planted with one variety, and if there are several varieties to be multiplied, they will be planted in separate farms. No foundation seed farm is established on field where sweet potato has been grown in the preceding crop season. All these measures are taken to ensure that the varieties multiplied are kept in their original identity and no admixtures of other strains will occur. The foundation seed farms are ordinarily planted in August or September with seed potatoes produced ready for distribution in February or early March of the following year. Distribution of foundation seed potatoes to the stock seed farms is free of charge.

2. The stock seed farms: These seed farms are established at different prefectures (hsien), forming the second level of the seed multiplication system. They differ from the foundation seed farms, however, in that the vine cuttings produced from the stock seed farms are used for distribution instead of seed potatoes. The stock seed farms are operated by prefectural farmers' associations or by contract farmers under their supervision. To facilitate supervision and distribution work, these seed farms are established only at one to three places in a prefecture in a season. Fields are carefully selected and, as the stock seed farms are mostly operated by contract farmers, they are separated from one another for some distance to avoid possible contamination among varieties. In case contaminations or off-type plants are found in the fields, roguing is strictly enforced. At the average production of 1,050,000 vine cuttings per hectare, one hectare of stock seed farms will be enough for planting 17.50 hectares of the extension seed farms on the basis of planting 60,000 vine cuttings per hectare. The distribution of vine cuttings from stock seed farms to extension seed farms is free of charge and is made sometime in May or June. For compensation, the prefectural farmers'

associations or contract farmers who operate the stock seed farms are given some cash subsidy from PDAF.

3. The extension seed farms: These seed farms planted with vine cuttings from the stock seed farms are established at different townships and form the third or final level of the whole multiplication system. From these farms, again vine cuttings are used for distribution. The extension seed farms are as a rule operated by contract farmers under the supervision of township farmers' associations. At each prefecture a few townships are selected for establishing the extension seed farms in a season and the work is rotated to other townships in the following crop season. For each township, only one recommended variety is multiplied. Attempt has been made in recent years to concentrate the extension seed farms to a few villages in a township for better management and supervision. The extension seed farms must also be well managed, to be free from the admixtures of other varieties and to be as free from diseases, insects and other noxious weeds as possible. Planting is made in May and June, and the distribution of vine cuttings in August or September. To each hectare of the extension seed farms, 60,000 vine cuttings are planted, which, in turn, produce about 900,000 vine cuttings per hectare. This will be enough for planting 30 hectares of the farmers' fields at the rate of 30,000 cuttings per hectare according to the ordinary cultural practice. The extension seed growers will sell their vine cuttings at a price approved by PDAF, but they will also receive certain cash subsidies from the government as compensation.

The whole system as described above may be illustrated by the following diagram:

Seed farms	Time of planting	Seed material projected per hectare	Time of distribution	Operating agency
Foundation seed farms	Aug.-Sept.	12,000 kg. of seed potatoes	Feb.-Mar.	District agricultural improvement stations
Stock seed farms	Feb.-Mar.	1,050,000 vine cuttings	May-June	Prefectural FAs or contract farmers
Extension seed farms	May-June	900,000 vine cuttings	Aug.-Sept.	Township FAs or contract farmers

From the above diagram, it may be seen that the whole system starting from the time of planting foundation seed farms to the time of the distribution of the vine cuttings from the extension seed farms to the farmers may be completed within a period of about one year. This system has obvious advantage over the old system adopted before the War and until 1955, when seed potatoes were used for distribution from all three levels of seed farms, and were required for the planting material to get from the foundation seed farm to the farmers' hand for general planting.

Acreage and seed material that have been established, produced and distributed during the past three years are shown in the following:

Year	Foundation seed farms		Stock seed farms		Extension seed farms	
	Acreage (ha.)	Seed potato output (kg.)	Acreage (ha.)	Cutting output	Acreage (ha.)	Cutting output
1957	5.04	65,980	4.96	3,641,300	59.98	27,721,200
1958	3.95	51,195	4.03	3,011,260	48.41	23,206,600
1959 (Planned)	4.05	48,600	4.05	4,252,500	70.88	63,787,500

III. Inspection and Certification

Since the ICA sponsored First Far East Seed Improvement Conference was held in summer 1956 in Taipei, a Seed Certification Program has been initiated. For sweet potato, the inspection, certification and specifications were first applied in 1958. Aside from regular supervision by operating agencies, all seed multiplication farms for sweet potato are now subject to careful field inspection. The first inspection is made about one month after planting, and the second at the time when the potato tubers or vine cuttings are ready to be distributed. Inspection and certification are made by the agencies designated by PDAF as follows:

A. Foundation seed farms — Inspected and certified by PDAF, TARI, Chiayi Station, or other agency assigned by PDAF. Field inspectors submit reports to PDAF, district stations, and the operating agencies within five days after the inspection.

B. Stock seed farms — Inspected and certified by TARI or Chiayi Station, and district stations. Copies of the reports are submitted by field inspectors of the district stations to PDAF, the prefectural farmers' associations, the operating agencies and contract farmers through prefectural farmers' associations within five days after inspection.

C. Extension seed farms — Inspected by district stations and prefectural farmers' associations. Copies of the reports are submitted by the inspectors of prefectural farmers' associations and sent to district stations, the township farmers' associations, the operating agencies, and their contract farmers.

Seed materials from qualified fields are distributed for further multiplication or for general planting.

IV. Sweet Potato Seed Certification Standards

A. Field Requirements

1. The land on which the seed multiplication farms are established shall not have sweet potato grown in the preceding crop season.

2. To each farm, only one recommended variety is grown.

3. The seed multiplication farms must be isolated for some distance from sweet potato of farmers' fields or from fields belonging to different classes of seed multiplication.

4. The seed multiplication farms must be established on land with good drainage system.

5. Compost containing sweet potato residue shall not be used on seed multiplication farms.

B. Field Inspection

1. One field inspection shall be made when plants attain uniform growth, which is about one month after planting.

2. A second inspection shall be made when seed materials are ready for distribution.

C. Field Standards

Factor	Standard		
	Foundation	Stock	Extension
Other varieties	None	None	None
Diseases	None	None	Maximum 0.2%
Potato weevils	None	None	Maximum 0.2%

D. Seed Potato Standards (for foundation seed farms)

Factor	Standard
Other varieties	None
Size of tubers	Between 200-400 gm.
Shape of tubers	Uniform and normal in growth.
Tuber skin	Free from wounds and insect damage.
Internal structure	Solid, with no hallow space.
Sprouting	Preferably no sprouting.—Sprout not over 1 cm. in length in case sprouting does occur during rainy season.

E. Standards for Vine Cuttings (for stock and extension seed farms)

Factor	Standard	
	Stock	Extension
Varietal mixture	None	None
Diseases	None	None
Insect damages	None	None
Length of vines	30 cm.	30 cm.
Nodal number per vine (minimum)	6	6

In 1958, inspection and certification were made in most of the foundation and stock seed farms and it was found that, in most cases, they met the certification standards. The results may be reported in the following:

Item for inspection or certification	Foundation seed farm	Stock seed farm
Field inspection		
1. Total acreage inspected (ha.)	3.79	3.52
2. Acreage meeting certification standards (ha.)	3.79	3.52
3. Acreage disqualified (ha.)	None	None
Certification of seed potatoes from foundation seed farms		
1. Total amount of seed potatoes inspected (kg.)	51,795	—
2. Amount meeting certification standards (kg.)	51,195	—
3. Amount of seed potatoes disqualified (kg.)	600	—
Certification of vine cuttings from stock seed farms		
1. Total number of vine cuttings inspected	—	1,829,373
2. Number of cuttings meeting certification standards	—	1,660,323
3. Number of cuttings discarded	—	169,050 (less than 10%)

Certification of seed material from extension seed farms was not tried in 1958, but it will be done as soon as training of necessary personnel is completed. The certification of foundation and stock seed farms is, at present, carried out by PDAF, Chiayi Station and the district stations.

V. Processing and Distribution of Seed Material

Processing and distribution of seed material from qualified seed farms vary with the kind of seed material produced. The present system may be briefly described in the following:

A. Distribution of Seed Potatoes from Foundation Seed Farms

Seed potatoes from foundation seed farms are harvested about five to six months after planting. Only those which meet the certification standards are selected for seed. Soil is removed from them for better observation to make sure that each seed potato selected is free from wound or insect damage. The certified seed potatoes are packed into jute bags, each containing about 60 kg. To each bag, a tag is attached carrying the name of variety, name and address of the shipper (in this case the district station), number of bags and total weight of seed potatoes to be shipped, inspection number and names of inspectors, date of shipment, and name and address of the consignee (in this case the prefectural farmers' associations). The seed potatoes are shipped by trucks to the prefectural farmers' associations which would either plant them in their own stock seed farms or distribute them to contract stock seed growers. The whole process must be completed within a week after harvesting.

B. Distribution of Vine Cuttings from Stock Seed Farms

As mentioned before, stock seed farms are planted with foundation seed potaoes, and the planting is made in February or March every year. After three or four months, when plants are in their best growth, the qualified stock seed farms will cut the vines. Two harvests of cuttings are made about one month apart. Under proper management, each seed potato will give from 10 to 15 stalks at each harvest or a minimum of 21 vine cuttings from it in two harvests of cuttings. The cut potato vines are bound into bundles, with 1,000 per bundle. After being inspected, certified and tagged by seed inspectors, the certified potato vines are shipped to the extension seed growers by ox-carts. The distribution of vine cuttings must be completed within two days after the cutting is made.

C. Distribution of Vine Cuttings from Extension Seed Farms

The extension seed farms are planted with vine cuttings at different townships in May or June. After three or four months of growth, they, in turn, are ready to be cut for vines. Usually 15 top cuttings can be obtained from each plant in two harvests of cutting. After being carefully inspected, the healthy vines are packed into bundles, 1,000 per bundle and tagged. They are distributed right in the field to the farmers for general planting.

After distribution, complete records will be kept by the operating agencies and also other agencies concerned.

VI. Government Subsidy for Sweet Potato Seed Multiplication

In order to encourage proper management of all seed farms and distribution of seed material, the following subsidies have been given by PDAF to the operating agencies for sweet potato seed multiplication.

A. Subsidy to foundation seed farms — As seed potatoes from the foundation seed farms are distributed to stock seed growers free of charge, the district stations, as the operating agencies, are provided in their annual budget an appropriation of NT$3,750 to NT$4,000 per hectare to cover the expenses for operating foundation seed farms. The total budget for all foundation seed farms of sweet potato is about NT$30,000 annually for the whole province.

B. Subsidy to stock seed farms — The vine cuttings from the stock seed farms are also given free to the extension seed growers. To compensate the operating agencies, the prefectural farmers' associations or their contract farmers for the labor and loss in potato production as a result of vine cutting, a cash subsidy of NT$3,750 to NT$4,200 per hectare is given by PDAF. The annual budget for this item is about NT$20,000.

C. Subsidy to extension seed farms — Vine cuttings from extension seed farms are not given free, but sold to the ordinary farmers at a price considerably lower (usually about one third lower) than the market price. This measure is taken so that the farmers will be willing to buy the new sweet potato cuttings from extension seed growers instead of using the cuttings of their old varieties. Therefore, in order to cover the loss incurred from the reduced price and at the same time to encourage the extension seed growers to produce and distribute as many healthy cuttings as possible, the PDAF pays the extension seed growers a subsidy on the basis of the number of cuttings which they have distributed. The present rate of the subsidy is NT$20 per 10,000 vines or about NT$1,800 per hectare of extension seed farms. The total annual budget for this item is about NT$120,000.

D. Subsidy for expenses for packing and transporting seed material — Subsidy for expenses for packing and transporting foundation seed potatoes is NT$0.20 per kg., for stock seed farm potato vines NT$15 per 10,000, and for extension seed farm potato vines NT$12 per 10,000. The total annual governmant expenses for these items are approximately NT$150,000.

E. Subsidy for supervision and travelling expenses — As many of stock and extension seed farms are distributed in different prefectures and in different townships and are operated by contract farmers, adequate supervision is necessary. Supervision and travelling expenses are appropriated by PDAF, although the sponsoring agencies do contribute a part of the expenses from their own budget. The annual expenditure for this purpose from the government is approximately NT$50,000.

The whole budget for sweet potato seed multiplication work in a year at present in Taiwan is about NT$360,000. From this fund, about NT$250,000 is given as subsidies, and to this part, JCRR has contributed about NT$190,000 every year.

VII. Distribution of Seed Improvement Information to Farmers

To implement the seed production and distribution program of sweet potato, the following methods have been used by PDAF and their operating agencies to disseminate seed improvement information to the farmers:

A. Publication of extension circulars — Extension circulars on the characteristics of new sweet potato varieties, method of the production of seed material and, recently, the certification of seed material have been published by PDAF.

B. Posting of signboards on seed multiplication farms — At each seed multiplication farm, a signboard is posted. On the signboard, the following information is written: the name of variety, the name of seed grower, and the name of sponsoring agency. As the seed farms are generally located near the roadsides and most Taiwan farmers can read, they can easily get the information from the signboards and go to the seed growers or to the sponsoring agencies asking for details.

C. Estahlishment of demonstration plots for new varieties — These demonstration plots are established not adjacent to, but close to seed multiplication plots. In the demonstration plots, the variety to be multiplied and an old variety are planted side by side for comparison. At the time of harvest or before the vines are cut from the fields, a field visit will be held and farmers from nearby localities will be invited to the demonstration and the seed multiplication plots to see the performance of multiplied varieties. This method of establishing demonstration plots and holding farmers' visits have been found to be the most effective way in extending the seed and crop improvement information to the farmers.

D. Holding of field contests among seed growers — In addition to field visits, contests are usually held among the seed growers. The best seed growers receive prizes or rewards from PDAF or local prefectural governments. This promotes the interest of seed farm operators to do a good job.

VIII. Sweet Potato Production in Taiwan

With the extension of new improved varieties and good seed material through the seed multiplication and distribution system, the unit yield of sweet potato in

Taiwan during the past few years has been considerably increased. As a result in increase in unit yield, it is possible now for the Government to divert gradually some of the sweet potato acreage to other essential crops such as soybeen, rapeseed and wheat without jeopardy to the sweet potato availability. The increase in unit yield during the past few years may be shown in the following table, and it is hoped that in a few more years, the sweet potato acreage may be reduced to less than 200,000 hectares.

Sweet Potato Production in Taiwan between 1953–1958

Year	Acreage (ha.)	Production (M.T.)	Yield per ha. (kg.)
1953	237,788	2,276,942	9,576
1954	247,551	2,556,823	10,326
1955	245,513	2,437,443	9,928
1956	230,236	2,568,104	11,154
1957	228,760	2,693,417	11,774
1958	222,767	2,927,495	13,141

PRELIMINARY REPORT ON WHEAT BREEDING FOR RUST RESISTANCE IN TAIWAN

Keh-ming Lin and Chao-jan Tseng[1]

I. Wheat Rust in Taiwan

The leaf rust caused by *Puccinia rubigo-vera tritici* is the most destructive wheat disease in Taiwan. The damage is usually more than twice as much as that of the stem rust caused by *Puccinia graminis* which is the second important in Taichung Area. Though the annual loss caused by the rusts differs year to year depending upon the degree of its development which is affected greatly by the climatic conditions, it is estimated to be not less than 10% of the total production in average.

When hot and windless weather lasts for a considerable number of days after the middle of December and very foggy nights follow it, serious damage on wheat by the leaf rust may be expected. In such years approximately twenty to forty percent of the total production may be lost.

The measures of rust control being recommended by government in Taiwan are: (1) sowing at proper time, especially not too late; (2) refraining from the over-application of nitrogen, proper quantity of potassium should be used; (3) not irrigate at last stage of growing period; (4) avoiding too dense planting and keeping good ventilation of wheat field; (5) applying proper fungicides such as "dithane" or "lime-sulphur mixture" whenever there are indications of its outbreak.

Though these recommended controlling methods are effective to some extent, their efficacy is not satisfactory when the rust is serious and universally breaks out. Some of them are not quite economical due to the high cost of the chemicals.

Therefore, developing the immune or highly resistant wheat varieties to rust is no doubt the most logical approach in solving the problem, though it may take a long time, because of the wide physiological specialization of rust races.

1. Senior Specialist and formerly Specialist at the Taichung District Agricultural Improvement Station, Taiwan, China, respectively.

In analyzing wheat varieties in Taiwan, they have proved themselves to be the outstanding varieties of having most of desired agronomic characters, such as high productivity, good quality and especially early maturity to suit our special cultivating system, since wheat is planted as a winter crop during the short period after the harvest of 2nd rice crop and before the transplanting of the first rice crop in rice fields of Taichung area. But none of them is resistant to rust.

The authors started the studies on this particular problem in 1953 and have put their effort on the improvement of rust-resistant varieties.

The authors desire to acknowledge their indebtedness to Dr. S. H. Ou and Dr. C. F. Cheng of JCRR for their valuable suggestions and criticisms in connection with this work as well as their assistance in making this paper possible.

II. Varietal Resistance to Rust

A. Material and Method

Observational tests on rust resistance of a total of 346 varieties and strains mainly introduced from the U. S. A. and Japan and some from Canada, Australia, Russia and China Proper, including those obtainable locally, were carried out at Taichung, Taiwan, in 1952 and 1953.

To make the tests easier, these varieties were sown and observed at the fields located near sea-coast, where the environmental conditions are favorable for rust development. Then the following means were employed to accelerate the development of the pathogen: (1) Seeds were sown 15 days later than the regular sowing time, (2) Heavy nitrogen was applied by using twice as much as the standard amount of ammonium sulphate as basic manure and top dressing during the vegetable growing period, and (3) The test field was kept as wet as possible by frequent irrigation.

Twenty plants were planted in a row with two replicates for each variety and the rust infection was observed on row basis on March 1 and 10, 1952 and 1953.

B. Classification of Rust Resistance

The following five classes were used to classify the degree of resistance to rust.

1. HR—Highly Resistant
   No uredinia formed, small flecks, chlorotic or necrotic areas frequent.
2. R—Resistant
   Uredinia few, small, always in small necrotic spots, also many necrotic areas without development of uredinia.

3. MR—Moderately Resistant

Uredinia of moderate size fairly abundant, always in necrotic or chlorotic spots.

4. MS—Moderately Susceptible

Uredinia of moderate size fairly abundant, no necrosis produced, sometimes slight chlorosis immediately surrounding the uredinia.

5. HS—Highly Susceptible

Uredinia abundant, large size, no necrosis or chlorosis immediately surrounding the uredinia.

C. Experimental Results

The results of two years' observation are presented in the following tables:

Table 1. Number of Wheat Varieties in Different Classes of Resistance

Resistant to	HR	R	MR	MS	HS	TOTAL
Leaf rust	36	42	87	66	115	346
Stem rust	22	18	152	76	78	346

The result shows that there are wide varietal differences in rust-resistance among those 346 varieties tested.

Table 2. Highly Rust-resistant Varieties in Taichung, Taiwan

Resistant to	Varieties
Leaf and stem rust	HsHp 4603, SHp S607, (Frontana X Thatcher), (Timstein X New Thatcher), Selkirk, Towner, Yuma
Leaf rust only	Kinai No. 2, No-lin No. 60, No-lin No. 61, Gabo, Chabo, Wheat e13, Stanhalsor, KP 4108, KGP 4508, KGP 4521, Lawrence, Isaria, Anrore, Extralation, Shie-non No. 5, No. 24 and No. 56, KP K4614
Stem rust only	Kinai No. 63, Kis 4608, Wheat P. B. 591, Sea Poam, SHSW 4610

As shown in the Table 2, the varieties resistant to both leaf and stem rust are all those introduced from foreign countries, and none of the local varieties show any resistance to rusts.

III. Some Studies on Rust

A. Physiologic Specialization of *Puccinia rubigo-vera tritici*

Leaf-rust reaction of 20 varieties was observed in Taichung and reported in the Table 3. Comparison was made with the results tested at five different localities in wheat region of U. S. A.

Table 3. Leaf-rust Resistance of Wheat Varieties in Different Localities in U. S. A. and Taichung

Varieties	Madison Wisconsin	Rosemount Minnesota	Langdon N. Dakota	Highmore S. Dakota	Lincoln Nebraska	Taichung Taiwan
Lee	R	R	R	—	3%	R
Rival	30%	32%	40%	25%	70%	S
Rushmore	40%	45%	—	30%	63%	R*
Henry	20%	1%	—	—	84%	S
Thatcher	70%	100%	40%	40%	75%	S
Henry X 1907	—	0%	—	—	—	S*
Henry X Cadet	R	R	—	0%	—	S
Lee X 3175	—	1%	5%	—	—	S*
Thatcher X Surpresa	—	R	R	0%	—	R
Hope X Timstein	—	—	—	0%	—	S*
A. M. 10 X New Thatcher (N. S. 3780)	—	—	R	—	—	S*
Timstein X New Thatcher	—	1%	—	—	—	HR
Frontana X Thatcher (II-46-3)	—	HR	—	—	—	HR
Frontana X Thatcher (II-46-5)	—	HR	—	—	—	HR
Frontana X Thatcher (II-46-13)	—	HR	—	—	—	HR
Carleton	—	R	—	—	—	S*
Mindum	—	R	0%	0%	R	HR
Stewart	—	0%	0%	0%	—	S*
Nugget	—	R	0%	0%	—	R
Taichung Wheat No. 31	—	—	—	—	—	S

Remarks: (%) The percentage of leaf rust infection
(*) Indicating the variety showing different reaction to leaf rust at Spring Wheat Region of U. S. A. and Taichung, Taiwan

It can be seen from the Table 3 that a same variety may show different reaction to leaf rust at different localities and it is considered to be due to the different composition of leaf rust races.

The distribution of physiologic races of leaf rust, *Puccinia rubigo-vera tritici*, in Taichung area of Taiwan has been observed by using several spring wheat varieties whose reactions to 45 physiologic races of leaf rust had been studied by M. N. Levine and others and the observation results are shown in the Table 4.

Table 4. Reactions of Wheat Varieties to Some Physiologic Races of *Puccinia rubigo-vera tritici*

Varieties	Reaction at Taichung, Taiwan	Reaction at St. Paul, Minnesota — Races to which tested variety shown: Resistant	Susceptible
Lee	R	1, 2, 3, 4, 5, 6, 7, 9, 11, 13, 14, 15, 16, 17, 19, 21, 28, 31, 33, 35, 37, 40, 43, 49, 50, 52, 58, 64, 77, 90, 91, 93, 105, 107, 126, 128[1]	12
Rival	S	1, 2, 3, 5, 9, 11, 15, 20, 28, 58, 90	10, 12, 14, 16, 17, 18, 21, 31, 33, 35, 49, 52, 61, 93, 107, 126, 128
Henry	S	1, 2, 3, 5, 7, 9, 10, 11, 12, 14, 15, 16, 20, 21, 26, 28, 33, 43, 49, 58, 61, 90, 91, 107, 126	17, 18, 31, 35, 52, 77, 93, 126, 128
Thatcher	S	44	1, 2, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 20, 21, 26, 28, 31, 33, 35, 40, 43, 49, 50, 52, 60, 61, 64, 77, 90, 91, 93, 107, 126, 128
Timstein X New Thatcher	HR	1, 2, 3, 5, 7, 9, 11, 12, 13, 14, 15, 16, 21, 28, 31, 35, 43, 52, 58, 90, 93, 107, 126, 128	
Carleton	HS	1, 2, 3, 5, 7, 9, 10, 11, 13, 14, 15, 16, 17, 18, 20, 21, 28, 31, 33, 35, 49, 52, 77, 90, 93, 126	12, 58, 61, 107, 108
Mindum	R	1, 2, 5, 7, 9, 10, 11, 13, 15, 16, 17, 18, 20, 21	3, 12, 14, 61, 90, 107, 128
Stewart	HS	2, 5, 10, 13, 20, 26, 28, 31	1, 3, 7, 9, 11, 12, 14, 15, 17, 18, 21, 33, 35, 49, 52, 58, 61, 77, 90, 93, 107, 126, 128

1. Figures indicate the numbers of physiologic races.

Based on the above results, the following conclusions may be drawn:

1. A part of the physiologic races of leaf rust found in Taichung area, Taiwan, may consist of some races which do not exist in the Spring Wheat Region of the U. S. A.

2. Among 45 races of leaf rust, a) the races 3, 12, 14, 61, 90, 107 and 128 do not exist in Taichung, Taiwan, and b) one or a part or all of the races of 1, 2, 5, 6, 7, 9, 10, 11, 12, 13, 15, 16, 17, 18, 20, 21, 26, 28, 31, 33, 35, 40, 43, 45, 50, 58, 64, 77, 91, 93 and 126 may exist in Taichung, Taiwan.

B. Inheritance of Rust Resistance

According to the test of varietal resistance to rust reported in former paragraph, the strain of "Timstein X New Thatcher" was recognized as the most suitable rust-resistant material for the wheat breeding program of Taiwan because of its high resistance to both leaf and stem rusts and its relatively early heading time which makes the cross with wheat varieties of Taiwan easily possible.

The cross combination of "Taichung Wheat No. 31 X (Timstein X New Thatcher)" was used as the material of genetic study.

The F_1 plants obtained from the above mentioned cross showed complete resistant to leaf rust while susceptible to stem rust.

Eighty F_2 plants were tested for their rust reactions at the diseased field under favorable environmental conditions for rust development. Observation was made and the degree of rust infection on each plant was recorded according to the classification of rust resistance described above. The result is shown in the following table.

Reaction	Number of plant
Resistant to leaf rust but susceptible to stem rust	43
Resistant to both leaf and stem rusts	25
Susceptible to both leaf and stem rusts	10
Susceptible to leaf rust but resistant to stem rust	2

This result shows evidently that the resistance to leaf rust is governed by one pair of dominant genes, then another pair of independent recessive genes controls the resistance to stem rust. Resistance to leaf rust showed 3:1 ratio to susceptible with 20–30% probability of X^2 (1.60), and, on the contrary, 1:3 ratio was obtained for resistant against susceptible to stem rust with 20–30% probability of X^2 (1.250). The result of further study on F_3 conforms this conclusion.

IV. Breeding of Rust Resistance

A. Material and Method

(Timstein X New Thatcher) has been used as the resistant parent to cross with the local wheat varieties, Taichung No. 31 and No. 32, since 1953. The methods of testing resistance and its classification used were same as explained above.

Pedigree and backcross methods have been used in this breeding program.

In pedigree method, 1,500 individuals were planted in F_2 generation in 1955, then lines were established after F_3 generation. Thereafter, the plants which showed high rust-resistance and possessing desirable agronomic characters were selected from each generation.

Backcross method, in which Taichung No. 31 was used as the recurrent parent, was employed alternately with selfing. At least more than fifty seeds were obtained from each backcross. Three times of backcross was completed in the year of 1958 and the progenies were tested for resistance.

B. Strain Selection

Two strains from pedigree program and ten from backcross program have been selected in their homozygous status. They are all of high rust-resistant varieties with excellent agronomic characters.

C. Regional Test at Taichung Area

Local test, in which five-row plots with three replicate design was used, was carried out in 1959 in order to study the local adaptability and rust-resistance of 4 newly established strains in different localities.

Table 5. Test of Adaptability and Rust Resistance in Different Localities of Taichung Area, Taiwan

Variety	Lungching		Neipu		Fuhsing		Hsilo		Yuanli		% of yield
	L(c)	S(d)	L	S	L	S	L	S	L	S	in average
Taichung Strains											
No. 137(a)	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	100.4
No. 138(a)	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	104.6
No. 140(a)	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	95.9
No. 141(a)	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	108.4
Taichung Wheat											
No. 23(b)	MS	MS	HS	MR	HS	MS	MS	MR	MS	MS	87.0
No. 31(b)	MR	MR	MS	MR	HS	MS	MS	MR	MS	MS	100.0
No. 32(b)	MR	MR	HS	MR	HS	MS	MS	MR	MS	MS	90.6

Remarks: (a) Newly established resistant strains from pedigree method
(b) Common commercial varieties in Taichung area, Taiwan
(c) Reaction to leaf-rust
(d) Reaction to stem-rust

The above table indicates that these newly established strains are highly resistant to both leaf and stem rust at all tested localities in Taichung area, and consequently the yield was higher than local commercial varieties compared.

V. Summary

A. Great difference in resistance to leaf and stem rust was found among the 346 wheat varieties introduced from the United States and other countries in Taichung area of Taiwan. Among the introduced resistant varieties, Timstein X New Thatcher, which has a relatively early heading date, was selected to cross with two local leading wheat varieties, Taichung No. 31 and No. 32, to develop new resistant wheat for growing in Taichung area, Taiwan.

B. Resistance to rusts was tested under natural condition. Rust epidemics were induced by planting in a special locality where rust outbreaks were most frequent and by late sowing, heavy nitrogen fertilizer application and frequent irrigation.

C. Through pedigree selection and selfing and backcrossing of the progenies of the crosses, four new strains in homozygous state were selected. The four strains were highly resistant to both leaf and stem rust in five localities tested in Taichung area. The four new strains are stable, early maturing to suit local rotation system and yield better than old varieties.

D. Reaction of the test varieties used in Spring Wheat Region of America in Taichung indicated that some physiological races existing in Taichung area are absent in the States and some, vice versa.

E. Genetical analysis of the resistance in the progenies indicated that resistance to leaf rust is governed by a single pair of dominant genes and to stem rust, by a single pair of recessive genes. Combination of backcrossing and selfing of the progenies is therefore employed to introduce the rust resistance to established varieties.

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SEED MULTIPLICATION, CERTIFICATION AND DISTRIBUTION OF WHEAT IN TAIWAN

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I. Introduction

Wheat is grown in Taiwan principally as a winter crop between two crops of paddy rice. It is planted in late October or early November just before or after the harvesting of the second rice crop. Harvesting is done in March before the transplanting of the first rice crop in the following year. Some plantings are made on dryland area following the harvesting of sweet potato or peanuts in the fall.

The main wheat producing regions in Taiwan are confined to a few prefectures in the central part of the Island. About 83 percent of the total acreage are found in Taichung Prefecture, Changhwa Prefecture and Taichung City, whereas wheat in all other prefectures constitutes the remaining 17 percent. Following the extension of the Sankuo soybean variety in northern prefectures, wheat is planted in Miaoli, Hsinchu and Taoyuan after the harvesting of soybean in the fall. The wheat acreage projected for different districts in 1959 may be shown in the following table:

District	Prefectures	Acreage (ha.)	% of the total
Northern district	Taoyuan	150	7.0
	Hsinchu	200	
	Miaoli	1,500	
Central district	Taichung City	3,000	83.3
	Taichung	10,000	
	Changhwa	9,000	
	Nantou	100	

Southern district	Yunlin	1,500	7.9
	Chiayi	400	
	Tainan	200	1.8
Eastern district	Taitung	300	
	Hwalien	150	
Total		26,500 ha.	100.0%

In previous years, wheat in Taichung and Changhwa was mostly interplanted in paddy fields about 10 to 15 days prior to the harvesting of the second rice crop. No or very little soil preparation and seedbeds were made before planting, and seeds were broadcast in most cases directly in the ripening paddy fields. As a result, the yield was generally very poor. Recently, with the development of early maturing varieties of Ponlai rice such as Taichung 65, 150, 155, 175, 178, 179, etc., farmers begin to plant wheat after rice is harvested and soil prepared, and to narrow seedbeds of about 100 cm. in width. In Tainan, Chiayi and Yunlin, where wheats are grown primarily on dryland area, seeds are sown to the soil after sweet potato or peanuts are harvested.

During the past few years, with the improvement of cultural practice, distribution of good seeds, and in absence of serious disease epidemic, the yield of wheat has steadily increased. The average yields per hectare since 1955 are above 1,500 kg., which are higher than the highest prewar record of 1,396 kg. per ha. in 1903. Wheat production in Taiwan during past few years is shown in the following:

Year	Acreage (ha.)	Production (m. t.)	Yield per ha. (kg.)
1903	3,559	4,970	1,396
1945	2,548	753	296
1953	13,506	14,288	1,058
1954	11,089	15,493	1,397
1955	12,843	19,304	1,503
1956	15,615	27,099	1,735
1957	19,943	36,129	1,812
1958	22,470	39,741	1,769

From the above table, it may also be seen that the acreage of wheat in Taiwan has been significantly increased since the adoption and enforcement of the First and Second 4-year Agricultural Development Plans respectively in 1953 and 1957. The local annual requirement of wheat every year, at present, is between 200,000 and 240,000 metric tons. Only about one-fifth to one-sixth of the above amount is provided locally, while a large portion is imported. With further improvement on wheat varieties, change on cropping systems following the extension of soybean in northern and eastern prefectures, and further development of irrigation projects in Changhwa, Yunlin, Chiayi and Tainan Prefectures, wheat acreage and production in Taiwan can be substantially increased.

II. Taiwan Wheat Varieties

A. Wheat Varieties for Paddy Fields

The common wheat varieties for paddy fields in Taichung, Changhwa, Yunlin, Taitung, Miaoli, Hsinchu and Taoyuan are Taichung 2, 23, 29, 31 and 32, of which Taichung 31 is most popular, accounting for about 70 percent of the total. All Taichung wheats are improved varieties with early maturity, developed by the Taichung District Agricultural Improvement Station through cross breeding between Japanese and other foreign wheat varieties. The variety census in recent years is approximately as follows:

Variety	Acreage %
Taichung 31	70
Taichung 29	17
Taichung 32	5
Taichung 2 } Taichung 23 }	8
Total	100%

The origin and characteristics of the Taichung improved varieties are indicated in the table below:

Variety	Parentage	Days to maturity	Resistance to rusts	Yield per ha.[1] (kg.)
Taichung 2	Saitama 27×Showa wase	114	Moderate	2,218
Taichung 23	Florence×Saitama 27	105	Moderate	1,897
Taichung 29	Saitama 27×Showa wase	107	Resistant	1,965
Taichung 31	Showa wase×Saitama 27	109	Intermediate	1,998
Taichung 32	Florence×Saitama 27	113	Moderate	2,230

[1] Average of 5-year comparative tests at Taichung.

All the above Taichung varieties are very good in quality, Taichung 31 being more popular than the others because of its wide adaptability in Taichung and

Changhwa areas. However, none of them is highly resistant to leaf or stem rusts. In a year when no rust epidemic occurs, they may give a very good yield, but during a serious epidemic, the loss may be very severe. The following experimental data obtained by Mr. K. M. Lin of the Taichung District Agricultural Improvement Station may be used to illustrate this point:

Yield of Wheat Affected by Rust Infection in Taichung and Fuhsing in February 1959

Locality	Degree of rust development	Variety	Yield (kg./ha.)
Taichung	Weak rust development	Taichung 31	2,892
		Taichung 32	3,281
Fuhsing	Heavy rust development	Taichung 31	1,700
		Taichung 32	1,075

Since all commercial wheat varieties on paddy fields in Taiwan are more or less susceptible to rusts, breeding for disease resistance has become the main objective in the present wheat varietal improvement program. Since 1953, the Taichung District Agricultural Improvement Station has made a number of crosses using known resistant varieties such as New Thatcher, Timstein, Selkirk with the local commercial varieties. At least four new strains obtained from the original cross between (Timstein × New Thatcher) and Taichung 31 have been found to be more rust resistant than Taichung 23, 31 or 32. These four strains were developed after alternate backcrossing and selfing for three times to the Taichung 31 following initial crossing between (Timstein × New Thatcher) and Taichung 31 in 1953. Preliminary regional tests conducted at five localities in Taichung area in 1959 are presented in the following for reference:

Rust Resistance and Yield of Four New Strains of Wheat Conducted at Five Localities in Taichung Area in 1959

Variety	Lungching		Neipu		Fuhsing		Yuanli		Hsilo		% of yield in average
	L	S	L	S	L	S	L	S	L	S	
New strains											
No. 137	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	100.4
No. 138	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	104.6
No. 140	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	95.9
No. 141	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	108.4

Taichung wheat											
No. 23	MS	MS	HS	MR	HS	MS	MS	MS	MS	MS	87.0
No. 31	MR	MR	MS	MR	HS	MS	MS	MR	MS	MS	100.0
No. 32	MR	MR	HS	MR	HS	MS	MS	MR	MS	MS	90.6

L=leaf rust, S=stem rust, HR=highly resistant, HS=highly susceptible, MR=moderately resistant, MS=moderately susceptible

The yield of the new strains may not be significantly higher than that of the Taichung No. 31, but under serious disease conditions, the difference will be very great and the new strains will yield much higher than the Taichung wheat varieties.

B. Wheat Varieties for Dryland Areas

The wheat varieties grown on dryland areas in Yunlin, Chiayi and Tainan are native varieties. They have become rather mixed and are very poor in yield. As a result, the acreage of native wheat varieties has been considerably decreased and, at present, less than one thousand hectares are planted in the above three prefectures. Except in a part of Yunlin near Changhwa, where Taichung 31 is grown on paddy fields, none of the Taichung wheat varieties is adapted on dryland areas becuase they are not tolerate to the winter drought in that area. For this reason, the Tainan District Agricultural Improvement Station collected in 1952 over 1,400 heads of native varieties from farmers' fields in Tainan area, and, through pure line selection, selected two new varieties, Tainan Nos. 2 and 3. These new varieties have a longer maturing period than the Taichung wheats of the central districts, but are adaptable for dryland planting in the southern part. They were tested at three localities in Tainan and Chiayi in 1954 to 1956 and again at six localities in 1958. Field results are summarized in the following two tables·

Yield of Two New Dryland Wheat Varieties at Three Places in 1954–1956

(Average of 3 years' data)

Variety	Days to maturity	Yield per ha. (kg.)				
		Tainan	Hsiehchia	Yichu	Average	Index
Tainan 2	150	1,873	1,955	2,350	2,059	143.0
Tainan 3	139	2,039	1,971	2,096	2,035	141.4
Native	143	1,423	1,327	1,569	1,440	100.0

Yield of Two New Dryland Wheat Varieties at Six Places in 1958

Variety	Tainan Prefecture			Chiayi Prefecture			Average (kg./ha.)	Index
	Hsiehchia (kg./ha.)	Peimen (kg./ha.)	Chiku (kg./ha.)	Yichu (kg./ha.)	Tungshih (kg./ha.)	Putai (kg./ha.)		
Tainan 2	2,094	2,028	2,759	2,755	1,983	1,746	2,227.5	124.5
Tainan 3	2,148	2,130	2,760	3,072	2,392	1,941	2,407.1	134.5
Native	1,704	1,782	2,134	1,951	1,733	1,434	1,790.0	100.0

Of these two new dryland varieties, Tainan 2 matures earlier than the native variety of the southern part, but Tainan 3 is about a week later. Both of them yielded 30 to 40 percent higher than the native wheat with Tainan 3 a little better than Tainan 2.

III. Wheat Seed Multiplication

Wheat seed multiplication work in Taiwan has been carried out by the Taiwan Provincial Department of Agriculture & Forestry (PDAF) since 1950. The system consists of three levels, e. g. foundation, stock and extension seed farms, with the production of extension seeds in the third year, and has produced fruitful results. It not only keeps the planting wheat varieties pure, but also furnishes the farmers with good quality seeds. Seed quality is important for wheat is grown in Taiwan only once a year and the seeds have to be stored through a period of some 9 months through hot and humid weather. At present, no seed multiplication work is done for native wheat varieties and the multiplication of improved varieties is confined primarily to Taichung Wheat Nos. 31, 32 and 29. The operation of wheat seed multiplication system may be briefly outlined in the following:

A. Foundation seed farms in the first year — The foundation seed farms are established at and operated by the District Agricultural Improvement Stations at Taichung and Taitung and recently by the Tungshih Seed and Seedling Multiplication Station at Taichung Prefecture. Breeders' seeds for planting foundation seed farms are either supplied by the Taichung District Agricultural Improvement Station or carefully selected from their own multiplied seeds by the operating agencies themselves. Any off-types or weeds present in the fields are carefully eradicated to ensure varietal purity. Plants after heading are sprayed with dithane at least twice to prevent the infection of rusts which usually occur in late January or early February if weather favors rust development. Seed sowing is made in late October or early November after the land is prepared following the harvesting of rice or sweet potato and peanuts in the fall and made into narrow seedbeds of 50 to 100 cm.

in width. Seeding rate is 60 kg. per ha. with the output of 900 kg. of pure foundation seeds per ha. after processing and screening. This is enough to multiply 16 ha. of stock seed farms in the following crop year. Wheat varieties multiplied at the foundation seed farms in the fall of 1958 are shown in the following:

Location of foundation seed farms	Wheat varieties multiplied	Projected acreage (ha.)	For stock seed farms at
Taichung DAIS	Taichung 29	0.80	Taichung, Yunlin Prefectures and Taichung City
	Taichung 31	1.00	
	Taichung 32	0.20	
Tungshih Station	Taichung 31	2.00	Miaoli, Taichung and Changhwa Prefectures
Taitung DAIS	Taichung 32	0.10	Taitung Prefecture
Total		4.10	

B. Stock seed farms in the second year — These stock seed farms are established at the prefectural level and are, at present, operated by the prefectural farmers' associations in Miaoli, Taichung, Changhwa, Nantou, Yunlin and Taitung Prefectures. In case stock seed farms are operated by farmers contracted by the associations, the farmers are carefully selected. They are usually the ones who have made good records in the past. Field preparation and seeding rate are similar to foundation seed farm, except the minimum seed output of stock seeds is set at 1,000 kg. per ha. Varietal purity and disease control are equally emphasized and any field which does not meet the certification standards will be disqualified for seed. Seeds from stock seed farms must be sold to township farmers' associations after inspection and certification, and will be kept, stored and distributed to extension seed growers in different townships when next crop season comes.

C. Extension seed farms in the third year — The extension seed farms are established at different wheat producing townships and operated by contract farmers under the supervision of the township farmers' associations. Stock seeds are bought by the township farmers' associations and distributed to contracted farmers for seeding the extension seed farms. Field preparation, seeding rate and disease control are similar to foundation and stock seed farms and the minimum seed output is also set at 1,000 kg. per ha. after screening and processing. The extension seeds, after inspection and certification, are sold or loaned to the farmers for general planting in the next crop season.

Although the whole wheat seed multiplication system from foundation to extension seed farms takes a period of three years to complete a cycle, actually it is a continuous process and every type of seed multiplication farms is operated by different responsible agencies in every crop season. The whole wheat seed multiplication system now practised in Taiwan may be summarized in the following diagram:

Level of seed farms	Operating agencies	Seeds supplied by	Seeds distributed to
Foundation seed farms	District agricultural improvement stations and Tungshih Seed & Seedling Multiplication Station	Taichung District Agricultural Improvement Station or by operating agencies themselves	Stock seed farms in prefectural level
Stock seed farms	Prefectural farmers' associations and contract farmers	District agricultural improvement stations and Tungshih Seed & Seedling Multiplication Station	Extension seed farms in township level
Extension seed farms	Township farmers' associations and contract farmers	Prefectural farmers' associations	General farmers

Acreage and amount of wheat seeds multiplied since the establishment of first foundation seed farms in 1950 in Taichung may be summarized in the following table:

Year	Foundation seed farms		Stock seed farms		Extension seed farms	
	Acreage (ha.)	Production (kg.)	Acreage (ha.)	Production (kg.)	Acreage (ha.)	Production (kg.)
1950	10.00	7,587	—	—	—	—
1951	10.00	10,336	100.00	80,496	—	—
1952	10.00	14,857	96.65	66,807	852.14	616,462
1953	6.40	4,976	71.45	92,180	724.12	791,251
1954	6.00	8,212	49.07	73,295	565.36	800,073
1955	5.30	6,250	51.50	87,082	504.40	711,615
1956	5.00	4,320	50.00	94,273	507.42	809,102
1957	4.12	8,350	40.30	84,996	482.73	941,187
1958	4.10	6,127	46.74	98,233	592.98	1,169,015

Wheat varieties multiplied: Taichung Nos. 2, 23, 29, 31 and 32, with multiplication of Taichung 2 and 23 terminated since 1957.

The production of 1,169,015 kg. of extension seeds in 1958 will be enough for extension of nearly 20,000 hectares in 1959 on the basis of 60 kg. of seeding rate per ha. This is about four-fifths of the total acreage of wheat projected for 1959. The seeds for the remaining one-fifth will have to be provided by the farmers themselves.

IV. Inspection and Certification

For wheat seed multiplication farms, one field inspection is made when the crop is fully headed. At that time, no off-type plants or varietal mixtures should be present in the fields. All barnyard or other noxious weeds are already removed and cleaned. After seeds are harvested, two seed inspections are made, one at about one month after harvesting and the other at just before the distribution of seeds in next planting season. Field and seed inspection of wheat are carried out, at present, by the following agencies designated by Provincial Department of Agriculture & Forestry.

A. Foundation seed farms—By Provincial Department of Agriculture & Forestry and Taichung District Agricultural Improvement Station or other experiment stations if necessary.

B. Stock seed farms—By Taichung and Taitung District Agricultural Improvement Stations with the help of prefectural farmers' associations.

C. Extension seed farms—By prefectural and township farmers' associations with spot checks by the Taichung and Taitung District Agricultural Improvement Stations.

The inspecting agencies should submit reports to Provincial Department of Agriculture & Forestry and operating agencies within five days after inspection. Disqualified fields or seeds are rejected for further multiplication or extension to farmers. Notification of the cases should be made by the operating agencies to contract farmers at the earliest possible time.

V. Wheat Seed Certification Standards

Seed certification standards for wheat were worked out in 1957 after the closing of the First Far East Seed Improvement Conference held in Taiwan in 1956. These certification standards were put into practice for the first time in 1958. The wheat seed certification standards adopted in Taiwan may be presented hereunder for reference:

A. Some General Requirements

1. Wheat varieties to be multiplied must be the ones recommended by experiment stations, and at each seed farm, only one variety is multiplied.

2. Seed multiplication farms should be separated at least 3 meters from other wheat fields. This separation may be done by planting extra rows of the same wheat variety outside of the seed multiplication farms or planting plants of other crops as guard rows.

3. Drying of seeds should be done on cement ground where no wheat seeds of other variety have been dried before it, otherwise it should be thoroughly cleaned so as to avoid varietal admixtures.

4. Seeds of two different varieties are not to be stored in the same bin unless they are respectively packed in separate sacks.

5. Storage bins or seed granaries must be cleaned and inspected before seeds are put in. This measure is taken also to avoid varietal contaminations.

B. Field Standards

Factor	Maximum permitted in each level of seed farms		
	Foundation	Stock	Extension
Other varieties	0.5%	1.0%	5.0%
Diseases	None	None	None

C. Seed Standards

Factor	Standards		
	Foundation	Stock	Extension
Varietal purity (minimum)	100%	100%	98%
Foreign matters (maximum)	0.3%	0.5%	1.0%
Moisture content (maximum)	11%	11%	13%
Germination (minimum)	90%	85%	80%
Wt. per 1,000 seeds	(see below)		

D. Minimum Weight per 1,000 Seeds

Taichung No. 29	37.0 gm.
Taichung No. 31	35.0 gm.
Taichung No. 32	38.0 gm.

Results of field and seed inspection made in 1958 are presented in the following:

Field/seed inspection	Foundation seed farms	Stock seed farms	Extension seed farms
Field inspection			
(1) Total acreage inspected (ha.)	4.10	47.84	—
(2) Acreage meeting certification standards (ha.)	4.10	45.17	—
(3) Acreage disqualified (ha.)	None	2.67(5.6%)	—
Seed inspection			
(1) Total amount of seeds inspected (kg.)	5,301	60,245	698,700
(2) Amount of seeds meeting certification standards (kg.)	5,301	56,785	682,600
(3) Amount of seeds disqualified (kg.)	None	3,460 (5.74%)	16,100 (2.30%)

From the above table, it may be seen that, of the total stock seed farms established in 1958, 2.67 ha. or about 5.6% were disqualified. This was due primarily to bird damage and poor field management. In seed inspection, about 5.74% of stock seeds and 2.30% of extension seeds were disqualified. These were due to high moisture content of seeds and poor germination percentage.

VI. Processing, Storage and Distribution

At the time of harvest, which begins usually from late February to early March, wheats from qualified fields are harvested in bundles, and threshed with a foot pedal thresher. Wheat grains will then be sun-dried on cement drying ground, and when they are sufficiently dried, they are fanned with a winnower to separate the chaff from grains. Several dryings are necessary, until the moisture of grains comes down below 11 percent in case of foundation and stock seeds and 13 percent in case of extension seeds. A seed inspection will be made about one month after harvesting, and those meeting the certification standards are kept for seeds.

The certified seeds, after being properly labelled, are stored in wooden bins installed inside wheat seed granaries, each bin being about 2.4m. × 1.06m. × 2.7m. and able to store approximately 2,400 kg. of pure wheat seeds. The bin is built of wood lined with aluminum sheet inside to keep out moisture, insects and rats. Each individual wooden bin has a lit on top for putting in pure seeds and an outlet near the base at the front side for letting out seeds. Usually, there are a series of 4 or 5 bins installed together in the same granary to store seeds of different varieties. These bins are built about 30 cm. above ground level in order to prevent the dampness arising from the earth. Foundation seeds are kept by the district agricultural improvement stations and Tungshih Seed & Seedling Multiplication Station, while stock and extension seeds are kept by township farmers' associations.

To provide facilities for drying and storage, JCRR has, during past years, given subsidies to 600 stock and extension seed growers in Taichung, Changhwa and Miaoli Prefectures to construct 600 units of cement drying grounds each of 60m.^{2} in size, for drying wheat seeds. In addition, JCRR has contributed part of the money to the farmers' associations in these three prefectures to construct 16 wheat seed granaries, 11 of these which have each a floor area of 121.3m.^{2} with a capacity of holding 64,000 kg. of seed and 5 of 96.7m.^{2} with a capacity of 48,000 kg. As the wheat acreage in Taiwan will be considerably enlarged in the years to follow, JCRR has appropriated another sum of NT$3,518,200 in 1959 budget for constructing 24 more of wheat seed granaries in Miaoli, Taichung, Changhwa, Nantou, Yunlin, Tainan and Taitung, each ranging from 106m.^{2} to 160m.^{2}, having a total capacity of holding 1,680 metric tons. When all these 24 new seed granaries are completed, Taiwan will have 39 wheat seed granaries of various sizes at different districts with a total holding capacity of approximately 2,400 metric tons of seeds, enough for planting 40,000 hectares of wheat each year.

Distribution of wheat seeds from different seed multiplication farms are carried out in the following manner:

A. Seeds produced from the foundation seed farms operated by the Taichung, Taitung and Tungshih Stations are distributed through the prefectural farmers' associations to the stock seed growers free of charge.

B. Seeds produced from the stock seed farms are purchased by township farmers' associations at market price after harvesting, drying and certification. These seeds are stored in tight bins of the wheat seed granaries with labels. If the farmers' associations are not able to purchase all of seeds with their own fund, the Provincial Food Bureau will buy and preserve the seeds for them. Prior to planting time, these seeds are sold or loaned to the extension seed growers.

C. Seeds produced from the extension seed farms are distributed to farmers in exchange for common wheat grains or cash. Farmers will either pay cash or barter in kind with a 10 percent premium for the extension seeds. In case farmers do not want to exchange their seeds until wheat planting time, Provincial Department of Agriculture & Forestry will make special arrangement so that the seeds will be bought either by Provincial Food Bureau or by township farmers' associations at 10 percent premium price. The seeds will then be sold or loaned to ordinary farmers at the planting time.

The present wheat seed multiplication and distribution system has run quite smoothly because wheat planting in Taiwan is confined to one crop a year and many farmers are still unable to keep the quality of seeds in their own storage. Furthermore, as the wheat acreage enlarges, more seeds will be needed. On the other hand, there is the possibility that many of the township farmers' associations which are in charge of the wheat seed multiplication farms will not be able to appropriate enough funds at the time of harvest to purchase all seeds from stock and extension farm growers in the future unless the Provincial Food Bureau can provide the funds. Means of financing an enlarged program is under study.

VII. Distribution of Seed Improvement Information to Farmers

To implement the wheat seed multiplication and distribution system, the following methods have been used by Provincial Department of Agriculture & Forestry and their operating agencies to disseminate seed improvement information to the farmers.

A. Publication of extension circulars on wheat—Extension circulars on wheat varieties, cultural method, seed production, seed storage, etc., have been published by the Provincial Department of Agriculture & Forestry and the Taichung District Agricultural Improvement Station.

B. Posting of signboards on seed multiplication farms—Usually at each seed multiplication farm, a signboard is posted. On the board, the type of seed farms, name of variety, name of seed grower, name of sponsoring agency and date of planting are written. Farmers in nearby regions can easily read the information from the signboard and go to the seed growers or to the sponsoring agencies asking for detail information or for exchange of seed material.

C. Establishment of cultural demonstration plots—Each year, 30 to 40 cultural demonstration plots are established at the wheat growing localities to show the proper cultural method on wheat. These demonstration plots are operated by contract farmers under the supervision of the district agricultural improvement stations and the prefectural and township governments. Usually, before planting is made, training classes are held at different townships to explain the method of culture. At these meetings, all requirements for seed production are emphasized.

D. Holding of field visits and contests—At the time of harvest, field visits will be held for farmers from nearby regions to visit the seed multiplication and demonstration plots. Contests will be held among seed growers and the best growers will receive prizes or rewards from Provincial Department of Agriculture & Forestry or local prefectural governments. This promotes the interest of seed farm operators to do a good job on seed production.

VIII. Government Subsidy for Wheat Seed Multiplication Work

Since the establishment of wheat seed multiplication and distribution system, Joint Commission on Rural Reconstruction and Provincial Department of Agriculture & Forestry have given the following subsidies to the operating agencies for seed multiplication work;

A. Subsidy for multiplication of foundation seeds—Foundation seeds are multiplied by the Taichung and Taitung District Agricultural Improvement Stations and recently by the Tungshih Seed & Seedling Multiplication Station at Taichung Prefecture. These seeds are distributed to stock seed growers free of charge. The operating agencies are provided, however, in their annual budget an appropriation of NT$3,000 per ha. to cover the operating expenses. The annual total budget for this item is about NT$12,000 to NT$14,000.

B. Subsidy for multiplication of stock seeds—The stock seeds are sold to township farmers' associations at the market price. They are distributed then to different townships for establishing extension seed farms. However, in order to encourage the stock seed growers in operating the stock seed farms, the growers are given a cash subsidy of NT$300 per ha. The total annual budget for this item is about NT$15,000 at present. No subsidy is given to extension seed growers for extension seeds, for extension seeds are paid by the farmers with a 10 percent premium at the time of distribution.

C. Subsidy for material and labor for seed certification—Since the enforcement of seed inspection and certification system in 1958, an appropriation has been made by Joint Commission on Rural Reconstruction to assist operating agencies in conducting field and laboratory tests of multiplied seeds. The budget for this item was only NT$4,000 in 1958, but it will become considerably larger as more seeds will be subject to certification when the acreage of wheat is increased.

D. Subsidy for establishing demonstration plots—A subsidy of NT$300 per ha. has been given to contract farmers for setting a demonstration farm. In the past years, 40 demonstration farms on wheat cultural method have been established every year. The annual budget for this item is totalled at NT$12,000.

E. Subsidy for holding training classes and farmers' visits—Joint Commission on Rural Reconstruction has given as subsidies NT$500 for each training class and NT$500 for each farmers' visit group. The total annual budget for these two items is about NT$30,000 for the whole province. This budget is appropriated because it has been found that the holding of training classes and farmers' visits is the most effective way in extending the seed and crop improvement information to the farmers.

F. Subsidy for publication of extension circulars—To facilitate the dissemination of seed and crop improvement information to farmers, extension circulars on wheat are published by Provincial Department of Agriculture & Forestry and the district agricultural improvement stations. Annual expense for this item is about NT$15,000.

G. Subsidy for supervision and travelling expenses—To strengthen the seed supervision and certification work, the operating agencies are given supervision and travelling expenses from the Provincial Department of Agriculture & Forestry and the Joint Commission on Rural Reconstruction for their seed multiplication work, although some additions may be needed from their own budget. The total government subsidy for this item is about NT$30,000.

The total budget for wheat seed multiplication work in Taiwan in 1958 was about NT$150,000, toward which, the Joint Commission on Rural Reconstruction contributed about NT$100,000. This did not include the funds needed for procurement of multiplied seeds, which were appropriated exclusively by the township farmers' associations or financed by the Provincial Food Bureau.

PEANUT IMPROVEMENT AND SEED PRODUCTION IN TAIWAN

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I. Introduction

Peanuts (*Arachis hypogaea* L.) have been grown in Taiwan since the late 15th century. It is one of the main dryland crops planted in rotation or interplanted with other field crops such as sugarcane, sweet potato or soybean. It is used for food, feed and oil. With the increase in population in recent years, the demand for peanuts steadily increases. The acreage of peanuts in 1945 just after the War was only 24,626 hectares, but in 1958, it has leaped to 104,704 ha. with an increase of more than fourfold. The peanut varieties grown formerly in Taiwan were all native varieties. Through the efforts of the Tainan District Agricultural Improvement Station and the Taiwan Agricultural Research Institute, improved varieties have been released for commercial planting since 1950. At present, the improved peanut varieties occupy about 35 percent of the total acreage. Through the extension of these varieties, the unit yield has also been significantly increased during the past few years. The trend in production of peanuts is shown in the following table:

Year	Acreage (ha.)	Production (m. t.)	Yield per ha. (kg.)
1945	24,626	11,565	472
1950	83,387	57,110	685
1955	96,034	66,572	693
1956	98,258	81,847	833
1957	103,584	93,714	905
1958	104,744	97,890	935

Peanuts in Taiwan are planted both in spring and fall seasons. Spring planting may start as early as the middle of December or as late as the middle of May, varying with localities. The peak of spring planting is, however, between February and April. The fall crop may be planted in June or as late as November, the main planting period being between July and September. About 60 percent of the peanuts in Taiwan is planted in the spring and 40 percent in the fall.

The main peanut growing regions are in the southern part of the Island. Of 104,744 hectares planted in 1958, 39,690 ha., 9,544 ha. and 6,892 ha. are in Yunlin, Chiayi and Tainan Prefectures, respectively. These three prefectures constitute more than one half of the total acreage. The geographical distribution of the peanut based on 1958 data may be shown by the following table:

Locality	Acreage (ha.)	Percentage (%)
Taipei and Ilan district	3,366	3.2
Hsinchu crop district	6,235	6.0
Taichung crop district	13,798	13.2
Tainan crop district	57,041	54.5
Yunlin Prefecture	(39,690)	(37.9)
Chiayi Prefecture	(9,544)	(9.1)
Tainan Prefecture	(6,892)	(6.6)
Tainan City	(915)	(0.9)
Kaohsiung crop district	5,857	5.5
Eastern Taiwan	15,515	14.8
Penghu Prefecture	2,932	2.8
Total	104,744	100.0

II. Taiwan Peanut Varietal Improvement

A. The Native Varieties

The native peanut varieties were believed to have been introduced to Taiwan by the early settlers from Fukien and Kwangtung even before the occupation of Taiwan by Chinese General Koxinga in 1662. In 1900, there were 11,600 hectares of peanuts planted with a production of about 6,000 metric tons. At present, the native varieties still occupy about 65 percent of the total acreage. Of these native varieties, 95 percent is of the Spanish type and 5 percent of the Virginia type. Peanuts of the Spanish type are erect in growth habit, small seeded, thin shelled, mature generally in 4 months and have no seed dormancy. Those of the Virginia type are characterized by their prostrate growth habit, comparatively dark green leaf color, large seeds, thick shells, late maturity and dormancy of seeds. The prostrate or runner type is planted primarily in Penghu Prefecture and in the area along the west sea coast of Changhwa, Yunlin and Tainan Prefectures, where heavy wind prevails. It seems to stand better than the Spanish type under drought conditions, but because of its late maturing habit and dormancy of seeds, the Virginia type of peanuts is planted only one season in a year instead of two seasons as the Spanish type. Some common native varieties of the Spanish and Virginia types are:

Spanish type	Virginia type
Native Pei-yu-tou	Ta-pon
Lao-kung-tze-tou	Fan-tzu-tou
Lung-yen-tou	Yuan-yang-tou (small seeded)
Liu-tsu-tou	Chu-chih-tzu-tou (erect)
Red and white kernel tu-tou	

B. The Improved Varieties

At present, at least five improved varieties have been released for commercial planting and two more are added in the seed multiplication list in 1959. The total acreage occupied by the improved varieties is about 35,000 hectares or approximately 35 percent of the total.

1. Extension of Tainan Pei-yu-tou Nos. 1, 2 and 5 in 1950:

These three varieties are the first improved varieties of peanuts released for commercial planting in Taiwan. They were selected from the native Pei-yu-tou by pure line selection by the Tainan District Agricultural Improvement Station in 1927. Yield trials conducted between 1935 and 1942 showed that they yielded about 10 to 20 percent higher than the native varieties. However, seeds of these varieties were not multiplied for extension until 1950 when they were released for planting in Yunlin, Chiayi and Tainan Prefectures in the following years.

Their origin and yielding ability are indicated below:

Variety	Origin	Yield per ha. (kg.)		Oil
		Spring crop	Fall crop	(%)
Tainan Pei-yu-tou No. 1	From native Pei-yu-tou grown in Peikang, Yunlin Prefecture	1,589	1,657	57.60
Tainan Pei-yu-tou No. 2	From native Pei-yu-tou grown in Changhwa Prefecture	1,586	1,707	53.81
Tainan Pei-yu-tou No. 5	From native Pei-yu-tou grown in Tungshih near Chiayi Prefecture	1,532	1,467	54.57
Native Pei-yu-tou (check)		1,272	1,444	52.36

Tainan Pei-yu-tou No. 1 has a much wider adaptability than the other two varieties, and at present, about 30,000 hectares are planted in Yunlin Prefecture, and several hundred hectares in Chiayi and Tainan Prefectures. Tainan Pei-yu-tou No. 2 is planted in Yunlin and Hsinchu Prefectures, and a small acreage of Tainan Pei-yu-tou No. 5 is planted in Taichung Prefecture.

2. Extension of Tainung No. 1 and Tsingtao in 1957:

These two varieties were developed by the Taiwan Agricultural Research Institute in 1953. Tainung No. 1 was selected from a variety of peanuts introduced from Huai-yuan Prefecture of Anhwei Province and Tsingtao was introduced from Tsingtao City of Shantung Province in mainland China in 1949. Both of them joined the province-wide regional varietal tests in 1954 and 1955. Result of the tests showed that Tainung No. 1 yielded significantly better than the native varieties and Tainan Pei-yu-tou No. 1 in many places and Tsingtao was especially adapted in Hwalien Prefecture, as may be seen in the following table:

Location	Yield per ha. (kg.)						
	Tainung No. 1	Tsingtao	Tainan Pei-yu-tou No. 1	Tainan Pei-yu-tou No. 2	Tainan Pei-yu-tou No. 5	Native (1)	Native (2)
Taipei	1,503	1,459	1,374	1,338	1,334	1,362	1,329
Hsinchu	1,181	1,141	1,219	1,211	1,218	1,196	1,088
Taichung	1,639	1,587	1,757	1,710	1,834	1,766	1,498
Huwei	1,434	1,264	1,315	1,342	1,346	1,397	1,272
Peikang	1,351	1,310	1,365	1,371	1,375	1,319	1,347
Putze	1,447	1,396	1,432	1,484	1,477	1,282	1,470
Hsinhwa	1,291	1,189	1,241	1,244	1,285	1,153	1,165
Tainan	2,651	2,555	2,748	2,698	2,783	2,550	2,753
Kaohsiung	1,702	1,576	1,576	1,575	1,596	1,469	1,586
Taitung	1,901	1,809	1,820	1,909	1,832	1,891	1,678
Hwalien	3,214	3,086	2,666	2,826	2,795	2,470	2,327
Average	1,756	1,670	1,683	1,701	1,716	1,623	1,592
Index	110.3	104.9	105.7	106.8	107.8	101.9	100

Seeds of Tainung No. 1 and Tsingtao were multiplied in 1956 and extended to the farmers for general planting in 1957. Since then, Tainung No. 1 has been extended to Ilan, Hsinchu, Taichung, Kaohsiung, Pingtung, Taitung and Hwalien Prefectures with an estimated acreage of about 4,500 hectares in 1959. Tsingtao is planted primarily in Hwalien Prefecture and some in Taichung and Kaohsiung Prefectures.

Some of the important characteristics of the five imporved varieties as presented in the foregoing sections 1 & 2 with some native varieties as recently determined by the Taiwan Agricultural Research Institute are shown in the following table:

Variety	Av. yield per ha.[1]	% seeds over pods	Fat (%)	Crude protein (%)	Days to maturity
Tainan Pei-yu-tou No. 1	1,683	65.4	56.8	25.82	120
Tainan Pei-yu-tou No. 2	1,701	63.5	56.6	26.61	120
Tainan Pei-yu-tou No. 5	1,715	65.1	53.5	28.32	120
Tainung No. 1	1,756	63.6	55.4	29.60	120
Tsingtao	1,670	63.0	54.6	24.75	120
Peikang Pei-yu-tou	1,615	66.5	55.1	26.54	120
Taitung Yu-tou	1,643	65.2	54.7	25.93	120
Taitung Da-kung-tou	1,601	65.1	54.8	24.61	120
Lao-kung-tzu-tou	—	—	54.6	25.58	120
Tainan Pei-yu-tou	—	—	54.3	29.22	120
Pingtung Pei-yu-tou	—	—	55.4	26.10	120
Li-chi-tze	—	—	47.3	32.73	140
Yuan-yang-tou	—	—	51.8	22.75	160

[1] Yield data taken from the regional varietal tests conducted in 1954-55.

3. Seed multiplication of Tainan Nos. 6 and 7 in the fall of 1959:

Tainan Nos. 6 and 7 are newer varieties obtained by the Tainan District Agricultural Improvement Station from the crosses made respectively between Peikang Pei-yu-tou and Tainan Pei-yu-tou No. 1 and between Java Small 12 and Tainan Pei-yu-tou No. 1 in 1950. They were put into regional varietal test in 1957 at five localities in Tainan, Chiayi and Yunlin Prefectures, and the yields of these two varieties were in most cases better than that of Tainan Pei-yu-tou No. 1 or Tainung No. 1. The result may be shown in the following:

Variety	Yield per ha. (kg.) in 1957					Average (kg.)	Index
	Tainan	Yungkang	Putze	Peikang	Huwei		
Tainan No. 6	1,858	1,232	1,890	1,909	1,587	1,695	105.6
Tainan No. 7	2,022	1,266	1,826	1,921	1,446	1,696	105.7
Tainung No. 1	1,671	1,164	1,688	1,922	1,186	1,526	95.1
Tainan Pei-yu-tou No. 1	1,865	1,216	1,834	1,807	1,304	1,605	100.0

The above yield data were based on unshelled peanuts. If they were based on shelled seeds, the percentage of increase of the two new varieties over Tainan Pei-yu-tou No. 1 was about 10 percent with Tainan No. 6 and 8 percent with Tainan No. 7. These two new varieties are, therefore, put into seed multiplication list in 1959 and will be extended to farmers for general planting in Yunlin, Chiayi and Tainan Prefectures in 1960.

C. Varietal Improvement Work in Progress

Besides the varieties which have been released for extension or under seed multiplication, many others are now in progress at different stages of testing. They may be briefly grouped into the following few categories:

1. New peanut varieties in regional varietal test:

In addition to Tainan Nos. 6 and 7, there are several others which were put into regional varietal test in 1957 and 1958. These varieties selected according to their past records include the following:

From Tainan DAIS:
- Nankai No. 1
- Nankai No. 3
- Nankai No. 4
- Nankai No. 5
- Nankai No. 6
- Nankai No. 7
- Nankai No. 8
- Nankai No. 10
- Tainan No. 6
- Tainan No. 7
- Tainan No. 8

From TARI:
- P-49B-3
- P-49B-26
- P-49B-51
- P-49B-52
- H-51B-123
- H-51B-166
- H-51B-284
- Kinorales (an introduced variety from the Philippines)

Of the varieties selected by Taiwan Agricultural Research Institute, H-51B-123 seems to be most promising. Preliminary results showed that it yielded about 5 percent higher than Tainung No. 1 or Tainan Pei-yu-tou No. 1.

2. Varieties from pure line selection:

In 1954, JCRR gave subsidies to Taiwan Agricultural Research Institute and Tainan District Agricultural Improvement Station to make single plant selections from the farmers' fields throughout the Island. Altogether, 2,616 single plants and 1,975 seed groups of native peanuts were collected. They were planted in the fall of 1954 at the Tainan District Agricultural Improvement Station. From these materials, the following seven promising lines have been selected. The average yields of these seven lines tested in two seasons in the fall of 1957 and in the spring of 1958 were as follows:

Lines	Average of two seasons (kg./ha.)	Index
TP (B)-3	1,563	113
NT (B)-2	1,560	113

CY (B)-55	1,549	112
YL (B)-20	1,535	111
TP (B)-37	1,507	109
CY (B)-19	1,507	109
ML (B)-47	1,494	108
Tainan Pei-yu-tou No. 1	1,383	100

3. Varieties from foreign introduction:

In the spring and fall of 1957 and in the spring of 1958, 16 varieties introduced from abroad and out-lying islands of Free China were tested at Taipei, Taichung, Tainan and Taitung Prefectures for three seasons. It was found that some introduced varieties yielded better than the local improved varieties. These new varieties are, therefore, selected to be tested with other varieties in the regional varietal test in 1959. The average yield of these introduced varieties in three seasons may be shown in the following for reference:

Varieties	Average yield per ha. (kg.)	Index
Florence Sp.	2,113	95.0
Argentine	2,208	99.3
Spanish 205	1,844	82.9
Spanish 18-38	2,247	101.0
Improved Sp. 2-B-48-1	2,345	105.4
Spanish 18-38-42	1,701	76.5
Dixie Spanish	1,753	78.8
Spain	1,691	76.0
Spanish White	2,611	117.4
Spanish Small	1,890	85.0
Sp. 146-H-48-3	2,110	94.9
Southern Cross	2,222	99.9
Kinorales	2,186	98.3
White Nanking	1,848	83.1
Kinmen Native	2,363	106.3
Tainan Pei-yu-tou No. 1	2,224	100.0

Many peanut varieties of different types have been introduced to Taiwan from various parts of the world. At present, the Taiwan Agricultural Research Institute has 158 varieties and the Tainan District Agricultural Improvement Station has 109. The varieties introduced since 1956 include the following:

a. Introductions from U. S. A. (1956): NC-1, NC-2 and C-37 from North Carolina State College, obtained by Dr. W. C. Gregory from irradiated material.

b. Introductions from Japan (1956): Chiba No. 74, Chiba No. 55, Chiba Semi-erect, Tachi-rakuda No. 1, Sakazuki-sei and Java 13 from Narita Branch Station of Chiba.

c. Introductions from Thailand (1957): Surin and Chiengmai from Tha Phra Experiment Station.

d. Introductions from the Philippines (1959): Native White, Native Brown, Tirik and E. G. Red from College of Agriculture, University of the Philippines.

Some of these introduced varieties such as NC-2 and C-37 have been used for breeding disease resistance and others are under observation tests.

4. Selection of varieties from irradiated material:

In the spring of 1957, two varieties of peanuts, Tainan Pei-yu-tou No. 1 and Tsingtao, each consisting of 10,000 seeds, were sent to the Brookhaven National Laboratory in U. S. A. for X-ray and thermal neutron treatments. Treated seeds were sent back to Taiwan in May of the same year and planted at the Tungshih Seed and Seedling Multiplication Station in Taichung Prefecture under the supervision of Taiwan Agricultural Research Institute. Since then, three irradiated generations have been grown. At R_2 generation, 3,336 strains were selected and of these, 648 strains were found to be fairly resistant to *Sclerotium rolfsii* after artificial inoculation. The other 2,688 strains were found to possess certain good agronomic characters. These selected strains are now in the R_4 generation and further selection will be made in 1959.

5. Breeding for disease resistant varieties:

In Taiwan, *Sclerotium* wilt, *Cercospora* leaf spot and rosette disease are the most serious peanut diseases. None of the commercial varieties grown at present are satisfactorily resistant. Besides the selection of resistant varieties from irradiated material, efforts have been made by the Tainan District Agricultural Improvement Station and Taiwan Agricultural Research Institute to develop disease resistant varieties by crossing the Spanish with the Virginia type, and then to select resistant varieties with the erect or semi-erect characteristics. Introduced varieties such as NC-2 (resistant to *Sclerotium* wilt), C-37 (resistant to leaf spot) and Dixie Giant have been used to cross with Tainan Pei-yu-tou No. 1, Tainung No. 1, Tainan No. 6 and Tainan No. 7. The work is still in progress and it is expected that some varieties selected from these crosses eventually will be more resistant to diseases than the present commercial varieties.

III. Method of Seed Multiplication

A. Recommendation of Peanut Varieties for Seed Multiplication and Extension

Peanut varieties recommended for seed multiplication and extension are based on the performance of the varieties and on the demand of the farmers. This recommendation is usually made at the spring or fall meeting of the Provincial Upland Food Crop Improvement Conference called by Provincial Department of Agriculture & Forestry. At this meeting, all specialists on upland food crops from Provincial Department of Agriculture & Forestry, research experiment stations, district agricultural improvement stations and JCRR will attend and a careful review of all peanut varieties tested or grown at different localities will be made. The best ones and those specifically requested by farmers will be recommended for seed multiplication and extension. The peanut varieties which have been recommended by the meeting and approved by the Provincial Department of Agriculture & Forestry for multiplication during the past two years are shwon in the following table:

Prefecture	Varieties
Ilan	Tainung No. 1
Taipei	Tainung No. 1
Hsinchu	Tainan Pei-yu-tou No. 1 Tainan Pei-yu-tou No. 2
Taichung	Tainung No. 1 Tsingtao
Tainan	Tainan Pei-yu-tou No. 1 Tainan No. 6 Tainan No. 7
Kaohsiung	Tainung No. 1 Tsingtao Yuan-yang-tou (for Penghu)
Taitung	Tainung No. 1
Hwalien	Tainung No. 1 Tsingtao

After the meeting, a list of seed multiplication with the name of varieties, acreage to be planted and amount of seeds to be produced at each prefecture is prepared by Provincial Department of Agriculture & Forestry. This list will be announced later at the Provincial Food Production Conference to be executed by the agencies of different levels concerned.

B. Peanut Seed Multiplication System and Its Operation

Peanut seed multiplication work is carried out by a system which has been established in Taiwan since 1950. It followed the same pattern as used in othei grain crops such as rice and wheat. The system consists of three levels, e. g. foundation, stock and extension seed farms, each one operated by a level of agencies designated by Provincial Department of Agriculture & Forestry. The operation of this seed multiplication system is briefly described in the following:

1. The foundation seed farms. The foundation seed farms are estabished every season at Taipei (Ilan), Hsinchu, Taichung, Tainan, Kaohsiung, Taitung and Hwalien Prefectures at and by the different district agricultural improvement stations. Seed peanuts for the foundation seed farms are supplied either by the district agricultural improvement stations themselves or by the Tainan District Agricultural Improvement Station and Taiwan Agricultural Research Institute, especially those of the newly released varieties. Only one variety is planted in each field; and, if there are several varieties to be multiplied, they will be planted in different fields at specified distance. No foundation seed farm is established on a field where peanuts have been grown in the preceding crop season. In case any distinguishable off-type plant is found in the field, it will be duly eradicated. All these measures are taken to ensure that no varietal admixtures will occur in the multiplied seeds. Seeding rate for peanuts is at the average of 140 kg. of seeds per ha. with an estimated production of seed peanuts of 1,000 kg. per ha. Before planting is made, seeds are treated with a fungicide, Spergon, to prevent from the attack by diseases such as *Sclerotium* wilt. After four or five months of growth, they are harvested, and foundation seeds are distributed to stock seed growers for establishing stock seed farms.

2. The stock seed farms. The stock seed farms are established at the prefectural level under the operation of the prefectural farmers' associations or prefectural governments (as is the case of Yunlin Prefecture) or they may be operated by contract farmers under the supervision of the former. To facilitate supervision and distribution work, stock seed farms established in each crop season are concentrated in one township in a prefecture and then rotated to other township in the next season. Seeds for stock seed farms are supplied by the district agricultural improvement stations with foundation seed peanuts. Seeding rate is same as that for foundation seed farms and all seeds are treated with Spergon before planting. All off-types or diseased plants are rogued from fields before harvest. In case the field is heavily infested with *Sclerotium* wilt or rosette disease, it will be disqualified. Seeds produced are used for establishing extension seed farms the next crop season. The average seed production of stock seed farms is 1,000 kg. per ha.

3. The extension seed farms. The extension seed farms are established at the township level, forming the third or final level of the peanut seed multiplication system. They are operated by contract farmers under the supervision of township farmers' associations or township offices. The extension seed farms are concentrated in one or two townships in a prefecture at each crop season and each extension seed farm is at least 0.5 ha. in size. When peanuts in one township are mostly replaced with new varieties, the extension seed farms will then be moved to other townships. Field practices including disease control are same as those for foundation or stock seed farms. Seeds produced are distributed to farmers for general planting. The average seed production of extension seed farms is 1,100 kg. per ha. after processing and selection.

The whole system as described above may be illustrated by the following diagram:

Seed farms	Operating agency	Average seeding rate (kg./ha.)	Estimated seed output (kg./ha.)
Foundation seed farms	District agricultural improvement stations	140	1,000
Stock seed farms	Prefectural farmers' associations or prefectural governments	140	1,000
Extension seed farms	Township farmers' associations, local township offices or contract farmers	140	1,100

Acreage and seed peanuts multiplied during the past years since 1953 are shown in the following:

Year	Foundation seed farms		Stock seed farms		Extension seed farms	
	Acreage (ha.)	Seed output (kg.)	Acreage (ha.)	Seed output (kg.)	Acreage (ha.)	Seed output (kg.)
1953	10.00	10,000	92.16	92,160	—	—
1954	10.00	10,000	57.00	68,400	—	—
1955	11.05	9,550	47.08	42,850	649.40	542,913
1956	11.00	10,684	67.06	63,960	190.20	190,200
1957	11.25	11,250	76.74	76,930	402.87	448,816
1958	10.70	10,116	59.69	58,741	254.38	246,420

Varieties multiplied: Tainan Pei-yu-tou Nos. 1, 2 and 5, Tainung No. 1, Tsingtao, Pingtung Yu-tou, Yuan-yang-tou, etc.

IV. Inspection and Certification

Since the First Far East Seed Improvement Conference held in summer 1956 in Taiwan, the seed certification program has been initiated for all the major food crops. For peanuts, the inspection and certification were started in the fall crop of 1957. Aside from regular supervision by operating agencies, one field inspection is made at the time when plants are in flowering and the other just before the harvesting of seeds. Seed inspection and certification is made within five days after harvested seed peanuts are processed and dried. Inspection and certification are made by the agencies designated by Provincial Department of Agriculture & Forestry as follows:

A. Foundation seed farms and seeds—Inspected and certified by Provincial Department of Agriculture & Forestry, Taiwan Agricultural Research Institute and Tainan District Agricultural Improvement Station.

B. Stock seed farms and seeds—Inspected and certified by district agricultural improvement stations with the help of prefectural farmers' associations or prefectural governments.

C. Extension seed farms and seeds—Inspected and certified by prefectural farmers' associations or prefectural governments with the help of township farmers' associations or township offices. Spot checks are made by the district agricultural improvement stations.

The inspecting agencies should submit reports to Provincial Department of Agriculture & Forestry and operating agencies within five days after inspection. Only seeds from qualified fields are distributed for further multiplication or for extension to farmers for general planting.

V. Peanut Seed Certification Standards

A. Field Requirements

1. Peanut varieties to be multiplied must be the recommended varieties. To each seed farm, only one variety is multiplied.

2. The land on which the seed multiplication farms are established should not have peanuts grown or dried in the preceding crop season.

3. Seed multiplication farms should be separated at least 2 meters from other peanut fields. They may be separated by planting the same variety as guard rows or by planting other distinctly different crops.

4. Facilities for harvesting and storing the harvested seeds should be carefully investigated before new seeds are put in. No seeds of two varieties are stored in the same building unless properly bagged and sealed.

B. Field Standards

Factor	Maximum permitted in each level of seed farms		
	Foundation	Stock	Extension
Other varieties	None	0.2%	0.5%
Sclerotium disease	None	0.2%	0.5%

C. Seed Standards

Factor	Standards		
	Foundation	Stock	Extension
Varietal purity (minimum)	100%	98%	96%
Foreign matters (maximum)	1%	2%	3%
Germination (minimum)	90%	85%	85%
Moisture content of seeds (maximum)	14%	14%	14%
% seeds over pods (minimum)	67%	66%	65%

The results of field and seed inspection conducted in the fall of 1957 and in the spring of 1958 in some seed multiplication farms may be reported in the following:

	Foundation seed farms		Stock seed farms		Extension seed farms	
	Fall 1957	Spring 1598	Fall 1957	Spring 1958	Fall 1957	Spring 1958
Field inspection						
(1) Total acreage inspected (ha.)	5.00	5.20	38.87	21.75	25.30	40.61
(2) Acreage meeting certification standards (ha.)	5.00	5.20	38.47	20.55	25.30	40.61
(3) Acreage disqualified (ha.)	—	—	0.40	1.20	—	—
Seed inspection						
(1) Total amount of multiplied seeds inspected (kg.)	5,300	5,655	35,343	20,343	21,292	24,662
(2) Amount of seeds meeting certification standards (kg.)	5,300	5,655	35,243	20,343	21,292	24,662
(3) Amount of seeds disqualified (kg.)	—	—	—	—	—	—

From the above table, it may be seen that, of the fields and seeds inspected, only small acreage of the stock seed farms was discarded, the percentage being about 1.10% in the fall and 5.53% in the spring in 1957–58. These disqualified fields were due to poor management and varietal contaminations. It is hoped that all seed multiplication farms and seeds will be inspected and certified as soon as training of necessary personnel is completed.

VI. Seed Processing, Storage and Distribution

After field inspection, qualified fields are harvested for seed when matured, which is about 120 days after planting for the erect type and from 140 to 160 days for the runner type. As most of the peanuts are planted in sandy soil or sandy loam, peanut plants can be easily removed from the soil by hand. In case some tools have to be used, harvesting is made with the help of a hoe. Threshing of pods from the plants is done right in the field. It is done generally by hand but sometimes, a peanut harvesting knife is used. It is a light, convenient and inexpensive implement consisting of a blade made of soft steel and a wooden handle. However, to improve efficiency, trials have been made recently to thresh peanuts with pedal rice thresher by modifying certain parts in the machinery. Harvested pods after cleaning off earth and other foreign matters are packed in jute bags and hauled by ox-carts from the fields to cement grounds for drying.

The moisture content of freshly harvested pods or unshelled seed peanuts varies from 20 to 60 percent depending upon the water content in the soil at the time of harvesting. It takes several days of sun-drying to reduce it to below 10 percent. By that time seeds inside the shells are fairly dried and free from shell walls. The shells can then be easily splitted open by pressing with the fingers.

The dried seed peanuts after being inspected by responsible agencies are bagged and sealed and attached with a certifying tag indicating the type of seeds, the name of variety, date of harvesting, name of seed growers and the operating agency. They are stored temporarily at the storage house of township farmers' associations before distribution is made. Peanuts in Taiwan are grown two seasons a year, and seeds produced in the preceding crop season are used for seed in the following crop season. Since the interval between two crops is very short, usually less than two months, storage of seed peanuts is not a serious problem.

Seeds for distribution are not shelled. Foundation seed peanuts are distributed by the district agricultural improvement stations to the prefectural farmers' associations or prefectural governments either free of charge or at a price lower than the market price. Foundation seeds are then loaned to stock seed growers for establishing stock seed farms without interest. At the time of harvest, stock seed growers will return the same amount of seeds to the prefectural operating agencies. These seeds are used then for establishing demonstration farms to facilitate the extension and distribution of multiplied seeds. The stock seeds are sold to extension seed growers through prefectural farmers' associations or prefectural governments at a fair price approved by PDAF.

Recently, an attempt has been made by PDAF to distribute to each farmer only a limited amount of extension seeds so that they can be further multiplied by farmers themselves. In this way, extension seeds can be distributed to a greater number of farmers and thus facilitating a quicker extension of new varieties released.

VII. Government Subsidies for Peanut Seed Multiplication Work

To encourage the seed growers to produce good seed and to facilitate the distribution of good seed material, the following subsidies have been given by Provincial Department of Agriculture & Forestry, with JCRR financial assistance, to the operating agencies for peanut seed multiplication work:

A. Government Appropriation for Multiplying Foundation Seeds

Foundation seeds are multiplied by the district agricultural improvement stations of Provincial Department of Agriculture & Forestry. These district agricultural improvement stations are provided in their annual budget an appropriation of NT$ 3,000 per ha. for producing foundation seeds of peanuts. The total annual budget for this item for the whole province is about NT$ 30,000.

B. Subsidy for Multiplying Stock and Extension Seeds

Although stock and extension seed peanuts are sold at a price little higher than the market price, the stock and extension seed growers are given a cash subsidy of NT$ 300 per ha. to compensate their work. This is found necessary for at least two main reasons: (1) their fields must be subject to inspection and certification and any off-type or diseased plant must be eradicated; and (2) their seeds must be sold to the government agencies on the basis of a price approved by Provincial Department of Agriculture & Forestry and these seeds are to be distributed according to the government plan. The total budget for this item each year is from NT$ 150,000 to NT$ 200,000.

C. Subsidy for Packing and Transportation of Multiplied Seeds

This subsidy is given only to the district agricultural improvement stations and prefectural farmers' associations (or prefectural governments) for packing and transporting of multiplied foundation and stock seeds, on a basis of NT$ 0.15 per kg. The total annual expenses for this item is about NT$ 15,000.

D. Subsidy for Handling Seed Distribution

Seed storage and distribution are handled by the prefectural or township farmers' associations. At the time of seed storage and especially at the time of seed distribution, some loss of seeds is unavoidable. The government gives some subsidy to cover this loss. The present rate is NT$ 5.0 per 100 kg. of seeds. The total annual budget for this item is about NT$ 40,000 in a year.

E. Subsidy for Holding Farmers' Visits

At the time of harvest, farmers in nearby area are invited to the seed multiplication farms to see the method of seed production and the superiority of new varieties over the old ones. The best seed growers are given rewards or prizes by Provincial Department of Agriculture & Forestry or by prefectural governments. The expenses for holding farmers' visits in two seasons in a year is about NT$20,000.

F. Subsidy for Supervision and Travelling Expenses

As most of the stock and extension seed farms are distributed in different prefectures and townships, the operating agencies are given by Provincial Department of Agriculture & Forestry certain financial assistance for supervision work. The amount for this item is about NT$ 20,000 a year.

G. Subsidy for Publication of Extension Circulars, etc.

To facilitate the distribution of seed improvement information to farmers, subsidies are given by Provincial Department of Agriculture & Forestry and JCRR to agencies concerned for publishing extension circulars, posting signboards on seed multiplication farms, holding discussion meetings and training classes and conducting other activities in connection with the seed improvement work. The annual budget for this item is about NT$ 20,000.

The total budget for peanut multiplication work in 1959 is approximately NT$ 400,000, of which JCRR has contributed about NT$ 320,000.

SOYBEAN IMPROVEMENT AND SEED PRODUCTION IN TAIWAN

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I. Introduction

Soybean improvement work in Taiwan has a rather late start. The first improved variety was released for commercial planting in 1956 in Miaoli, a prefecture north of Taichung, where soybean has never been grown before. Only two hundred hectares were tried that summer. However, within a short period of three years, not only the area of this variety has been greatly expanded, but other new improved varieties have also been selected for extension in other districts of the Island. In 1959, the acreage occupied by the new varieties in three planting seasons is expected to reach a total of over 28,000 ha., or more than 50 percent of the total soybean projected acreage. Such a rapid increase in the acreage of new soybeans is due to several reasons: (1) the new soybean varieties are of yellow seed type, good for food, oil and beancakes; (2) they yield significantly better than the native green or black beans; (3) they fit better in the local cropping and rotation system; and (4) there is an increasing demand of more soybeans as a result of the increase in population and the expansion of hog raising program.

The annual requirement of soybean in this Island during the past few years is about 120,000 to 130,000 metric tons. Of this amount, the local production provides less than one-fourth, the other three-fourths or about 100,000 metric tons are being imported, primarily under the U. S. Aid Commodity Program. In order to meet the need and at the same time to reduce the amount of import, considerable effort has been made by local agencies to extend the new varieties and to make further improvement on soybean production. To implement this program, JCRR has contributed during the past three years over three million New Taiwan dollars for soybean improvement and extension work. It is believed that, with this combined effort, Taiwan will be able in another few years to increase its local production of soybean to 100,000 metric tons. Some background information on soybean agriculture in Taiwan is briefly mentioned in the following:

A. Acreage and Production

Soybean was formerly a minor crop, but has become important in Taiwan in recent years because of the increasing local demand for oil, beancakes and daily food uses. As already stated above, the annual consumption of soybean on this Island is estimated at 120,000 to 130,000 metric tons. To meet the need, the acreage of soybean has been increased steadily in recent years, especially after the extension of new soybean varieties. The acreage and production during the past few years may be presented in the following:

Year	Acreage (ha.)	Production (m. t.)	Unit yield (kg./ha.)
1945	7,405	1,957	264
1953	28,225	17,426	617
1954	30,048	20,310	676
1955	34,510	24,151	700
1956	37,505	26,442	705
1957	41,029	33,054	806
1958	45,031	38,567	856

B. Producing Area

Soybeans are grown principally in the southern part of this Island around Pingtung and Kaohsiung, where more than 24,000 hectares are found in these two localities. Other prefectures which lead in soybean production are Tainan, Chiayi and Yunlin, each constituting about 3,000 ha. Since 1956, soybean is grown also in Miaoli, Hsinchu and Taoyuan. With the addition of these new areas, soybean acreage will be considerably expanded in the years to come.

C. Planting and Harvesting Seasons

Soybeans are planted in Taiwan in spring (February-March), summer (June-July) and also in late fall (October-November). In Pingtung, Kaohsiung and Changhwa areas, soybeans are grown primarily as a catch crop between two crops of rice in the fall. In this case, soybean seeds are sown in the rice fields in October about 10 to 15 days before or just after the second rice crop is harvested, and soybeans are harvested before the first rice crop is planted in late January. In Tainan, Chiayi and Yunlin areas, soybeans are planted in both the spring and summer seasons, whereas in Miaoli, Hsinchu and Taoyuan, they are grown as a summer crop. Soybeans are harvested about four months after planting, depending upon the districts in which they are grown.

II. Varietal Improvement

A. Extension of New Soybean Varieties

1. The native varieties:

Before the extension of new soybean varieties, all the soybeans grown in this Island are native ones. They were believed to have been brought in from Southeastern part of the Mainland China, for similar beans are still grown at present at many places in Fukien and Kwangtung Provinces. However, after long years of planting under natural conditions, they have become badly mixed and formed many varieties. Generally speaking, the native soybean varieties may be grouped into the following few categories:

Type	% in native varieties	General characteristics
Green beans	42	Purple or white flowers with small green seeds.
Black beans	40	Purple or white flowers with small black seeds.
Small pearl beans	18	Purple or white flowers with small seeds in light yellow color.

Small pearl beans (Chu-tze-tou) are generally planted in the spring, green beans in the summer and black beans in the winter. Because of the low oil content, green beans and pearl beans are used primarily for making bean curd and bean milk, black beans for soybean sauce and animal feed, and only a very small portion of pearl beans has been used for oil extracton.

2. Extension of first improved veriety Sankuo in 1956:

Sankuo, or Sankoku in Japanese name, is the first improved variety of soybeans released for commercial planting in Taiwan. It was first planted in Miaoli with an initial extension of 200 hectares in the summer of 1956. The result was so striking with an average yield of about 1,500 kg. per ha. (more than double the yield of native green or black beans grown in southern parts), it was then extended to Hsinchu and Hwalien in 1957, to Yunlin and Chiayi in 1958, and to Ilan in the spring of 1959. The speed of expansion of the Sankuo variety during the past few years may be shown in the following table:

Expansion of Sankuo Variety in Taiwan since 1956

Prefecture	1956 (ha.)	1957 (ha.)	1958 (ha.)	1959 (planned) (ha.)	Planting season
Miaoli	200	1,200	2,400	3,000	Summer planting
Hsinchu	—	200	1,300	2,400	Summer planting
Taoyuan	—	—	230	1,200	Summer planting

Yunlin	—	—	400	1,200	Summer and some spring planting
Chiayi	—	—	400	1,200	Summer and some spring planting
Hwalien	—	1,000	1,500	2,000	Summer and some spring planting
Ilan	—	—	—	200	Spring and some summer planting
Total:	200	2,400	6,230	11,200	

Sankuo was introduced to Taiwan in 1952 by the Hsinchu District Agricultural Improvement Station from the Shikoku Agricultural Experiment Station in Japan. It was first tested at Hsinchu Station along with other introduced varieties and then at Miaoli and Hsinchu. Based on experimental results and field observations, and prompted by the need of some new crops for summer planting on the so-called "weather depending fields" in these two areas, Sankuo was selected for extension whereas other tested varieties were discarded. The results of some field experiments on Sankuo are given as follows:

Preliminary Varietal Trials at Hsinchu Station during 1952-54 (summer planting)

Variety	Yield per ha. (kg.)		
	1952	1953	1954
Sankuo (Sankoku)	1,613	1,726	1,805
Mei-yuk (Yonegatake)	1,868	786	1,810
Ho-kao-dou (Wakashima)	1,712	1,865	1,810
Yu-min-chia-li (Tomolokoshi Jai-lai)	880	1,615	1,183

Performance of Sankuo under Regional Varietal Tests at Hsinchu during 1956-57 vs. Other Released Varieties

Variety	Yield per ha. (kg.)			
	1956		1957	
	Spring	Summer	Spring	Summer
Sankuo[1]	None	1,953	None	2,835
Palmetto	119	1,090	112	1,926
Shih-shih (Jikkoku)	312	324	321	743

[1] Sankuo set no seed in spring planting in Hsinchu unless it is planted very early in January.

Performance of Sankuo under Varietal Tests at Miaoli in 1954 and Hsinchu in 1957 vs. Other Varieties

(summer planting)

Variety	Yield per ha. (kg.)	
	Miaoli (1954)	Hsinchu (1957)
Sankuo	2,860	1,852
Mei-yuk	2,120	1,584
Ho-kao-dou	510	1,349
Yu-min-chia-li	1,080	—

From the above tables, it may be seen that, of the four most promising varieties tested, Sankuo stands out the best. It gives steadily higher yield than others, although, sometimes, it may be outyielded by Mei-yuk or Ho-kao-dou. Also, based on field observation, Sankuo is more tolerant to drought than Mei-yuk and more resistant to soybean mosaic than Ho-kao-dou.

Sankuo is a yellow seed type of soybean with a high yielding capacity. It is adapted only for summer planting at Hsinchu, Miaoli and Taoyuan in northern Taiwan, although in other localities, both spring and summer plantings may be made. Under proper cultural method and with good control of insect pests, each plant may give as many as one thousand pods and each pod with two seeds or more. Summer planting is made in July and harvesting in early November. In case spring planting is done, it is sown in February and harvested in May or June.

It must be pointed out here that, at the beginning, Sankuo was selected primarily for Miaoli and Hsinchu areas. In these two Prefectures, there are over ten thousand hectares of the so-called "weather-depending fields", which were used formerly for planting sugarcane and followed by sweet potatoes in two-year cropping system. However, since the closing of the Miaoli and Hsinchu sugar mills in 1952, these weather-depending fields have been turned to grow rice. As there is a shortage of rainfall between July and December and no sufficient irrigation water to apply to all of the land, rice usually meets drought in the fall crop season. Planting of sweet potato to all these fields are not profitable. With the extension of Sankuo, it is now possible for the farmers to grow a crop of rice in the spring, soybean in the summer between July and November, and a crop of wheat, rape, broad beans or other vegetables in the winter, making a total of three crops in a year.

In Miaoli, Hsinchu and Taoyuan, trials have been started to interplant soybean on some tea and citrus plantations there in an attempt to increase cash returns.

3. Extension of the Palmetto variety in 1957:

Following the extension of Sankuo in northern Taiwan, a new variety of soybean called Palmetto was released for commercial planting in the southern part in the winter of 1957. It was planned to extend 350 hectares in Pingtung as an initial trial planting, but the actual acreage planted in that single season was 633 ha. in Kaohsiung and over 1,000 ha. in Pingtung. Planned acreage for 1958 in these two districts was 6,500 ha. in Pingtung and 5,000 ha. in Kaohsiung, with about 80 percent of which being planted in the winter and the other 20 percent in the spring and summer seasons. It is anticipated that by the year of 1959, this variety will not only be planted in Pingtung and Kaohsiung, but also in Tainan, Chiayi, Yunlin and Taitung on the east coast. By that time, at least 50 percent of native soybean varieties in Pingtung and Kaohsiung will be replaced by Palmetto.

Palmetto is an American variety of yellow seed type. It was selected originally from a Chinese variety introduced to the United States in 1927 from Nanking. In 1953, it was introduced back to Taiwan by the Kaohsiung District Agricultural Improvement Station. After field tests, it was found that, in fall planting in Pingtung, Palmetto not only outyields but also matures earlier than the native varieties. This is a very important character, for, in Pingtung as well as in Kaohsiung, more than 80 percent of soybeans are planted in the winter time on paddy fields between the harvesting of the 2nd rice crop and the transplanting of the 1st rice crop in the following year. Any late maturing soybean variety can not fill in this narrow gap, and it will be abandoned or turned under as green manure. In addition, Palmetto adapts equally well for spring and summer plantings. For this reason, in spite of the fact that some other tested varieties may give a higher yield than Palmetto, they have been discarded either because of their late maturity or because of their inadaptability to be grown in all three seasons. Therefore, Palmetto was finally selected for extension. Results of some field tests are presented in the following for reference.

Results of Preliminary Tests of Palmetto with Other Introduced and Native Soybean Varieties at Pingtung during 1954-55.

Variety	Av. yield per ha. (kg.)			No. of days to maturity		
	Spring	Summer	Fall	Spring	Summer	Fall
Palmetto	2,069	1,725	1,449	97	117	95
Acadian	1,155	1,520	1,135	119	127	93
Shih-shih	713	779	703	84	102	81
Pearl bean[1]	453	—	—	97	—	—
Green bean	—	649	—	—	122	—
Black bean	—	—	680	—	—	115

[1] Pearl, green and black beans are native varieties. They were grown respectively as check in different planting seasons.

Performance of Palmetto under Province-wide Regional Varietal Tests during 1956-57 vs. Sankou and Other Varieties in Pingtung

Variety	Year	Av. yield per ha. (kg.)			No. of days to maturity		
		Spring	Summer	Fall	Spring	Summer	Fall
Palmetto	1956	1,113	1,252	595[1]	92	104	84
	1957	1,555	1,602	1,673	92	113	86
Sankuo	1956	1,270	388[2]	428	105	121	90
	1957	829	604	1,806	97	132	86
Shih-shih	1956	660	229	—	87	80	—
	1957	997	147	1,192	85	83	77
Acadian	1956	1,024	357[2]	473	114	120	91
	1957	889	245	1,664	107	132	88
Native varieties[3]	1956	909	912	455	91	121	100
	1957	1,096	942	1.417	92	132	102

[1] Regional varietal test conducted at Pingtung in fall planting in 1956 was hit by typhoon in November, so the yields of all tested varieties were very poor.

[2] Sankuo and Acadian, when planted in the summer months at Pingtung, maintained prolonged vegetative growth, but set only a little amount of seed due to long days and high temperatures.

[3] Native varieties: Pearl bean in spring, green bean in summer and black bean in fall planting, as checks.

Spring planting is made in February or March, summer planting in June, and fall planting in early October, the harvesting time being in May, October and January, respectively. Palmetto should not be planted after October 15 in fall planting, for late planting brings the plants closer to the cold season, which not only affects the normal growth of plants, but significantly decreases the seed production. To avoid late planting, seeds may be sown in between rice rows at 15 cm. apart before rice is harvested by the "relay interplanting" method.

4. Extension of the Shih-shih variety in 1958 in Taichung:

Shih-shih (Jikkoku in Japanese name) is a Japanese variety introduced by the Kaohsiung District Agricultural Improvement Station in 1954. It is a short dwarf type of plants, yielding not as well as Palmetto in Pingtung and Kaohsiung area. However, in Taichung area, on account of its unique early maturing habit, Shih-shih was released for commercial planting in the winter of 1958. Three hundred hectares were planted for initial extension and another one hundred ha. will be planted in the spring of 1959.

It must be mentioned that Taichung and Changhwa in the central part of Taiwan are the most intensive farming regions in Taiwan. Besides two regular crops of rice, a third crop is usually grown in the winter and, in some places, a very short catch crop such as pickle melon in the summer, making a total of four crops on the same land in a year. Therefore, early maturity is the first requirement of any crop variety in order to fit in the crowd cropping system. Of the winter crops grown at present, wheat is the main one, followed by sweet potato, tobacco, soybean, vegetables and others. They are planted to paddy fields either after or about 10 days prior to the harvesting of the second rice crop by the "relay interplanting" method. Of the soybean, about ten thousand hectares of the green beans are planted every year in the winter, but only about three thousand hectares get to maturity for seed while others are usually turned under as green manure.

As an effort to improve the soybean production in that area, several new soybean varieties were tested by the Taichung District Agricultural Improvement Station in 1957 and 1958. Shih-shih was finally selected for its earliness to replace the old. The results of some field tests on Shih-shih may be shown in the following tables:

Performance of Shih-shih under Comparative Yield Test against Other Varieties Conducted at Taichung Station in 1957

Variety	Av. yield per ha. (kg.)			No. of days to maturity		
	Spring	Summer	Fall[2]	Spring	Summer	Fall
Shih-shih	899	1,199	797	108	77	82
Palmetto	581	1,823	910	132	93	97
Sankuo	157	2,308	1,062	154	112	95
Native variety	924	2,148	602	125	114	115

[1] Native varieties: Pearl bean in spring planting, green bean in summer and fall planting, as checks.
[2] 1958 data.

The spacing between rows and plants for this experiment is all 50 cm. and 20 cm., respectively.

Yield of Shih-shih vs. Some Other Varieties under Varietal Tests in Taichung Area in 1958

(Average of 12 places in spring planting and 10 places in summer planting)

Variety	Av. yield per ha. (kg.)		No. of days to maturity	
	Spring	Summer	Spring	Summer
Shih-shih	2,041	1,881	88	82
Palmetto	1,130	1,560[1]	103	94
Sankuo	—	1,675	—	112
Native pearl bean	1,387	1,550	93	97

[1] Average of 2 places only.

The spacing between rows and plants for Shih-shih is 30 cm. and 10 cm., respectively. This has now become the standard field practice for this particular variety, for it is a short dwarf type of plant.

5. Acreage planted to new soybeans since 1956:

As reported above, three new soybean varieties have been released for commercial planting up to present. The acreage which will be occupied by these three varieties in 1959 will exceed 28,000 hectares or more than 50 percent of the total soybean acreage projected for that year. The increase in acreage of new soybean varieties since the extension of Sankuo in 1956 in Miaoli may be shown in the following:

Acreage Increase of New Soybean Varieties since 1956

Variety	Prefecture	1956 (ha.)	1957 (ha.)	1958 (ha.)	1959 (est.) (ha.)	Planting season
Sankuo	Ilan	—	—	—	200	Spring
	Taoyuan	—	—	230	1,200	Summer
	Hsinchu	—	200	1,300	2,400	Summer
	Miaoli	200	1,200	2,400	3,000	Summer
	Yunlin	—	—	400	1,200	Summer
	Chiayi	—	—	400	1,200	Summer
	Hwalien	—	1,000	1,500	2,000	Spring, summer
	Total:	200	2,400	6,230	11,200	
Palmetto	Kaohsiung	—	633	5,000	7,000	Spring, summer, fall
	Pingtung	—	1,000	6,500	9,000	Spring, summer, fall
	Taitung	—	—	—	400	Spring, summer
	Total:	—	1,633	11,500	16,400	

(Some acreage in Tainan, Chiayi, Yunlin & Hwalien not included)

Shih-shih	Taichung	—	—	300	500	Spring, summer, fall
	Changhwa	—	—	—	200	Spring, summer, fall
	Total:	—	—	300	700	
(Some acreage in Nantou, Chiayi, Tainan, Kaohsiung, Pingtung & Taitung not induded)						
Grand Total:		200 (1956)	4,033 (1957)	18,030 (1958)	28,300 (1959 est.)	

The estimated acreage of new soybeans in 1959 from spring to fall crop seasons is about 28,000 hectares. Miaoli, Hsinchu and Taoyuan are the new areas, where soybean has not been grown before until Sankuo was extended in 1956. In other districts, new soybeans are extended to replace the poor native varieties on one hand and to develop new areas for soybeans on the other. From the above table, it may be said that so far a spectacular progress has been made, in spite of the fact that the soybean improvement work in this Island was started only during the past few years.

B. Varietal Improvement Work in Progress

Soybean improvement work in Taiwan is at present undertaken under a joint program among the College of Agriculture of the National Taiwan University (NTU), Taiwan Provincial College of Agriculture, Taiwan Agricultural Research Institute and Kaohsiung District Agricultural Improvement Station, with the cooperation of other district stations and agricultural experiment stations in carrying out various regional tests. Some of the varietal improvement work now in progress may be briefly mentioned in the following:

1. Single plant selection from farmers' fields:

In 1953 and 1954, with JCRR financial assistance, a total of 5,891 plants of the native soybeans were selected by the Kaohsiung District Station from farmers' fields in Pingtung and Kaohsiung. After years of selection and elimination, eight desirable lines have been obtained. One line given as Kaohsiung No. 1 joined the province-wide regional varietal test in 1958. Preliminary result showed that it yielded about 20 percent more than the native variety.

2. Breeding of new soybean varieties from artificial hybridization:

Cross breeding work on soybean was started by the Kaohsiung District Station in 1954 and Taiwan Provincial College of Agriculture in 1955. Considerable number of the crosses have been made between the native and introduced varieties since then. The purpose of breeding work is to incorporate such characters as early maturity, good quality and high yielding ability from introduced varieties to the native varieties which have comparatively wider adaptability and more disease and insect resistance. Some of the crosses have now been carried down to F_6 or F_7 generation, and a few very promising strains have been selected therefrom.

In the spring of 1957, some crosses were also made by the NTU College of Agriculture between American and Japanese varieties. Individuals selected from F_3 were tested at Taipei, Chiayi and Pingtung in the fall of 1958. Lines such as 114, 116, 120, 123, 125 and 104, 114, 116 were found to be promising in Taipei and Pingtung, respectively. They will be tested again in 1959.

A few crosses were also made by the NTU College of Agriculture between cultivated soybean and *Glycine tomentella*, a wild plant found in Taiwan, belonging to the same genus of soybean. Over one thousand plants have been obtained from these crosses. It is hoped that some desirable characters such as disease and insect resistance may be transferred from wild species to the cultivated soybeans. An improved technique for crossing soybean has been recently developed by the University.

3. Selection of desirable individuals from irradiated material:

In the spring of 1957, two soybean varieties, Sankuo and Ho-kao-dou (Wakashima) were sent by JCRR to Brookhaven National Laboratory in U.S. for X-ray and thermal neutron treatments. Treated seeds, each variety having 10,000, were sent back to Taiwan in July and grown by Taiwan Agricultural Research Institute in Hsinchu and Miaoli in 1957 and 1958. From R_2 generation, several individuals were found to be more resistant to rust disease and better in yield than the original varieties. Further selection will be made in R_3 generation in 1959.

4. Recent introduction of new soybean varieties from other countries:

As foreign varieties such as Sankuo, Palmetto and Shih-shih proved to be adapted to Taiwan, continuing effort has been made by JCRR to introduce more from other countries. From 1956 to 1958, the following varieties were introduced:

a. From U.S.A.: Perry, Wabash, Lincohn, Harosoy, Adams, Clark and Hawkeye from U.S. Soybean Regional Laboratory; Kim and Kanrich from Iowa through USDA Plant Introduction Section; and Jackson, Lee and Dorman from Jacob Hartz Seed Co., Arkansas.

b. From Canada: Crest from Experiment Farm, Morden, Manitoba.

c. From Japan.: Chojyu, Tokachi-hagada, Oyachi No. 2, Mansokin, Wasei-tsurunoka, Tokachihadaka, Shizunaidazu, Gindaizu, Marukotsubu, Bansei-hikarikuro and Richland from Hakkaido Agricultural Experiment Station; Norin 1, Norin 2, Norin 3, Tamamusume (Norin 6), Shinmeziro (Norin 10), Kimusume, Ibaraki No. 1, Shirobana Sai No. 1, Akazaya, Ojiro, Asahi No. 60, Ani and Fuji No. 4 from Ishioka Branch Station, Ibaraki; and Suzunari, Tokachi-hadaka, Pan-yu No. 65 and Tokachi-nagaha from Tokachi Branch Station, Hokkaido.

d. From the Philippines.: Mis 28 E. B., Mis 33 Dixi, Hybrid 2217, Bilomi 1, Bilomi 3, Bilofield, Black Manchurian, E. G. 1 and Yellow Biloxi 37 from U. P. College of Agriculture.

e. From Thailand.: Laheng, Chiengmai, Mac Tang and USA-Ard-A from Tha Phra Experiment Station.

At present, over 150 foreign varieties are kept by the Provincial College of Agriculture at Taichung and Kaohsiung District Station at Pingtung for testing and crossing purposes.

III. Cultural Improvement

A. General Improvement on Soybean Cultural Practice

Before the extension of new varieties, soybeans in Taiwan were grown by a very crude cultural method. No soil preparation and seedbeds were made. Seeds were sown by broadcast. In case soybean was planted to paddy fields, seeds were broadcasted to the fields before rice harvest. There was no definite spacing between plants or rows. Under such condition, no cultivation and weeding were possible and plants were usually heavily infected with insects and sometimes with diseases. Consequently, many fields were turned under as green manure before maturing and those set seed averaged less than 800 kg. per ha.

However, after new soybeans were planted, cultural practices have been greatly improved. Soil preparation and seedbeds are made before planting. Seed is sown in hills or in rows at a certain distance between rows and plants. Having a space between rows, cultivation, weeding and insect and disease control are possible. In case soybean is interplanted to paddy fields before rice is harvested, seed of soybean is sown to rice rows line by line instead of by broadcast, so that all necessary field operations can be carried out without difficulty after the rice is taken out from the fields. Usually, at certain regular intervals on the fields, shallow ditches are made crosswide or lengthwise to facilitate irrigation and drainage. With all these operations and coupled with the ability of new varieties themselves, the unit yield has been significantly increased, the average being above 1,400 kg. per ha. in spring and summer plantings and about 1,200 kg. in fall planting. Extension circulars on improved cultural method of soybeans have been published by district stations and PDAF and training classes were held at different localities to distribute new knowledge to the farmers. At present, some native varieties are cultivated following the improved method.

B. Improvement on Seed Quality and Seeding Rate

As soybean seeds are rich in oil and protein contents, they deteriorate rather easily and lose germination ability unless adequately dried and properly stored. The old practice used commonly by the farmers as well as by seed dealers is to store harvested seeds either in jute bags or in Chinese urns made of clay. Soybean seeds so stored are apt to absorb moisture from outside and become damaged by insects. After a few months of storage, the average germination percentage lowers to less than 50 percent. To compensate the loss in germination percentage, the farmers have to use twice as much of seed which is actually required. The general seeding rate is 60 to 70 kg. per ha. and seeding is made ordinarily by boradcast.

Since the extension of new soybeans, soybean seed multiplication system has been established. Seeds for farmers are provided by the prefectural or township farmers' associations at a reasonable price. These multiplied seeds are kept either in air tight aluminum bins or in soybean seed granaries before distribution is made. The average germination percentage is well above 90 percent, when seeds are so stored. With good seed, the seeding rate may be cut down to 15 to 25 kg. per ha. in spring and summer plantings and to 25 to 35 kg. per ha. in fall planting. Also, seeding by hills or by rows helps to cut down the amount of seed used.

C. Control of Soybean Insects

Soybean insects are serious in Taiwan. At every stage of growth, there are certain insects which cause death or damage to plants. The most injurious insects are soybean root maggot, stem maggot, leaf folder, white marked moth, Taiwan yellow moth and green stink bug. They occur throughout the Island and almost in every crop season. During the past two years, with JCRR financial and technical assistance, studies have been made by the Taiwan Agricultural Research Institute regarding their occurrence, life history, growth habit, type of damage to soybean and method of control. Through these studies, Endrin has been found to be the most economical and effective insecticide to control these insects. Four applications of Endrin at concentrations of 1:800 or 1:1000 are sufficient to protect the plants from attack. Spray schedule is as follows:

1st spray Summer planting—7 days after sowing: Endrin 1:1000.
Spring and fall planting—14 days after sowing: Endrin 1:1000.
2nd spray 20 days after first spray: Endrin 1:1000.
3rd spray When flowering nearly over: Endrin 1:800 or 1:1000.
4th spray Upon swelling of pods: Endrin 1:800–1:1000.

Control of insects has now become a standard field practice in new soybean culture and has been carried out very satisfactorily by the farmers. Some control work has also been made on native beans with insecticides.

D. Work on Soybean Disease Control

Work on soybean disease control is also undertaken at present by the Taiwan Agricultural Research Institute. A preliminary survey made by the Taiwan Provincial College of Agriculture shows that, at least, sixteen kinds of diseases are present on soybean. Rust (caused by *Phakospsora saiae*), purple stain seed (caused by *Cercospora kikuchii*), Fusarium pod rot, Sclerotinia rot, seed rot (caused by *Fusarium scirpi* f. *tracheiphilum*), rosette disease and mosaic are the common ones, and, in some seasons, they cause considerable damages to soybean. Treatment of seed with Spergon to control seed rot and Sclerotinia rot has produced some results. Spraying of dithine to control rust seems also effective. All these control measures are still under investigation and as soon as they are found to be economical and practical, they will be recommended to farmers for general practice.

E. Improvement on Fertilizer Application

For native soybeans, very little fertilizers have been used by the farmers. For new soybeans, an application of 5,000–8,000 kg. of compost, 150–200 kg. of calcium superphosphate and 30–50 kg. of potassium chloride has been recommended. In some places where soil fertility is very low, the addition of some ammonium sulphate or urea solution is necessary. During the past two years, JCRR has given out several hundred tons of fused phosphate to be tried on soybeans. The result is very satisfactory. Fields with fused phosphate give not only higher yield but better developed seeds than those without, the increase in some cases reaching as high as 50 percent. A more detailed study on soybean fertilizer application is now conducted at different district stations with JCRR subsidy.

F. Experiment on Inoculation of Soybean with Nodule Bacteria

This work is undertaken recently by Professor Ming-huei Wu of the Taiwan Provincial College of Agriculture. Several isolates from the American Nitragin and from native strains were used. Preliminary results show that the American inoculant gives an increase in yield from 3 to 12 percent and native selected strains from 2 to 16 percent when compared with no inoculation.

G. Experiment on Intercropping of Soybean with Sweet Potato

Intercropping is a common farm practice in Taiwan agriculture. Intercropping of soybean with sweet potato has gradually been practised by the farmers since the extension of new soybean. Several experiments have been made to show the effect of soybean on the yield of sweet potato when they are interplanted and the comparative net returns of the farmers when one crop of sweet potato is compared with the two intercropped crops. The following is an experiment conducted in the spring of 1958 at Ling-loh Township of Pingtung by the Kaohsiung District Station. Sweet potatoes were planted in 18 rows of 10 meters in length, the spacing between rows and plants being 1 meter and 33 cm., respectively. To these 18 rows, except 6 rows where no intercropping was made, 6 rows were interplanted with Palmetto and 6 rows with Shih-shih soybeans. They were replicated four times in randomized arrangement. Soybeans were planted along the sweet potato rows of the same sides, distance between soybean plants being 20 cm. The result is as follows:

Plot	Sweet potato			Soybean			Total cash returns NT$
	Yield (kg./ha.)	Unit price per kg. NT$	Cash returns NT$	Yield[1] (kg./ha.)	Unit price per kg. NT$	Cash returns NT$	
Sweet potato with Palmetto	23,413	0.45	10,536	406	6.0	2,438	12,974
Sweet potato with Shih-shih	23,159	0.45	10,421	288	6.0	1,728	12,149
Sweet potato only	23,530	0.45	10,588	—	—	—	10,588

1. Yield of soybean interplanted on per ha. of sweet potato. Here, the spacing of sweet potato rows was 1 meter, which was two and three times wider than the regular spacing of Palmetto and Shih-shih. Therefore, the actual yield of soybean, if put on per ha. basis, should be double and triple of the above figures for Palmetto and Shih-shih, respectively.

On the basis of the above, there is an additional cash profit of about NT$1,500 to NT$2,300 per ha. when sweet potato is intercropped with soybean. The decrease in sweet potato yield as a result of intercopping has been calculated as from 2 to 20 percent.

Recently, some intercopping is made on tea and citrus plantations with soybeans in Miaoli and Hsinchu. The average yield of soybean is from 500 kg. to 800 kg. per ha.

IV. Soybean Seed Multiplication

A. Soybean Seed Multiplication System and Its Operation

Soybean seed multiplication system was established only after the new soybean variety Sankuo was released for commercial planting in 1956. It follows the same pattern as that of rice or wheat, dividing the seed multiplication system into three levels of seed farms: foundation seed farm, stock seed farm and extension seed farm. The first foundation seed farm was established at the Hsinchu District Station in 1956 with the stock and extension seed farms in Miaoli in the same year. The operation of the soybean seed multiplication system may be briefly outlined in the following:

1. The foundation seed farm:

The foundation seed farms are established at and operated by the district agricultural improvement stations or their branch stations in Taipei, Hsinchu, Taichung, Tainan, Pingtung, Taitung and Hwalien. Seeds for foundation seed farms are carefully selected by the district stations and any off-types shown in the fields will be duly eradicated to ensure varietal purity. Recently, attempt has been made to multiply the "breeder seed" of all released soybean varieties at the Seed & Seedling Multiplication Station of Taiwan Provincial Department of Agriculture & Forestry (PDAF) up on the mountain at Tungshih Township of Taichung so that a better quality of pure seed may be obtained. Seeds produced from the mountain nursery will then be distributed to different district stations for setting up foundation seed farms. Seeding rate varies with varieties, seasons and localities. The minimum output of pure seed from the foundation seed farms, after processing and screening, is set at 800 kg. per ha., which will be enough for 25 to 50 ha. of the stock seed farms in the following crop season. In Miaoli, Hsinchu and Taoyuan in northern Taiwan, where soybean is grown only in summer, foundation seed farm is established at the Hsinchu Station at that season only. Whereas, in other localities, where soybean is grown in almost every season, foundation seed farms are established in spring, summer and/or fall. Foundation seed farms are set only on the land where no soybean is grown in the preceding crop and seeds produced therefrom will be distributed to stock seed growers for setting up stock seed farms in different prefectures. Soybean varieties multiplied at foundation seed farms during the past three years at different district stations may be shown in the following:

District Station	Varieties multiplied	For stock seed farms at:
Ilan Branch Station	Sankuo	Ilan Prefecture
Hsinchu Station	Sankuo	Miaoli, Hsinchu and Taoyuan Prefectures
Taichung Station	Shih-shih	Taichung Prefecture
Tainan Station	Sankuo	Yunlin and Chiayi Prefectures
Kaohsiung Station	Palmetto	Kaohsiung and Pingtung Prefectures
Taitung Station	Palmetto	Taitung Prefecture
Hwalien Station	Sankuo	Hwalien Prefecture

2. Stock seed farms:

The stock seed farms are established at different prefectures and operated by prefectural farmers' associations or contract farmers under their supervision. At each prefecture, only one to three stock seed farms are established at a season, so that adequate supervision can be performed. Seeds for stock seed farms are supplied by the district station free of charge from foundation seed farms. The land on which stock seed farms are set shall have no soybean grown in the previous crop season. Seed sowing is made by hills, spacing between hills and plant rows being 15–20 cm. and 50 cm. in spring and summer planting and 10–15 cm. and 40–45 cm. in fall planting. Spacing for Shih-shih has been corrected to 10 cm. between hills and 30 cm. between rows, for it is a much smaller plant than Sankuo or Palmetto. At the time of growth, among other cultural practices, insect control must be faithfully carried out. To this effect, Endrin has been given as a government subsidy to all seed growers contracted. Only the seed farms which are free from varietal admixtures and free from insect damages and diseases are harvested for seed. The average yield of seed per ha. from the stock seed farms, after processing and screening, is set at 900 kg., which again will be enough for planting 25 to 50 ha. of extension seed farms in township level. The stock seed growers must sell their seed to prefectural farmers' associations, and to this effect, they receive certain government subsidies from the latter party to operate the stock seed farms.

3. The extension seed farms:

The extension seed farms are established at different townships forming the third or final level of soybean seed multiplication system. These seed farms are operated by contract farmers under the supervision of the township farmers' associations. At each prefecture, usually only three to four townships are selected for extension seed multiplication work at a season and each extension seed farm must be of at least 0.5 ha. in size. However, to facilitate the extension of new soybean varieties in new districts, extension seed farms may be established in most of the townships within a prefecture upon the approval of PDAF. Seeds for extension seed farms are supplied by the township farmers' associations with stock seeds, which are bought from the prefectural farmers' associations and then sold or loaned to contract farmers. Insect control must be done as mentioned in stock seed farms, so that all seeds produced are fully developed and damaged pieces are reduced to minimum. If diseases are present, they should be duly sprayed with proper fungicides and diseased plants must be taken out from the fields. If diseases are serious, the extension seed farms will be disqualified. Only good fields are harvested for seed. The average yield of extension seed farms is set at 1,000 kg. per ha. after screening and processing. The harvested seeds will be bought and kept by the township farmers' associations and, when planting season comes, sold or loaned to the farmers for general planting.

The operation of the whole soybean seed multiplication system may be summarized and illustrated with the following diagram:

Level of seed farms	Operating Agency	Seeds supplied by	Seeds to be distributed to
Foundation seed farms	District stations	District stations	Stock seed farms in prefectures
Stock seed farms	Prefectural farmers' associations or contract farmers	District stations	Extension seed farms in township level
Extension seed farms	Township farmers' associations or contract farmers	Prefectural farmers' associations	General farmers

Acreage and amount of soybean seeds multiplied during past three years after the extension of new varieties may be shown in the following table:

Level of seed farms	1956		1957		1958		Total	
	Acreage (ha.)	Amount (kg.)	Acreage (ha.)	Amount (kg.)	Acreage (ha.)	Amount (kg.)	Acreage (ha.)	Amount (kg.)
Foundation seed farms	0.05	40	0.35	220	0.50	510	0.90	770
Stock seed farms	1.00	900	6.00	5,200	13.00	18,510	20.00	24,610
Extension seed farms	20.00	20,000	158.74	166,740	281.00	356,000	459.74	542,740

Varieties multiplied: Sankuo, Palmetto and Shih-shih.

B. Inspection and Certification

For the soybean seed multiplication farms, one field inspection is made before the maturity of seeds. After seeds are harvested, they will be inspected again 20 days after threshing. If harvested seeds are kept over a period of three months, another seed inspection is necessary which is done at the time just before seed distribution. Field and seed inspection of soybeans are carried out, at present, by the following agencies assigned by PDAF:

1. Foundation seed farms—By PDAF and Taiwan Agricultural Research Institute or other district stations if necessary.

2. Stock seed farms—By district stations and prefectural farmers' associations.

3. Extension seed farms—By prefectural and township farmers' associations with the spot checks by the district stations.

The inspecting agencies should submit reports to PDAF and operating agencies within five days after inspection. Disqualified fields or seeds will be rejected. Notification should be made by the operating agencies to contract farmers in the earliest possible time.

Seed certification standards for soybeans were worked out in 1957 following the closing of the First Far East Seed Improvement Conference held in Taiwan in the summer of 1956. However, they were revised several times in 1958 after the new soybeans have reached to a considerable acreage. The soybean seed certification standards as finally recommended may be presented in the following for reference:

Soybean Seed Certification Standards

A. *Some general requirements.*

1. Soybean varieties to be multiplied must be the released varieties approved by PDAF. To each seed farm, only one variety is multiplied.

2. Seed multiplication farms should be made on land on which no soybeans were grown in the previous crop season. This measure is taken to avoid unnecessary contamination from other soybean varieties.

3. Seed multiplication farms should be separated at least 2.5 meters from other soybean fields. If the seeding of other farmers' fields is made by broadcast, a distance of at least 6 meters will then be required.

4. Drying of harvested seeds should be made on the ground where no other varieties of soybean had been dried before. This measure is taken also to avoid varietal admixtures.

5. Seed containers or storage houses should be duly inspected before new seed lots are put in. No seeds of two varieties are put in the same bins of the granary unless they are properly filled in jute bags and clearly labelled.

B. Field standards.

Factor	Maximum permitted in each level of seed farms		
	Foundation	Stock	Extension
Other varieties	None	0.2%	0.2%
Rust or mosaic	None	Light	Light

C. Seed standards.

Factor	Standards for each level of seed farms		
	Foundation	Stock	Extension
Varietal purity (minimum)	100%	99%	99%
Broken seeds (maximum)	0.5%	1.0%	2.0%
Foreign matters (maximum)	0.5%	2.0%	2.0%
Moisture content (maximum)	13.0%	13.0%	13.0%
Germination percentage before planting (minimum)	90.0%	85.0%	80.0%

Although no certification of seeds was made in 1958, multiplied seeds inspected met with the above standards and, in fact, as multiplied seeds were well kept in air-tight aluminum cans or in newly built seed granary, their germination rates were above 85 percent.

C. Seed Processing, Storage and Distribution

After field inspection, qualified fields will be harvested for seed at the time when the leaves have dropped from plants. The harvested plants are usually tied into bundles and loaded on ox-carts hauling from the fields to cement drying grounds for threshing. Harvesting is preferably done in the morning before the sun comes high, so that every pod still remains intact and inside seeds will not drop off from the pods to the field. Threshing is done commonly with the help of a simple farm tool called flail, which has a short wooden stick called swingle hanging freely at the end of a long wooden handle, and this swingle can swing freely and beat the seeds out from the pods. Empty pods and stalks are cleaned from seeds after threshing and seeds are sun-dried for several days until the moisture content comes down below 13 percent. These seeds will then be further cleaned with Clipper Cleaner Model M-2, so that all foreign matters and broken pieces will be cleaned out from the seeds. Seeds after being inspected will be stored in air-tight aluminum cans or in seed granaries, labelled with all necessary information including name of variety, type of seeds, name of seed growers, and the name of operating agencies. If the seeds are kept in storage more than a period of three months, several sun-dryings will be necessary, so that the moisture content of seeds will be kept under

13 percent. With high moisture, seeds will easily deteriorate and lose germination power. Germination test is conducted before seed distribution is made.

Distribution of foundation seeds to stock seed growers is made by the district station free of charge through the prefectural farmers' associations. Stock seeds from stock seed growers are bought and kept by the prefectural farmers' associations, and, when planting season comes, distributed to the extension seed growers through the township farmers' associations either in cash or on loan basis. Extension seeds from extension seed growers are bought and sold to ordinary farmers by the township farmers' associations. The stock and extension seed growers are given certain government subsidies, but the sale price of their seeds after being suggested by the prefectural or township farmers' associations must be approved by PDAF.

To provide facilities for drying and storage of multiplied seed, JCRR has, during the past three years, given financial assistance to construct 750 cement drying grounds, each about 20 P'ing or 66 M^2, at various townships in Taoyuan, Hsinchu, Miaoli and Hwalien; 1,200 aluminum cans each enough to hold 100–120 kg. of seeds; and three seed granaries for soybeans in Miaoli, Hsinchu and Hwalien. Each seed granary has a floor area of 132 M^2 to 198 M^2 enough to store 60 to 80 metric tons of soybean seeds. As the acreage of new soybeans will be greatly expanded in the following few years, more drying grounds and seed granaries will be needed to facilitate the soybean extension program.

D. Distribution of Information on Seed Improvement to Farmers

The following methods have been used for distribution of seed improvement information to farmers:

1. Publication of extension circulars:

Extension circulars on new soybean varieties concerning their varietal characteristics, cultural methods and seed multiplication system have been published by various district stations. Recently, a special bulletin on soybean insect control has been written by Taiwan Agricultural Research Institute and published by PDAF.

2. Holding of training classes on soybean cultural method:

Just before planting, training classes on soybean culture are held first at the prefectures and then at various townships. Farmers as well as local extension workers will participate. At the meetings, every phase of the work concerning soybean culture and seed production will be explained and discussed by the specialists from PDAF, agricultural research stations and district stations. General and specific requirements for setting seed multiplication farms will also be emphasized.

3. Field demonstration and farmers' visits:

Field demonstrations of new soybean varieties are usually established near the seed multiplication farms. At the time before harvest, field visits will be held and, at which time, farmers from nearby villages will be invited to visit the demonstration plots to see the performance of new varieties. This has been found effective not only for the distribution of seeds of new varieties, but also for the distribution of new knowledge on crop and seed improvement information to the farmers.

E. Government Subsidies to Soybean Seed Multiplication Work

To facilitate the extension of new soybeans, the following subsidies from PDAF and JCRR have been given to soybean seed multiplication work:

1. Appropriation of fund for multiplication of foundation seeds:

Foundation seeds are multiplied by the district stations and given free to stock seed growers. Expenses for operating foundation seed farms are appropriated by PDAF on the basis of NT$3,000 per ha.

2. Subsidy to stock seed growers for multiplying stock seeds:

The stock seed growers are given a cash subsidy of NT$1,000 to NT$2,500 per ha. This subsidy is given so that they will render extra labor for insect and disease control work and their seed farms will be subject to field and seed inspection. They are obliged also to sell their seeds to our operating agencies. However, to a new district, a higher subsidy is given so as to stimulate the interest of the farmers in running seed multiplication farms. It is hoped that, after a few years, no government subsidy is required for this item and the expenses for seed multiplication work will be included in the sale of seeds.

3. Subsidy to extension seed growes for multiplying extension seeds:

Extension seed growers are also given a cash subsidy of NT$300 to NT$500 per ha. at present, and it is hoped that this subsidy will eventually be unnecessary. Seeds so produced, however, must be sold to the township farmers' associations for general distribution. Prices for extension seeds are usually a little higher than that of ordinary soybeans. To sell the extension seeds to the farmers at the ordinary price, JCRR had, at the beginning of the extension of new soybean in Miaoli, Hsinchu and Hwalien, given a special subsidy to cover price differentials between buying and selling prices. This subsidy has been suspended since 1958, and the farmers are paying their own a little higher price for extension seeds at present.

4. Subsidy of insecticides for insect control:

In order to ensure that seed multiplication farms are free from insect damages, stock and extension seed growers are given free insecticides Endrin or PM at the government cost for controlling insect pests. These insecticides are procured locally from PDAF and distributed through prefectural and township farmers' associations.

5. Subsidy for packing and transportation of multiplied seeds:

Expenses for packing and transportation of multiplied seeds are also given by the government on the basis of NT$0.01 per kg.

6. Subsidy for processing, storage and distribution of seeds:

The prefectural and township farmers' associations are given expenses for extra labor in processing and drying of seeds during storage. At the time of storage and distribution, some loss of seeds are bound to happen. The government gives some subsidy to cover this loss. The present rate is about NT$0.80 per kg. for processing, storage and distribution.

7. Subsidy for supervision and travelling expenses:

The district stations as well as the prefectural and township farmers' associations are given expenses for supervision of seed multiplication farms. A part of supervision and travelling expenses, however, are paid out from their own budgets for extension work.

8. Other government subsidies:

During the past three years, since the extension of the first soybean variety Sankuo in Miaoli in 1956, JCRR has contributed over three million New Taiwan dollars for soybean varietal and seed improvement work such as setting varietal demonstration plots, holding training classes and farmers' visits and publishing extension circulars, etc. This appropriation is made in line with the JCRR policy of boosting local soybean production through the uses of better varieties, better seeds and better cultural methods.

CORN IMPROVEMENT IN TAIWAN

Y. S. Tsiang and S. C. Chang[1]

Corn is a crop which has shown its wide adaptation to various environmental conditions in Taiwan; it can be grown on any type of soil in any season of the year. Having a relatively short growing period, corn is commonly grown as a winter catch crop on rice field in the central western part of the Island. In the southern and eastern parts, it is often intercropped with sweet potato or soybean on dryland. It is also an ideal crop for hilly land because of its resistance to drought.

Prior to World War II, the largest corn acreage in Taiwan was 2,677 hectares in the year of 1941 with a total production of 3,045 metric tons of shelled corn. After the War, due to the increasing demand of feed as well as food, the acreage of corn has increased year after year. In 1958, the total acreage amounted to 9,199 hectares and production, 12,240 metric tons.

Although corn production has been on an increase every year, the average unit area yield of shelled corn in 1958 was still only 1,330 kilograms per hectare. The use of inferior open-pollinated varieties was the main factor causing this low yield.

This paper reports the work on varietal improvement of corn in Taiwan since 1952 and its results obtained as of March 31, 1959.

Trial of Introduced Hybrid Varieties for the First Time

No attempt has ever been made to improve corn varieties in Taiwan until 1952 when the Joint Commission on Rural Reconstruction (JCRR) introduced from the U. S. A. and Central America sixteen hybrid varieties of various maturity groups and tested them twice in the year at seven localities representing different parts of

1 Senior Specialist and concurrently Secretary-General of the Chinese-American Joint Commission on Rural Reconstruction and Specialist of the Tainan District Agricultural Improvement Station, respectively.

the Island. The results of these trials indicate that even the earliest-maturing varieties such as Wisconsin 355 and Wisconsin 464 did not mature much earlier nor yield higher than the local farmers' varieties. The other hybrid varieties gave better yields, but they were too late in maturity.

From these corn hybrid yield trials, it was also learned that material for corn breeding in Taiwan should be introduced from the northern part of the temperate zone because the early-maturity character possessed in the material therefrom is much desired for fitting into the intensive rotation systems adopted on the Island. It is most likely that any attempt to make use of introduced material from the sub-tropical or tropical zones would be in vain.

Test and Multiplication of Introduced Inbred Lines

Since it is impractical to import hybrid corn seed every year from abroad even for trial purpose, the JCRR and the Tainan District Agricultural Improvement Station have introduced from the U. S. A. the inbred lines involved in the double-cross hybrid varieties which have shown better performance in the above-mentioned trials and also other lines, totalling 70. All the inbred lines were grown twice in 1956 for observation and multiplication and tested for their combining ability by the top-crossing method.

Development of Inbred Lines from Native Varieties by Controlled Pollination

In May 1953, the Tainan District Agricultural Improvement Station made a selection of 301 corn ears from farmers' fields in various parts of the Tainan-Chiayi area; and, beginning from the fall of 1953, the Station has undertaken an inbreeding program by the controlled pollination method. Three generations were grown each year. Through rigid selection, a total of 36 inbred lines have been developed.

In September 1955, another inbreeding program was started with eight farmers' varieties selected from Ilan and Hualien Prefectures. Three generations were grown each year. A total of four inbred lines have been developed.

Test for Combining Ability of Inbred Lines

For the purpose of finding out the combining ability of the inbred lines and selecting the best ones for the production of good hybrid varieties, yield trials were conducted of top-crosses of 21 early-maturing introduced inbred lines in the fall of 1956 and of 252 single crosses in the fall of 1957.

The results of the top-cross yield trial reveal that seven of the 21 introduced inbred lines have shown good combining ability as well as exceeding earliness under the conditions of Taiwan. The performance of the top-crosses involving the seven lines is shown in Table 1.

Table 1.

Yields and Percentages of Moisture at Harvest of Seven Best Top-crosses Tested in 1956

Inbred × Tainan Farmers' Variety	Yield of shelled corn kg/ha.	Yield of shelled corn Index	% Moisture at harvest
Oh 45 ×	7,144	133	20
Oh 26 ×	7,138	133	20
WF 9 ×	7,022	131	22
H 19 ×	6,994	130	20
Oh 28 ×	6,878	128	22
N 1 ×	6,794	127	20
Oh 43 ×	6,694	125	21
Tainan Farmers' Variety (as check)	5,361	100	25

From the single-cross yield trial, it was found that five of the inbred lines introduced from the U. S. A. combined well with each other and also well with the three inbred lines developed locally. The yield indexes and percentages of moisture at harvest of these best-performed single-crosses are shown in Table 2.

Table 2.

Yield Indexes and Percentages of Moisture of Single-crosses between Five American and Four Taiwan Inbred Lines[1]

	Oh 43	Oh 45	Oh 51A	WF 9	A 385	C	H	F
Oh 43								
Oh 45	165 (16)							
Oh 51A	263 (18)	201 (27)						
WF 9	202 (18)	186 (22)	—					
A385	254 (11)	158 (10)	150 (5)	—				
C	161 (18)	250 (16)	230 (11)	170 (26)	140 (15)			
H	163 (16)	309 (12)	236 (14)	—	145 (11)	—		
F	138 (20)	228 (14)	150 (20)	208 (19)	132 (10)	—	—	

1 Yield indexes are expressed in terms of Tainan Farmers' Variety as 100. Percentages of moisture at harvest are indicated in the parentheses as compared to Tainan Farmers' Variety as 24%.

Based upon the data obtained from the trials of top-crosses and single-crosses, three introduced inbred lines, viz., Oh 43, Oh 45 and A385, were selected for use in the production of double-crosses. In spite of their good combining ability and early maturity, all other introduced lines as indicated in Tables 1 and 2 have not been used mainly because of their high susceptibility to Helminthosporium disease.

All the three locally developed inbreds as indicated in Table 2, viz., C, H and F, have been used in the production of double-crosses. In addition, Inbred D, which has relatively long ears and many other desirable characters, has been used as one of the parental lines of double-crosses.

Yield Trials of Double-Cross Hybrids

By using the three introduced inbred lines and the four locally developed inbred lines as mentioned above, the following seven double crosses were made:

Hybrid No.	Double-cross
1	(Oh43 × Oh45) (H × F)
2	(A385 × Oh43) (H × F)
3	(Oh43 × Oh45) (H × C)
4	(A385 × Oh45) (H × F)
5	(Oh43 × Oh45) (D × C)
6	(A385 × Oh43) (D × C)
7	(H × F) (D × C)

In October-December 1958, yield trials of these seven double-cross hybrids together with Tainan Farmers' Variety as check were planted at 26 localities scattering all over the Island. As of March 31, 1959, nineteen trials have been harvested and data compiled but only partially analyzed. The preliminary results of the nineteen trials are summarized in Table 3.

Table 3.

Yields of Shelled Corn and Percentages of Moisture of Seven Double-cross Hybrids at Nineteen Localities, 1958-59[1]

(Taiwan Farmers' Variety Used as Check)

kg./ha.

Locality	Yield & % of moisture	Hybrid No.							
		1	2	3	4	5	6	7	Check variety
Hengchun	Yield	3,495 (252)[2]	2,938 (212)	3,020 (218)	2,568 (185)	3,115 (225)	2,876 (208)	2,828 (204)	1,384 (100)
	% of moisture	31.1	25.0	34.9	38.1	32.8	20.9	28.0	46.5
Pingtung	Yield	6,150 (160)	5,210 (135)	6,562 (171)	5,476 (142)	6,121 (159)	5,349 (139)	4,772 (124)	3,845 (100)
	% of moisture	25.1	24.9	25.5	22.6	26.9	26.9	24.3	38.3

(to be contiuned)

(continued)

Locality	Yield & % of moisture	Hybrid No. 1	2	3	4	5	6	7	Check variety
Tainan	Yield	6,708 (192)	5,806 (166)	6,527 (187)	6,187 (177)	6,562 (188)	6,029 (173)	5,225 (150)	3,494 (100)
	% of moisture	27.9	24.7	28.4	25.4	29.9	25.9	24.7	39.9
Hsinhwa	Yield	6,132 (157)	5,533 (142)	5,646 (145)	5,304 (136)	5,831 (149)	5,757 (147)	5,182 (133)	3,905 (100)
	% of moisture	24.7	22.7	25.3	23.3	26.3	24.7	21.5	37.0
Matou	Yield	4,143 (268)	4,218 (272)	4,444 (287)	4,334 (280)	4,539 (293)	4,417 (285)	4,006 (259)	1,548 (100)
	% of moisture	37.5	30.3	33.8	29.7	34.3	32.0	29.8	47.2
Shunhwa	Yield	6,743 (155)	6,258 (144)	7,250 (167)	6,589 (152)	7,193 (165)	6,733 (155)	5,467 (126)	4,349 (100)
	% of moisture	31.2	28.2	30.4	27.6	32.0	30.3	29.6	44.0
Kwantien	Yield	5,927 (158)	5,850 (156)	5,378 (143)	5,632 (150)	6,044 (161)	6,013 (160)	4,585 (122)	3,762 (100)
	% of moisture	30.9	28.8	31.7	28.8	33.5	32.3	29.6	49.0
Peiho[3]	Yield	4,187 (148)	4,200 (149)	3,943 (140)	3,595 (127)	4,378 (155)	4,121 (146)	3,628 (129)	2,820 (100)
	% of moisture	35.6	33.1	34.8	32.1	40.0	37.0	31.0	49.1
I-chu	Yield	7,422 (138)	6,645 (123)	7,809 (145)	6,509 (121)	7,400 (137)	6,623 (123)	5,842 (108)	5,395 (100)
	% of moisture	33.2	32.0	31.9	29.9	35.4	32.6	30.8	40.8
Loutsou	Yield	5,869 (153)	5,904 (154)	5,774 (150)	5,807 (151)	6,229 (162)	5,974 (155)	3,738 (97)	3 845 (100)
	% of moisture	34.5	29.5	36.5	29.2	39.4	33.6	35.9	51.7
Tapoa	Yield	4,358 (186)	4,633 (211)	4,655 (199)	4,542 (194)	5,103 (218)	5,012 (214)	4,300 (184)	2,341 (100)
	% of moisture	35.8	33.6	36.3	32.6	37.8	37.8	30.0	54.4
Meishan[3]	Yield	5,358 (144)	5,038 (135)	5,373 (144)	4,976 (134)	5,237 (141)	5,132 (138)	4,321 (116)	3,725 (100)
	% of moisture	36.7	33.3	34.3	30.6	39.0	35.5	30.8	54.4
Kuken[4]	Yield	3,221 (599)	3,045 (567)	3,621 (674)	3,059 (569)	3,268 (608)	3,081 (573)	3,377 (628)	537 (100)
	% of moisture	34.5	30.7	31.0	29.6	38.0	32.0	30.3	56.7
Touliu	Yield	5,252 (219)	5,168 (215)	5,452 (227)	5,804 (242)	5,493 (229)	5,001 (208)	4,659 (194)	2,401 (100)
	% of moisture	35.5	30.7	34.0	30.8	37.0	34.3	31.3	42.0
Tuku	Yield	5,035 (161)	4,279 (137)	4,861 (155)	4,364 (140)	5,123 (164)	4,530 (145)	3,754 (120)	3,127 (100)
	% of moisture	32.4	42.4	31.9	33.3	41.3	35.5	28.0	59.0
Tsitong[3]	Yield	6,190 (164)	5,969 (158)	6,268 (166)	5,082 (134)	7,144 (189)	5,524 (146)	4,582 (121)	3,782 (100)
	% of moisture	29.9	28.3	31.0	27.8	33.0	29.3	26.2	42.6
Erlun[3]	Yield	6,232 (194)	5,733 (179)	5,497 (171)	6,147 (192)	6.159 (192)	5,738 (179)	4,843 (151)	3,207 (100)
	% of moisture	38.1	36.3	41.7	35.9	41.1	41.1	38.3	61.4
Hsilo[3]	Yield	5.508 (236)	5,837 (251)	5,129 (220)	5,953 (253)	4,722 (202)	5,256 (225)	4,727 (203)	2,333 (100)
	% of moisture	44.5	40.7	45.5	40.5	53.5	49.4	42.7	70.1

(to be continued)

Locality	Yield & % of moisture	Hybrid No.							
		1	2	3	4	5	6	7	Check variety
Taichung	Yield	7,523 (153)	7,617 (155)	6,755 (138)	7,183 (146)	7,469 (152)	6,832 (139)	6,337 (129)	4,904 (100)
	% of moisture	30.8	28.5	30.2	28.0	32.3	32.8	28.0	49.5
Average	Yield	5,550 (174)	5,257 (165)	5,472 (171)	5,216 (163)	5,638 (176)	5,263 (165)	4,535 (142)	3,195 (100)
	% of moisture	33.2	30.7	33.1	30.3	36.0	32.8	30.0	49.1

[1] Yields of shelled corn were determined at the 15.5% moisture level.

[2] Figures in parentheses are yield indexes which are expressed in terms of the check variety as 100.

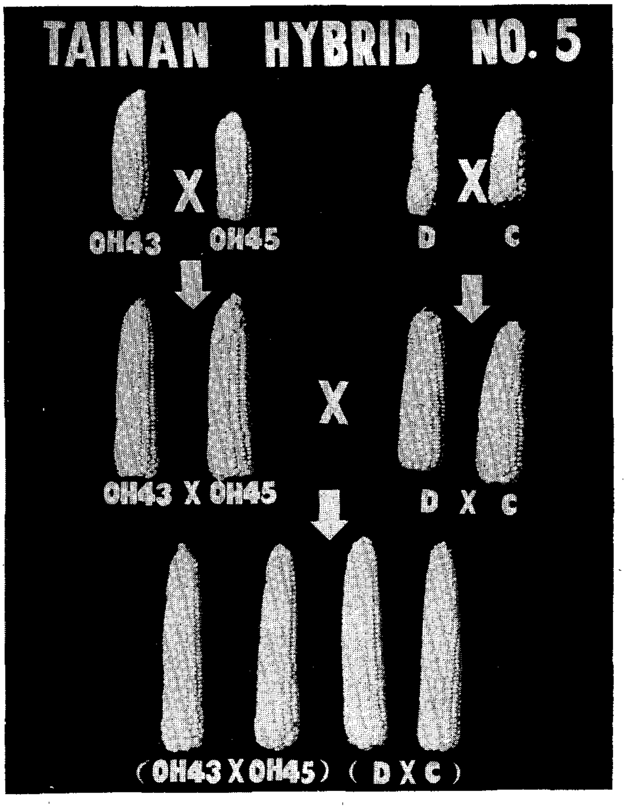
[3] The trials at Peiho, Meishan, Tsitong, Erlun and Hsilo were relay-interplanted; i. e., the corn seed was sown in the later part of October 1958 in rice fields 15-20 days before the harvest of the second crop of rice and the trials were harvested in the early part of February 1959 before the transplanting of rice seedlings for the first crop of 1959.

[4] The soil at Kuken is very sandy, and it was very dry during the growing period of the trial.

From Table 3, it may be seen that all the double-cross hybrids No. 1 to No. 6, each including two American inbred lines and two locally developed inbred lines, are higher in yield and earlier in maturity than the check, Tainan Farmers' Variety. Hybrid Nos. 2, 4 and 6, each having A 385, a line from Minnesota, U. S. A., as one of the parental lines, matured earlier but yielded less than Hybrid Nos. 1, 3 and 5. Hybrid No. 7 also yielded higher and matured earlier than the check variety, but it is a much lower yielder than any of the other hybrids because it has all the four parental lines developed from two native farmers' varieties which resemble each other and have less genetic diversity.

Field observations as well as the analyzed data have shown that Hybrid No. 5 is the best among all the hybrid varieties tested. It outyielded the check variety by a minimum of 37% at Ichu (with 5.4% less in moisture content at harvest) to a maximum of 508% at Kuken (with 18.7% less in moisture content at harvest). The average yield of Hybrid No. 5 in all the nineteen localities is 76% higher than the check variety and its average moisture content at harvest is 13.1% less than the check variety. Yield trials of this hybrid together with other hybrids are being further conducted at seven localities in the spring of 1959. It is expected that Hybrid No. 5 and possibly one or two other hybrids will be selected for seed multiplication and extension in the fall of 1959 for the growing of hybrid corn by farmers in Taiwan for the first time.

The following photo shows the ears of the promising corn variety, Tainan Hybrid No. 5 and its parental inbred lines and single-crosses.



Other Corn Breeding Programs

Tainan District Agricultural Improvement Station, with the assistance of JCRR, has also undertaken the following programs in connection with corn improvement:

A. Breeding for Resistance to Leaf-blight.—There are four inbred lines introduced from the U. S. A., which are very good combiners as well as early-maturing. However, none of them are used as a parent in any of the hybrids mentioned above because of their susceptibility to leaf-blight caused by Helminthosporium. This program is to attempt to introduce the genes for leaf-blight resistance to these four lines from a locally developed line, No. 138, by the back-crossing method.

B. Development of Male-sterile Inbred Lines.—This program aims at the development of male-sterile inbred lines by the back-crossing method in order to reduce the cost of seed production. Oh 51 A^T, which is a male-sterile line sent to Taiwan by the Cornell University, is used as a non-recurrent parent.

C. Development of Dwarf Inbred Lines.—For the purpose of producing dwarf hybrid corn to be grown in windy areas along the sea coast and on the Outlying

Islands, a program is being carried out to transfer the "brachytic-2" type dwarf character from a dwarf line No. 77 to all the normal inbreds used as parental lines of the above-mentioned promising double-cross hybrids.

D. Development of New Inbred Lines and Test for Their Combining Ability.—Thirty lines have been developed from the varieties collected from the aborigines areas in Hsinchu and Wushih. Top-crosses and single-crosses are being made for combining ability test.

E. Regional Trials of Single-crosses.—A number of single crosses involving new inbred lines have been made and tested for their yielding ability at six district agricultural improvement stations.

The above-listed programs are all underway and no results are yet available.

Expected Effect of Hybrid Corn on Taiwan's Agriculture

In Taiwan, the major upland crop is sweet potato, occupying a total acreage of more than 220,000 hectares each year since 1948. About 70% of the crop produced is for hog feed and 30% for human consumption. With the accelerated rate of development of hog raising and also the rapid growth of human population on the Island, the demand of better and more feed and food is greatly increasing. The growing of hybrid corn varieties, which are high-yielding and early-maturing, can partially meet the demand. From the nutritional point of view, corn is of greater value than sweet potato. Moneywise, hybrid corn can bring farmers more income than the sweet potato varieties which are now being grown. It can, therefore, be expected that hybrid corn will not only replace the farmers' corn varieties in the near future, but also take over a part of the land which is now grown to sweet potato. The time will come when more intercropping of hybrid corn with soybean will be made on dryland because the acreage of the latter crop is also rapidly expanding as a result of the extension of newly improved soybean varieties. Since the cultivable land in Taiwan is rather limited, such an intercropping system is most ideal for increasing unit area yield as well as total agricultural production in Taiwan.

With the introduction of corn in the cropping system and the expansion of corn acreage in Taiwan, it can be expected that the agricultural productivity could be further increased with favorable effects on the farmers' economic return and general agricultural development. It also demonstrates a case of technological innovation for the advancement of agriculture which requires relatively less capital outlay in comparison with the increase of output per unit of land.

VEGETABLE SEED PRODUCTION AND DISTRIBUTION IN TAIWAN

Luh, Chi-lin[1] and Wang, Chin-seng[2]

I. The Major Vegetable Crops of Taiwan

Increased vegetable consumption in recent years in Taiwan may be credited to both the increasing demand of protective food by people as a result of the improvement of living standard and the growth of population. In 1948, the total production of vegetable was 487,079 M. T. In 1957, it reached 705,010 M. T. However, when calculated on per capita basis, i. e., 62.3 kg. per person, the quantity of vegetable consumed in 1957 level is still considered less than desirable from the nutrition point of view.

There are many kinds of vegetable crops grown in Taiwan. The ones of more important commercial value are discussed in this paper.

A. The pulse family (*Leguminosae*) grown in Taiwan includes broad bean (*Vicia faba*), Kidney bean (*Phaseolus vulgaris*), lima bean (*Phaseolus limensis*), pea (*Pisum sativum*) and cowpea (*Vigna sinensis*). Except pea and broad bean grown in winter season, nearly all the rest kinds of beans are grown during spring, summer and autumn. Peanut (*Arachis hypogaea*) and soybean (*Glycine max*) are not considered as vegetables but they are grown extensively as dryland crops for food, oil and feed.

B. The Gourd family (*Cucurbitaceae*) grown in Taiwan with economic value consists of cucumber (*Cucumis sativus*), wax gourd (*Benincasa cerifera*), watermelon (*Citrullus vulgaris*), pickling melon (*Cucumis melo var. Conomon*) and vegetable sponge (*Luffa cylindrica*). Watermelon growing is a year-round practice. The other crops are produced principally in the summer seasons.

C. Nightshade family (*Solanaceae*) includes eggplant (*Solanum Melongena* var. *esculentum*), tomato (*Lycopersicon esculentum*), sweet pepper (*Capsicum frutescens*

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var. *grossum*) and potato (*Solanum tuberosum*). These vegetables are also produced on year-round basis, but their main producing seasons are winter and spring.

D. Mustard family (*Cruciferae*) provides the essential leafy vegetables in Taiwan. The important ones are cabbage (*Brassica oleracea* var. *capitata*), Paitsai (*Brassica chinensis*), Shangtung cabbage (*Brassica pekinensis*), leaf mustard (*Brassica juncea*). Besides these leafy crops, rape (*Brassica napus*) provides the vegetable oil, Chinese radish (*Raphanus sativus* var. *longipinnatus*) and kohlrabi (*Brassica caulorapa*) are also the important root and stem crops. Most of these crops are grown in winter and spring seasons, while few are in the summer season, due to the prolonged period of high temperature which retards the plant growth.

E. Lily family (*Lilliaceae*). Vegetables of this family with economic importance consist of onion (*Allum Cepa*), shallot (*Allium ascalonicum*), garlic (*Allium sativum*), Chiu-tsai (*Allium tuberosum*) and yellow day-lily (*Hemerocallis flava*). Except for the onion and garlic, the other crops are produced more or less year-round.

The vegetables of above five families are considered the most important ones grown in Taiwan at present. However, crops of other families, such as carrot (*Daucus Carota* var. *sativa*) of Parsley family (*Umbelliferae*); water convolvulus (*Ipomoea aquatica*) of Morning Glory family (*Convolvulaceae*); lettuce (*Lactuca sativa*), asparagus lettuce (*Lactuca sativa* var. *asparagina*) and Tung Hao tsai "Garland" (*Chrysanthemum coronarium*) of Compositae family; Taro or Dasheen (*Colocasia esculenta*) of A-run family (*Araceae*); ginger (*Zingiber offlcinale*) of Ginger family (*Zingiberaceae*) and spinach (*Spinacia oleracea*) of Goose Foot family (*Chenopodiaceae*) are also popular vegetables and grown in one season or another at different areas of this Island. Sweet potato (*Ipomoea batatas*) of Convolvulaceae is not considered as a vegetable, but as a dryland food and feed crop in Taiwan.

According to the official statistics of the Provincial Department of Agriculture & Forestry, the total area planted to vegetable crops in 1957 amounted to 84,193 hectares with a total production of 705,010 M. T. The production of home gardens is not included in the above figure due to the technical difficulty involved in the statistical compilation. It should also be noted that the production of soybean, peanut and sweet potato is not included in the above figure because they are, as mentioned above, not considered as vegetables.

II. The Supply of Vegetable Seed

The supply of quality seeds is of basic importance to the successful vegetable production. The supply of vegetable seeds in Taiwan has assumed some changes in recent years with respect to the kind, quantity and the source of supply, which may be briefly summarized as follows:

A. The Locally Produced Seeds

In spite of the year-round high temperature of the tropical and sub-tropical weather of Taiwan, local farmers still produce annually a portion of the vegetable seeds they need. Seeds of *Solanaceae, Leguminosae, Cucurbitaceae* and *Convolulaceae* are mostly produced and self supplied by individual vegetable growers without difficulty. Based on the rate of seed-sowing per hectare and the estimated planted area, the amount of seed self-supplied by the vegetable growers is estimated around 320,000 kg. which represented around 80 percent of the total amount of seed consumed in 1957. The total amount of vegetable seeds consumed in 1957 was around 400,000 kg. The planting materials other than seed, such as bulb, tuber and others are not included in the above figure.

Bean seeds are produced on irrigated land in arid sections of southern Taiwan where the foliage is kept dry and anthracnose spot may thus be effectively controlled. Watermelon seed is also produced in the same area during spring and fall when the temperature is comparatively cool. Seeds of local cabbage varieties are produced extensively in the place where the growing temperature is around 55–65°F. Seeds of Fengshan Pai-tsai are multiplied in southern area while those of Huang-chin Pai tsai in the central and northern section of Taiwan. Seeds of native summer radish which is also called Ta-pai-kee are multiplied in central Taiwan; while those of Ta-mei-hwa and Shaw-mei-hwa are produced in the paddy field after the harvest of second rice crop in northern Taiwan. Edible amaranth and water convolvulus seeds are multiplied in Tainan and Taichung areas.

The production of seeds of *Cruciferae* requires special technical care. Effort has been made to produce radish, cauliflower and cabbage seeds locally by selected seed farms operated either by the farmers or by the agricultural stations under a system of controlled production of foundation seeds, stock seeds and extension seeds. The production of Chinese radish seeds by the selected seed farms in 1957 amounted to 13,270 kg., and that of the cauliflower seeds and native cabbage variety 1,722 kg. and 649 kg. respectively. The total amount of cauliflower seed required annually was estimated at 1,000 kg. Thus the seed production of 1957, i. e., 1,722 kg., gave a surplus of some 700 kg. The total seed requirement of cabbage in 1957 was estimated at 4,000 kg. with the amount produced locally being only 649 kg., so it was necessary to import the balance. The production of radish seeds of pickling variety has not only met the local market demand, but also yielded a small surplus available for export.

B. The Imported Seeds

Many other vegetables of the *Cruciferae* family failed to produce seed freely due to the lack of a sufficiently low temperature on the plain to give the chilling effect necessary to flower differentiation. Thus, most seeds of the group and other families of similar nature still have to be imported from the temperate zone countries at present. Except the local varieties, cabbage seeds are imported from Japan. With the expanding acreage of hybrid O-S cross, the demand of Miike-chusei is decreasing. The importation of Minsterland spinach seeds from Japan is increasing in recent years. Considerable quantity of seed potato were also imported from Japan but there is a tendency of decrease in recent years. All carrot and onion seeds are imported directly from the United States of America. The quantity and source of the principal vegetables imported in the recent years are as follows:

Kind of vegetable	Quantity imported (kg.) during[1]			Country of origin	Principal varieties
	1955	1956	1957		
Pai-tsai	10,937	16,527	7,036	Japan, Hongkong	Kyoto No. 3
Cabbage	10,432	6,252	5,138	Japan, USA, Hongkong	O-S cross, Succession
Kohlrabi	1,616	1,374	587	Japan, USA, Hongkong	White Vienna
Chinese Kale	—	9	2	Hongkong	Large leaf
Cauliflower	39	—	1	Japan, U. S. A.	Kenjou
Indian mustard	1,019	4	5	Hongkong	Szechuan Tsai
Celery	4	3	12	U. S. A.	Utah
Lettuce	24	37	73	Japan, USA	Great Lake, Simpson
Spinach	5,541	8,043	9,536	Japan	Minsterland
Water convolvulus	—	1,200	—	Hongkong	Big leaf
Welsh onion	175	332	24	Japan	White Bunching
Onion	3,527	1,680	1,361	U. S. A.	Early Grano, Excel Bermuda
Chu-tsai	35	—	—	Hongkong	
Radish	17,081	293	18	Japan, Hongkong	Minowase, Tapai-kee
Turnip	—	—	10	Japan, Hongkong	Kokabu
Carrot	476	1,651	1,826	Japan, USA	Chantenay
Edible Burdock	159	360	353	Japan	Takinogawa
Watermelon	58	145	2	Japan	Shin Yamato
Squash	—	5	5	U. S. A.	Early Golden Summer
Sweet pepper	1	2	11	Japan, USA	California Wonder
Tomato	19	7	59	Japan, USA	Red top, Roma, Hukuju No. 2
Cucumber	5	7	7	Japan	Ochiai Hushinari

Melon	64	6	21	U. S. A.	RioGold, New Melon
Pea	—	—	45	Japan	Kinusaya white
Cowpea	—	600	1,000	Hongkong	Red seed
Sub-total: (seeds only)	51,212	38,537	27,132		
Irish potato	561,329	396,219	311,577	Japan	Irish Cobbler
Garlic	18,000	55,690	64,190	Hongkong	Soft stem (stalk)
Sub-total: (bulb and tuber)	579,329	451,909	375,767		

[1] Data secured from the Bureau of Quarantine & Inspection, PDAF.

It may be noted from the above table that the volume of the imported seeds is rather small in comparison with the amount produced locally and there is a tendency of decreasing from year to year. The drastic reduction of radish seed importation is especially notable and this is a result of the successful radish seed production promoted under the financial and technical assistance of the government and Joint Commission on Rural Reconstruction (JCRR). As technical improvement of vegetable seed production further improves, the seed import will be further reduced to a few vegetables, for which seed production in Taiwan is impossible at present.

III. Technical Improvement Employed in Vegetable Seed Production in Taiwan

Before World War II, there was nearly no regular vegetable seed production in Taiwan, because all seeds consumed were conveniently shipped in from the mainland China and Japan. Local production of vegetable seeds, however, became a necessity when seed supply was interrupted during the war. In the early post-war years, attention was paid to the seed quantity rather than the improvement of quality. The technique used then was rather primitive. It was not until 1950 that the agricultural stations started to develop vegetable seed production program with government and JCRR assistance. Scientific approach for the improvement of seed purity and uniformity were then emphasized. Improvement is pursued along two major directions:

A. Varietal Improvement

1. Introduction:

Varietal improvement through introduction, being most time saving and economical, is extensively used by the agricultural stations in Taiwan. Numerous kinds and varieties of vegetables have been introduced from other countries and the outlying islands of Taiwan. Among those introduced and tested, the following kinds have shown good adaptation and seed production ability under the local conditions:

Kind	Variety	Source	Characteristics
Kidney bean	Asgrow stringless	U. S. A.	Stringless, early mature
	Green Pod	Ditto	Excellent quality
Broccoli	Texas 107	Ditto	Wide adaptation
	Green Italian	Ditto	Ditto
Watermelon	Sugar Baby	Ditto	High sugar content, good shipping quality
	Iron Armor	Japan	Ditto
Sweet pepper	Ruby King	U. S. A.	Good shipping quality
	Caulifornia Wonder	Ditto	Ditto
Pai-tsai	Kinmen Pai-tsai	Kinmen	Fiberless, early mature

2. Selection:

Another effective and time saving way of varietal improvement used by the local experiment stations is the selection of superior lines among the existing varieties. The most outstanding example of this line of approach is the selection of Fengshan Pai-tsai, a heat-resistant line, selected from the native Pai-tsai varieties by the Fengshan Tropical Horticultural Experiment Station. The obtaining of early and late varieties of cauliflower is the achievement of the Tainan District Agricultural Improvement Station and the Fengshan Tropical Horticultural Experiment Station. The success of these selections made it possible for growers to supply Pai-tsai and cauliflowers for a much longer season than before by planting different varieties at different seasons and thus relieved to a marked extent the summer vegetable shortage of Taiwan.

3. Hybridization:

Breeding through hybridization takes a longer period of time, but is basic to varietal improvement. Hybridization of the native cabbage varieties for obtaining a heat resistant variety and that of cucumber for producing large sized fruits are underway.

B. Improvement of Seed Purity, Uniformity and Viability

1. Maintaining varietal purity:

The two main practices of the vegetable seed growers for maintaining the vegetable varietal purity are the elimination of the off-type plants and the controlled pollination. The controlled pollination is done either by hand pollination or bud pollination and the employment of screen cage. Screen cages are extensively used on large scale stock seed farms of radish. The cages currently used in Taiwan are of two dimensions, i. e., small size: $4' \times 4' \times 6'$ and the large size: $30' \times 20' \times 6'$. Hand pollination is employed in the production of cauliflower stock seed. The elimination of the off-type is usually done before the presence of flower stalk or when the crop reaches full maturity. The plant must be true to the type, any inferior character different from the true type of the given variety should be eliminated. Such practices are especially important to the production of foundation and stock seeds. Field inspection of the extension seed farms operated by contract farmers are made by horticulturist of the agricultural experiment stations to check the varietal purity.

2. Improvement of seed uniformity:

High seed uniformity is obtained by the use of seed cleaners. At present the seed cleaners used in Taiwan are imported from the United States. They are electric cleaners of various capacity, donated to the agricultural experiment stations by the JCRR for the cleaning of foundation and stock seeds. The individual private seed farms are not yet able to own such equipment as their seed production is of rather small amount and the investment in such equipment would not be economical. However, the vegetable seedsmen and seed dealers have been convinced of the advantages of using the cleaners after having seen demonstrations at the agricultural stations. When and if their vegetable seed production increases in volume, the seed cleaners may be extensively used by the seedsmen in Taiwan.

3. Keeping high viability:

The high temperature and high humidity hasten the loss of seed viability especially if storage is inadequate. To help improve the seed storage, a kind of air-tight, well insulated and durable aluminum containers are especially designed and built for the use of various seed farms and marketing centers in storing the locally produced vegetable seeds. Each container had a capacity of 30 gallons. Seedsmen and the contract seed farms received the containers from JCRR on loan basis while the agricultural stations concerned received the seed containers as JCRR grant. The contract seed farms receive government and JCRR assistance in construction of cement drying ground to improve the seed drying and processing. Agricultural experiment stations have started to install cold storage for storing vegetable seeds. With the cold storages installed, the effect of high temperature and high humidity on seed quality may be largely solved, and the production of vegetable foundation and stock seeds in Taiwan will be advanced one-step further.

C. Illustration of the Changing Technique of Vegetable Seed Production in Recent Years

1. Native cabbage varieties:

In the past, after the cabbage head is matured, the field was subject to a careful roguing in late October. Then the outer leaves of each plant were removed, the head was harvested by cutting off at 10–12 cm. above the ground and the remaining stem was left for seed production in the same field.

At present, the sexual phase of the crop has been modified so as to ensure more seed production from limited plants. The heads are removed from carefully selected plants. Then the remaining stems are applied with nitrogen fertilizer to promote sprouting. The sprouts are removed when they attain a height of 5–6 cm. and planted on a specially prepared seedling bed. As soon as new roots are well developed from these sprouts, the sprouts are transplanted to the field for seed production. This method has the benefit of producing more seeds of better quality yet with limited stock.

2. Cauliflower:

The head of ordinary cauliflower is usually too large for seed production. It has been found necessary to remove part of the hypertrophied branches for providing more space and allowing the remaining branches to develop flower stalks freely. In windy area, the hypertrophied branches of the central curd are left for seed production, and the side branches removed, for the central part of the curd is more resistant to wind. In less windy areas, the hypertrophied branches of the central curd are removed and the surrounding branches left for seed production in order to produce more seeds per unit area.

3. Pai-tsai:

The Fengshan Pai-tsai and Huang-chin Pai-tsai are replacing the native Pai-tsai in recent few years. These new lines of Pai-tsai are multiplied under the foundation seed system. Fall sowing are practised for producing high quality seeds in central and southern parts of Taiwan. The field for seed production is isolated. Another line of Pai-tsai introduced recently into Taiwan called Tsing Kang Pai-tsai is a promising one for summer production. The sowing in January in northern Taiwan is found very desirable for seed production.

4. Tomato:

With the improved technique of seed extraction, fermentation and drying, tomato seeds produced in Taiwan have been improved. Discoloring of seed, as usually experienced in the past, can now be effectively controlled by avoiding the fermentation process to not over 48 hours under Taiwan condition.

5. Radish:

The production of radish seed has been developed with improved seed production technique. The pickling variety is multiplied at high altitude to fulfill the low temperature requirement; while the native summer variety, the seed production of which requires no chilling treatment, is produced at the hillfoot of central Taiwan.

IV. Present Situation of Vegetable Seed Distribution and Marketing

A. Seeds Produced by Individual Farmers

Seeds of beans, eggplant, pepper, cucumber, tomato, etc. are produced by *individual vegetable growers themselves, consequently do not appear in commercial* channels in large quantity. The surplus seeds in most cases are collected by township brokers and marketed at township seed-stands in rural areas. The seeds so handled by the seed-stands are usually not properly stored. Seeds are sold to farmers on ounce-basis without bagging nor labeling. Since these seeds are collected bit by bit from many farmers, the uniformity of seeds is also a problem. However, since most growers save their own seeds for this group of vegetables through careful selection, the problems created by the village seed-stands affect only relatively few growers who happen to be short of seeds. This can be avoided in the second season for they will be able to save seeds by selection from the first crop.

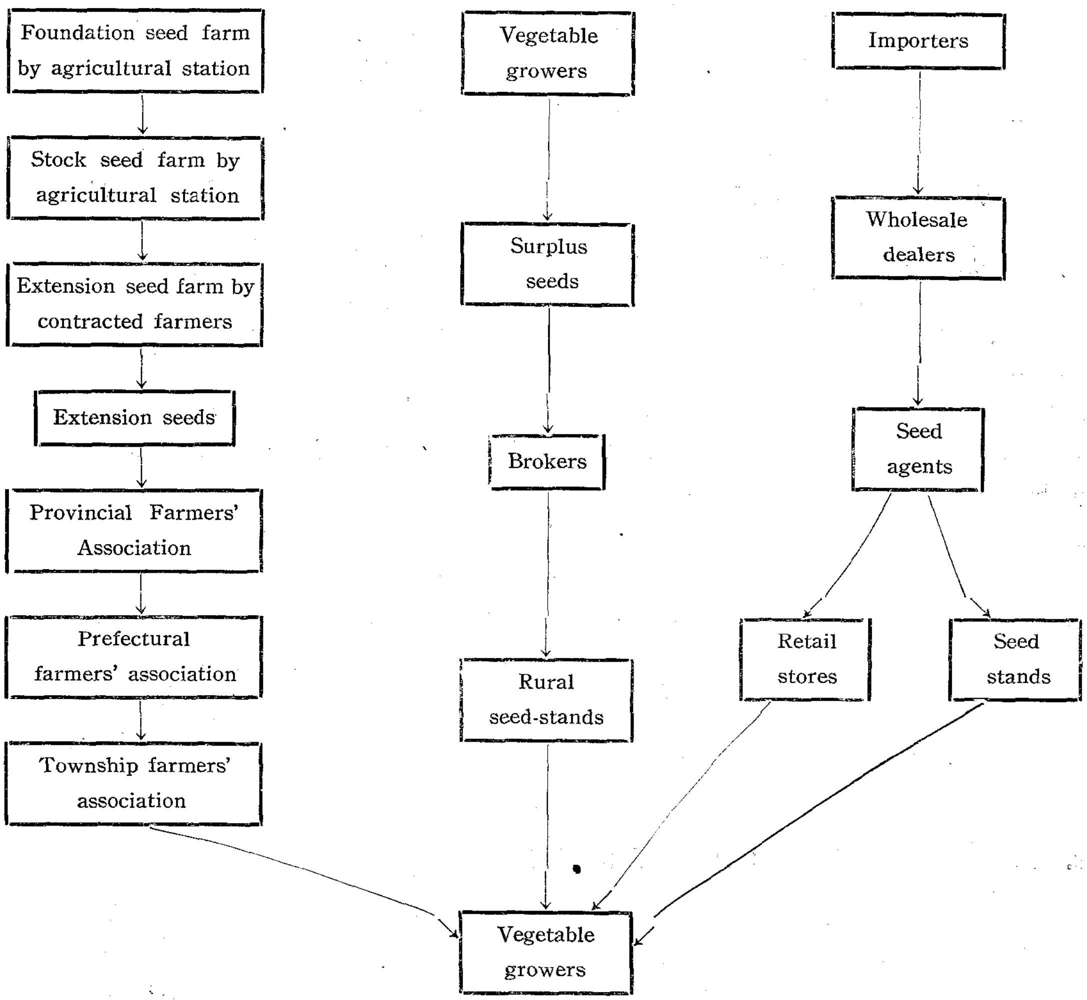
B. Seeds Produced by Contracted Seed Farms

Before 1956, the seeds produced by contracted seed farms, such as the seeds of radish, cauliflower and cabbage, were collected by the Provincial Farmers' Association and then marketed through the prefectural and township farmers' associations. Since 1957, seed farmers are encouraged to sell their seeds through the seedsmen or to market the seeds directly by themselves with the assistance of the farmers' associations. These seeds are usually properly packed in cloth bags and stored.

C. Imported Seeds

The imported vegetable seeds are distributed either by the importers or the seedsmen in Taipei through their agents at different cities and towns. The country agents would supply contracted farmers with free seed samples to run testing fields for seeds of new varieties.

The production and distribution system of vegetable seeds in Taiwan as described above may be illustrated by a diagram as follows:



V. Efforts to be Made for Future Improvement of Vegetable Seed Multiplication, Distribution and Marketing in Taiwan

A. Importation of Vegetable Seeds

Most crops of *Cruciferae* family failed to develop seeds satisfactorily on lowland of Taiwan. Recently experiments have shown that some vegetables of this family succeeded in producing seeds at a high altitude, i. e., 1,000 meters above sea level. However, due to the inadequate transportation facility and nonavailability of land in the mountain area for commercial scale seed production at present, the production of these vegetable seeds is still limited. While today, importation of certain kinds of vegetable seeds is still a necessity, plans are being made to solve the physical difficulties of producing crucifer vegetables at high altitude in the near future.

B. Need of Laboratory Testing of Vegetable Seeds

As mentioned in above paragraphs, vegetable seed farms so far are inspected only in the field for varietal purity. No laboratory inspection of the other important seed quality factors has been made. Since two seed laboratories are being established on this Island, and complete seed certification system has been established for all major food crops, such as rice, sweet potato, wheat, soybean and peanut, the horticulturists are studying the possibility of working out also the procedure and standards for field and laboratory certification of vegetable seeds, at least for those produced by the contracted seed farms.

C. Necessity of Proper Packing and Labelling

Standard bagging, packaging and labelling not yet widely practised by most seedsmen in Taiwan, with the exception of the seeds multiplied by large contracted seed farms under the supervision of the Provincial Farmers' Association. It is not deemed feasible to ask the small village seed-stands to sell locally produced seeds in packages, but it is the policy of the Taiwan Provincial Department of Agriculture & Forestry to promote proper packing and labeling of all seeds produced by large contracted farmers. As the latter expand in scale and variety, it is expected that packaged and labeled vegetable seeds will be more common which will help to gradually build up demand for such seeds by farmers in the future.

D. Stabilization of Seed Price

The price of vegetable seeds on local market tends to fluctuate greatly with the changes of supply and demand. To stabilize the price, a better planning and coordination in the seed production and importation is obviously necessary. The Government has recently given its attention to this problem, and a workable scheme for such planning and coordination is under study.

E. Improvement of Marketing Channel

The present marketing system of vegetable seeds in Taiwan has yet much to be desired as far as seed purity, price stability and distribution channel are concerned. But our immediate concern is with the 20 percent of seeds the general vegetable growers cannot produce by themselves. The main sources of supply of these seeds are two, namely, those produced locally by contracted seed farms and those imported. From practical point of view, it is more difficult to convince the merchants, e. g., vegetable seed importers, city seed wholesalers, township brokers and seed-stand men, to be conscious of the importance of seed purity, viability, uniformity, price stability, packing and labeling. But it is more feasible to educate the local contracted large seed farm operators on these requirements. This is to be pursued by the joint effort of the Provincial Department of Agriculture & Forestry, the farmers' associations, the agricultural experiment stations and JCRR. By research and experiments, it is hoped that the kinds of vegetables and amount of seeds produced locally by contract farmers will expand steadily. By applying field and laboratory inspection, it is hoped that the quality of such seeds will always be up to standard. By insisting on proper packaging and labeling, it is hoped that such seeds will stand out among all seeds made available to farmers. And by regulating the production carefully against demand, kind-wise and region-wise, it is hoped that the supply of quality seeds will be constant and at reasonable price to both growers and seed farm operators.

It is only when the locally produced seeds are well establised and expanded, that the imported seeds will reduce in amount and be forced to adopt the same proper marketing procedures.

As for the 80 percent of vegetable seeds which the farmers can produce for themselves, the future improvement would be to further improve the varieties and the method of seed production, cleaning and storage. It is again a matter of experimentation, demonstration, education and extension.

MULTIPLICATION AND DISTRIBUTION OF ORANGE AND PINEAPPLE PLANTING MATERIAL IN TAIWAN

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I. Orange (*Citrus spp.*)

A. Varieties for Multiplication and Extension

Orange varieties grown in Taiwan are many. However, varieties of commercial value are few. The following varieties are recommended by the Provincial Department of Agriculture & Forestry for multiplication and extension:

1. Ponkan (*Citrus Poonensis*)
2. Tonkan (*Citrus tonkan*)
3. Sikan (*Citrus sinensis*)
4. Valencia Late (*Citrus sinensis*)

Ponkan is a loose skin type orange, Sikan is a tight skin orange and the Tonkan is a kind in between the loose skin and the tight skin group. Both Ponkan and Tonkan are generally called mandarin oranges. Ponkan is marketed in October and November, Sikan from November to January, Tonkan in January and March and Valencia Late appears on the market during March, April and May.

In prewar days, only Ponkan and Tonkan were multiplied and distributed. The selection of tight skin type sweet orange varieties for multiplication and distribution in recent years is made with the hope to prolong the citrus fruit supply season by planting varieties of good keeping quality as well as of later period of maturity. Strains of Sikan and Valencia of superior quality selected from old orchards during mother-tree survey were collected for multiplication and extension. The sweet orange group varieties were also introduced into Taiwan from U. S. A. in 1953 to strengthen the program. The introduced scionwood, after having been grafted on local stalks, has shown satisfactory adaptation and will be valuable in the future citrus multiplication and extension program.

B. The Multiplication System and Its Operation

The present orange multiplication system in Taiwan consists of the following steps: mother-tree survey, collection and distribution of budwood sticks, supervision of nursery management, and extension of nursery trees.

1. Mother-tree survey:

The survey is conducted by agricultural experiment stations concerned in three areas according to the geographical distribution of mother-trees. The areas are divided as follows:

Area	Organization responsible for survey work
Taitung	Taitung District Agricultural Improvement Station
Hsinchu, Taipei & Ilan	Shihlin Horticultural Experiment Station
Taichung & Changhwa	Chiayi Agricultural Experiment Station

The purpose of the survey is to locate and inspect the fruit bearing trees true to the type of the desired varieties. The qualified trees once selected will be recorded as mother-trees from which budwood sticks are collected for multiplication purpose. The following requirements are set for the selection:

Fruit height and width: 6–7 cm.
Fruit weight: 150–200 gm.
Rind thickness: 2–4 mm.
Number of seeds: 0–10 seeds
Number of segments: 10–12 segments
Volume of fruit juice: 80–100 ml.
Brix degree: 10–15 Brix degrees
Acidity: 0.8–1.2%
Tree age: Above 8 years and below 20 years old
Number of fruits per tree: Over 100

The survey is conducted one month prior to harvest. Each selected mother-tree is given a tag with series number for identification. A form is filled out by the survey team workers and brought back for reference and file. Farmers' orchards with registered mother-trees are revisited once every year for checking the growth condition of the selected trees. Those found declining in growth, infested with disease, etc. are discarded. Meanwhile, new mother-trees will be located in each survey to enlarge the source of superior budwood sticks.

Since farm families of Taiwan usually have limited land and the average size of citrus orchard varies from 0.1 to 0.5 hectare, the scatterness of the small orchards made it very difficult for the surveyors to cover all orchards. The total number of trees selected is therefore still rather small, i.e., 1,400 mother-trees, and the amount of budwood sticks available each year for multiplication of superior nursery trees is limited. The government is considering the establishment of mother-tree orchards by agricultural stations and encouraging growers to report voluntarily the quality mother-trees in their own orchards to the agricultural stations so that the propagation program may be accelerated.

2. Selection of certified nurseries:

The collection and distribution of budwood sticks for multiplication is handled jointly by the prefectural governments and agricultural stations concerned. The agricultural stations are responsible for making recommendation on the location, amount and time of collection of the budwood sticks according to field survey record. The prefectural governments concerned are responsible for selecting the qualified nurserymen to receive the propagation materials.

The qualifications of the certified nurseries are as follows:

a. The nursery operator is in possession of 2-year old rootstocks with well developed root system spaced properly in the nursery ready for grafting.

b. Only the budwood sticks of known origin shall be used for multiplication.

c. The improved nursery technique as instructed by the agricultural stations shall be followed. The nursery trees multiplied should be properly managed with respect to the pest control, pruning, etc., before sold to growers.

The privileges of the authorized nurserymen are as follows:

a. The certified nurserymen are entitled to receive the selected budwood sticks free of charge through the prefectural government.

b. The nurserymen will be constantly advised by technical personnel dispatched by the prefectural governments and agricultural stations concerned.

c. The certified nurserymen will have free hand to dispose their nursery trees at prices set by themselves.

d. The qualified nurseries will be assisted by prefectural governments concerned for distribution of nursery trees.

As soon as the date for collecting budwood sticks is set, the owners of the mother-trees are asked to work cooperatively with personnel from prefectural government and agricultural stations for collection of the budwood sticks. In average, 50–100 budwood sticks are taken from each selected mother-tree, varying with age and vigor of the tree and the number of suitable budwood sticks available at the time of collection. Each budwood stick generally has some 4–6 buds. Immediately after taken from the tree, the budwood sticks are packed with moistened mosses, labelled according to variety and wrapped with plastic sheet for quick delivery to assigned nurserymen. The owners of the mother-trees, after collection of the budwood sticks, will receive fertilizers, pesticides or cash payment from the government as compensation. Very recently, the authorized nurserymen have begun to pay for the budwood sticks to the mother-tree owners directly, as they are convinced of the value of using budwood of a known origin.

3. Supervision of certified nurseries:

All the certified nurseries are supervised by horticulturists dispatched either by the prefectural government or by the agricultural stations concerned. The following practices are emphasized in the nursery management.

a. The grafting union must be protected from molding by the application of plastic cover and binding material so as to ensure a better percentage of graft-taken.

b. Percentage of graft-taken at each nursery is frequently checked so that the quantity of nursery trees available for release may be accurately estimated.

c. After having reached a height of 45 cm., the nursery trees are examined for the balanced development of branches, pruning may be practised if necessary.

d. The nurseries are closely inspected with respect to the disease and insect control. The kind of pesticides, concentration of spray and the time of application for controlling various kinds of pests are advised by the prefectural government and the agricultural station concerned.

e. By the time of nursery tree distribution, the nurserymen are asked to spray their trees thoroughly once more in order to minimize the dissemination of pests and diseases.

f. Nursery trees of either low growth vigor or having appearance of off-type mutations are discarded.

4. Distribution of nursery trees:

The amount of nursery trees of different varieties multiplied at each certified nursery is reported annually by prefectural governments concerned. About two months prior to the planting season, each orange-producing township is officially informed the availability of planting materials. In turn, the township office will inform the village chiefs. Based on the amount of nursery tree required by different townships, as reported by the township offices, the prefectural government will arrange with the certified nurseries for distributing nursery trees to various villages. In most cases, the nursery trees are brought back directly to the planting site by the growers themselves after the payment is made to the nurserymen. No burlapping is practised in Taiwan because the distance between the nursery and growers' orchard is usually rather short and trees are planted immediately after delivery.

There is no commercial middleman operating in the government supported multiplication and distribution program. The government acts as a switchboard rendering services but without charging any commission.

This governmental help in passing the information up and down is deemed necessary at the early stage of the program to insure that good growers will get good planting material.

C. Non-certified Nurseries

Stimulated by the increasing demand of oranges on the domestic market as well as the export possibilities, new plantings of different kinds of orange trees have been made steadily by farmers in recent years. Consequently, the propagation of orange nursery trees have also expanded rather rapidly. During the period of 1956–1958, some 500,000 to 800,000 nursery trees were produced and sold by nurserymen to general growers annually. Of this total amount, only 15 to 20 percent are multiplied and marketed under government supervision as mentioned above, while a majority of the nursery trees are multiplied from common budwood by ordinary nurseries, and sold to growers through middlemen. At present, government technical supervision has not yet reached such nurseries. It is hoped that with more quality budwood sticks available and expanded supervision effort, more and more nurseries may improve their management and their nursery trees. Meantime, the existence of the certified nurseries in important citrus producing areas may serve as demonstrations to common nurseries on the proper propagation technic and the advantage of using budwood sticks of known mother-trees.

II. Pineapple (*Ananas comosus*)

A. Variety for Multiplication and Distribution

The selection of pineapple variety for multiplication and extension in Taiwan is based entirely on the fitness for canning. There are several varieties of pineapple grown in Taiwan, Spiny red skin, Yellow skin, Spineless red skin and Dark skin are indigenous varieties; Tainung series No. 1 to No. 8 are hybrid varieties produced by the Chiayi Agricultural Experiment Station in pre-war years (1925–1927); while Smooth Cayenne is an introduced variety. The indigenous varieties can be grown under rather adverse condition, such as in soil of low fertility, land under shade, etc. They can be left in the field for years without replanting and yet still give some yield of fruits, but their fruits are small in size, deep eyed, seedy, of coarse-texture and valueless for canning. The hybrid varieties are mainly for table use readily. They are grown in negligible amount because their fruits, being of low fruit weight, low juice content and low yield, are not suitable for canning. At present, Smooth Cayenne is the only variety recommended for commercial planting. It has large fruit of good quality, fine texture, suitability for canning and good adaptability to local soil and climatic conditions.

B. The Multiplication System

The Smooth Cayenne was introduced into Taiwan before World War I from Hawaii. During the war time and in the early postwar years, it became badly mixed with off-types and had greatly degenerated. Since 1950, in order to rehabilitate the pineapple production in Taiwan, JCRR extended financial and technical support to the Fengshan Tropical Horticultural Experiment Station of the Taiwan Agricultural Research Institute and the Taiwan Pineapple Corporation for initiating and conducting a long range pineapple improvement program through selection and multiplication of the normal Smooth Cayenne variety.

1. Selection of normal Smooth Cayenne from local stock:

Pineapple is propagated annually by its slips, crown or suckers. The natural occurrence of off-type bud mutations even under normal conditions is comparatively high. According to A. D. Shamel's investigation in Hawaii, the production of off-type mutation amounts to as high as 25 percent. To keep the stock pure, continuous selection and eradication are necessary. Consequently the selection from the badly mixed field plants became the first step of the postwar pineapple improvement work in Taiwan. The method of selection adopted may be described briefly as follows:

a. Method of selection:

During the flowering period, a preliminary survey of the plant-crop field is made to observe and record the percentage of flowering as a reference in judging the uniformity of the plant growth. After that, a trained team is dispatched during the period from May to June to do the field selection work on a plant-by-plant basis. Under normal condition in Taiwan, 90 percent of fruit setting is obtained from a plant-crop when the field is properly managed and the plants have a vigorous growth. May and June are the months during which the plant-crop would have developed normal fruit characteristics for observation and selection. The plants of desirable fruit characteristics and normal plant growth will be selected. The selected individual plants are carefully examined at least twice by team members, before they are accepted. A color mark is painted or a color plastic label tagged on the leaf of each selected crown, slip or sucker.

b. Criteria of selection:

(1) Fruit characteristics should be true to the type of normal Smooth Cayenne, i.e., leaves spineless, fruit in cylinderic form, shallow eyed, with few slips (2–4) and the presence of sucker at the time of field survey.

(2) Only plants of normal and healthy growth and free from disease/insect infestations are selected as mother-plants.

(3) Only pineapple fields of plant-crops are chosen for making seedling selection. Selection is not to be made on fields of ratoon crops because the plant characteristics of the ratoon crops are generally not as clearly shown as those of the plant-crop.

(4) The pineapple seedling selection is only practised on the summer fruit crop.

2. Eradication of bad mutation:

Many kinds of off-type plants may be found in the pineapple fields. The eradication of such off-type progenies of Smooth Cayenne from the farmers' field is another approach for the purification of the planting materials. Farmers are advised to eradicate progenies from plants bearing any one of the following undesirable characters: 1) multiple crown, 2) tumor at fruit base, 3) bottle-neck, 4) multiple fruit, 5) eye beauty, 6) long-tom and 7) small fruit.

The field elimination of off-type progenies should be done before the harvest of fruit. Farmers are urged to remove the crown, slips and suckers from the off-type plants as early as possible for saving nutrition for the fruit development. After the eradication, the remaining good seedlings are selected and marked with red paint or tagged with labels before collection. After the completion of the eradication done by farmers, the fields are checked by the field workers from the township offices concerned and inspected by horticulturists of the agricultural stations.

3. Multiplication of planting materials of Smooth Cayenne:

The selected seedlings from desirable mother plants were planted in the nurseries operated either by Taiwan Pineapple Corporation's farms, the contracted growers, or the Fengshan Tropical Horticultural Experiment Station. The nurseries operated by the Taiwan Pineapple Corporation also served to demonstrate the improved cultural method on a commercial scale in conjunction with the use of superior planting material. The size of each individual nursery varied from 0.1 to 1 hectare. The quantity of seedlings selected and the area planted and multiplied in successive selections may be tabulated as follows:

Selection	Year	No. of seedling selected	Area planted (ha.)
Mass selection	1950	2,510,000	97.38
	1951	2,750,000	106.69
Re-selection	1952	1,375,000	55.00
	1953	1,000,000	40.00
Strain selection	1954	120,701	4.80
	1955	226,767	9.00
Clone test	1956	400,000	15.00
	1957	1,000,000	40.00
Adaptation test	1958	2,000,000	80.00
	1959	4,000,000 (goal)	160.00
General selection	1960	10,000,000 (planned)	400.00

Aside from the nurseries mentioned above, some pineapple farmers' fields, after having been carefully eradicated, were used as the sources of comparatively more dependable planting materials, as all undesirable progenies were supposed to have been removed and only better progenies were left in the field. These fields served the multiplication purpose and produced far larger amount of fairly good planting materials than those obtained through selection. The limited area of nurseries and small number of seedlings multiplied by selection were on account of the elaborative and time-consuming survey work required and the fact that there were few competent technical personnel available. On the contrary, the eradication of off-type progenies was done by skilled labor available at all pineapple farms oprated by individual pineapple growers in all pineapple producing areas of this Island.

C. Distribution of Quality Pineapple Seedlings

Commercial planting of pineapple in Taiwan was started in 1902. At that time, the native variety was commonly planted, and no official distribution of planting material was made. Later, the native variety was gradually replaced by the introduced "Smooth Cayenne", upon which the greatly expanded pineapple industry was later built.

With the introduction of pineapple varieties into Taiwan, two farms were established in 1925 and 1927 by the prewar agricultural authority to propagate seedlings of "Smooth Cayenne" for distribution and extension. The distribution was made on loan basis to the pineapple growers.

During the early post-war years, the badly degenerated planting materials was not worthy of official distribution. In these days, farmers obtained planting materials, good or bad, from their own field or from other farmers having surplus seedlings available.

As the demand for planting materials for new plantings grew, systematic supply of quality seedlings was deemed necessary, hence the above-mentioned selection and eradication program was started. As of today, the seedlings selected under selection program are limited in quantity and not yet available for large scale distribution to farmers. All seedlings selected are distributed mostly to the nurseries and farms of the Taiwan Pineapple Corporation and some to the Fengshan Tropical Horticultural Experiment Station and the District Agricultural Improvement Stations at Tainan and Taitung for further multiplication. It is planned that the selected seedlings will be distributed to pineapple growers through demonstration to be handled by the agricultural stations concerned and the Taiwan Pineapple Corporation, when the quantity of the selected planting materials further increases.

In order that new plantings may be made as far as possible with seedlings of good plant character, seedlings on farms of growers who possess comparatively large amount of seedlings of better plant character through practising eradication have been utilized to the best advantage as a stopgap measure for meeting the pressing need of new plantings and for preventing the spreading of the inferior planting materials. Starting the summer of 1956, famers who possess good stocks of planting materials of Smooth Cayenne are kept in record through field survey, and then they are encouraged to distribute their seedlings to other farmers through government support and certification. They are approached by local governments concerned and assisted technically by the technical personnel from agricultural stations for doing the necessary eradication. The seedlings of good plant character are collected, trimmed, sun-cured in the field, packed, and bought by the prefectural governments concerned at a premium price, and distributed to pineapple growers on the basis of cost plus shipping expenses. The prefectural governments concerned make close follow-up supervision of the seedlings distributed.

GRASSLAND DEVELOPMENT IN TAIWAN

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Introduction

Discussions at the First Far East Seed Improvement Conference (1) held in Taiwan in 1956 revealed a tremendous potential for grassland development and subsequent expansion of the livestock industry. Estimates made at that time indicated a potential area of over 21,000,000 hectares in the Far East countries suitable for forage production. The Food & Agriculture Organization of the United Nations Yearbook of Food and Agricultural Statistics for 1956 (2) shows that only 4,030,000 hectares were devoted to permanent meadows and pastures in these same countries, namely, Cambodia, Free China (Taiwan), Indonesia, Japan, Korea, Laos, the Philippines, Thailand and Vietnam. Much of this area is undoubtedly in poor quality forage which could be materially improved.

Meat and Milk Used Annually for Food in the Far East

To meet even the present requirements in Far East countries for meat, milk and other products from roughage consuming livestock requires considerable expansion in the livestock industry. In 1954, 364,000 metric tons of meat from cattle and sheep (roughage consuming animals) were produced. This includes the total production of carcass weight, excluding tallow and edible offal. This would represent the production from the equivalent of 2,080,000 cattle, based on an estimated live weight of 350 kg. each with a 50% dressing percentage. A total of 7,600 metric tons of beef, mutton and lamb representing the equivalent (on the above basis) of 50,600 head of cattle live weight is imported each year. Added to this is 23,200 head of cattle, most of which are brought in for slaughter each year. Thus the equivalent of 2,153,800 cattle (350 kg. in size) are used for food in Far East countries each year. Undoubtedly consumption would be increased if more beef, veal, lamb or mutton were available at reasonable prices.

The imports of dairy products into these countries represent a sizable volume.

In 1954 an estimated 214,400 metric tons of condensed and evaporated milk and 23,100 metric tons of powdered milk were imported. This roughly represents the equivalent of 1,040,800 metric tons of whole milk, and on the basis of an estimated output of 1,500 kg. per cow per year would represent the production from nearly 700,000 milk cows. Add to this the 926,000 metric tons of whole milk produced each year primarily in Japan, by approximately 260,000 milk cows, and nearly a million milking cows would be required to produce the milk that is used for food in the Far East annually. Undoubtedly more dairy products would be consumed if more were available in many of these countries.

In other words, the equivalent of a total of 2,153,800 cattle are required to be slaughtered annually to supply the beef, veal, lamb and mutton, and an amount equal to the annual production of 960,000 milk cows to provide the milk products for the people of the Far East. This in itself represents the direct production from over 3,000,000 animals. Including the animals in the herds required to produce and maintain this production, would indirectly result in a population several times this size. While it may not be feasible to produce livestock, & particularly milk, in all countries sufficient to meet the needs, nevertheless, in most countries considerable savings in foreign exchange now used for importing livestock and dairy products could result from the expansion of the livestock industry.

Grassland Development and Livestock Improvement in Taiwan

Imports of livestock and dairy products into Taiwan represent a substantial sum. The amounts in U.S. dollars for the period 1952–1956 are shown in the following table:

Item	1952 (US$)	1953 (US$)	1954 (US$)	1955 (US$)	1956 (US$)
Beef tallow	1,291,928	1,571,863	1,846,312	2,424,209	2,977,217
Hide & leather	1,776,976	1,208,405	1,714,806	1,098,857	1,772,948
Wool	1,514,909	3,214,000	2,745,465	3,098,857	1,772,948
Dairy products	1,987,261	2,999,940	2,535,660	2,005,266	1,794,532
Breeding stock	12,592	5,169	4,156	2,883	2,450
Others:					
Ham	29,545	150	—	—	—
Lard	1,886	3,251	48	—	—
Pork rind	1,523	10,892	11,278	—	2,928
Beef, canned	—	575	—	—	31
Total	6,616,620	9,014,245	8,857,725	9,007,615	8,034,449

Under the Japanese regime, the peak production of cattle was about 500,000 head (1935–1936). At the present time, Taiwan has a little more than 400,000 head of cattle, mostly draft cattle. Only the older cattle are slaughtered and then only under permit. Dairy cattle are few in number. Most recent estimates are about 2,600 head. Both dairy and beef enterprises can be expanded materially providing sufficient grassland areas can be developed to furnish sufficient good quality forage.

Potential Areas for Grassland Development

According to a recently completed marginal land survey of 1,400,000 hectares of hilly to steep land, having an elevation of 1,000 meters or less, over 70% is submarginal for cultivated crops. Most of this is Class VII land (based on a classification similar to the Land Capability Classification used in the U. S.) which totals about 900,000 hectares. Over half of this or more than 500,000 hectares has inadequate protective cover. About 150,000 hectares of the latter is cultivated at the present time, and another 115,000 hectares is now idle, chiefly abandoned tea, citronella, or sisal plantations or land in a sparse cover of weeds and grass. There is also approximately 250,000 hectares of land which has only a scattered stand of trees and which at the present time affords little protection from erosion. It is estimated that 100,000 hectares of the land now cultivated 92,000 hectares of the idle land and one-half of 125,000 hectares of the thinly forested lands could be developed for forage production. This is a total of 317,000 hectares and would constitute the principal area where early grassland and livestock development should take place. Planted to good species of grasses and legumes and with good fertilization and management practices, this area should be capable of supporting 800,000 mature cattle (or equivalent in animal units of other forage consuming livestock) or twice the present cattle population.

Future expansion may later take place at elevations above 1,000 meters. While there are 1,132,771 hectares of land at elevations over 1,000 meters most of this is extremely steep slopes, is exceptionally rocky or has very shallow soil, or is covered with dense stands of arrow bamboo which would require excessive expense to clear. Likewise, much of this land is inaccessible. About 1% or 100,000 hectares may be suitable and accessible for grassland development. Thus the total potential area for forage production in Taiwan may be about 417,000 hectares. These are tentative figures and when the data from the marginal land survey are completely analyzed, more accurate information will be available.

Development of A Grassland Program in Taiwan

The Taiwan Provincial Department of Agriculture & Forestry and the Chinese-American Joint Commission on Rural Reconstruction have been promoting the development of a grassland program since 1953. Initially, interest centered around the development of grazing farms in mountainous areas to produce draft cattle and also to supply "slack season" grazing for water buffalo and draft cattle during periods when these animals were not needed in the rice fields. Studies on the adaptation of forage crops were also included. This program has expanded so that now the following phases are included:

A. Research—Observations, investigations relative to the adaptability and performance of native and introduced forage crops and their relative productivity.

B. Development of grazing farms on dry upland and mountainous areas.

C. Development of feed and forage crops on government livestock farms and research stations.

D. Assistance to individual small farmers in developing forages for and management of small herds (one or more animals) for milk and beef production.

E. Assistance in developing community grazing areas on dry uplands near villages.

F. Multiplication and distribution of forage crop seed and plant materials.

In 1957 new grasses and legumes were introduced on government livestock stations and to date about 200 hectares of these improved forages have been established on these farms. An additional 140 hectares have been established on private farms and on farms of retired army servicemen. One of the most recent and promising developments has been a project to assist a group of twenty young Northern Taiwan farmers to become small dairy farmers. This is patterned after the program in Japan where farmers have started with one or two cows and have developed forage and increased the number of cows to two or more as feed supplies became available. Each of these men has been given a dairy cow by the Provincial Department of Agriculture & Forestry and he will return the first heifer calf for distribution to other farmers. Each farmer has from one to five hectares of upland on which to raise forage. They also have one or two hectares of rice paddy land which will be used to raise winter grain crops and Astragalus sinicus during the colder period from December to March when the upland forage producing areas are relatively unproductive. These farmers all live within a radius of several miles of each other and the milk is collected and marketed cooperatively at a newly established dairy plant in the center of this area.

Observations on Adaptation of Forage Crops in Taiwan

The early efforts at developing improved forage crops for Taiwan centered largely around alfalfa and some of the other temperate zone legumes. While it was possible to grow alfalfa, the problem was the same as in other subtropical and tropical sections—that of finding some way to grow this legume without the costly weeding required to maintain stands. Alfalfa has thus largely been a disappointment in most of the areas in Taiwan, because of its inability to survive heavy rainfall during certain periods and to compete with weeds. Cost of production has been reported to be about US$ 20 to US$ 30 or more per metric ton of dry hay equivalent. There are a few locations at higher elevations 1,500 meters and above, where alfalfa may have promise. However, here the soils are extremely acid, and sources of limestone are not available close by. The prohibitive cost of transporting limestone to these inaccessible areas rules out the use of alfalfa, for the present. Work, however, is being continued to find more suitable mothods of seeding alfalfa and other legumes and production techniques to make it possible to raise these legumes at a reasonable cost.

In this connection, it is interesting to note that over 87% of the land area of Taiwan is classified as tropical or sub-tropical. The following table prepared by the Taiwan Forest Research Institute shows the climatic zone ranges in Taiwan:

Climatic zones	Percentage of area	Altitude in north (meter)		Altitude in south (meter)	
		From	To	From	To
Tropical	56	Sea level	300	Sea level	600
Sub-tropical	31	300	1,500	600	2,000
Temperate	11	1,500	2,800	2,000	3,500
Frigid	2	2,800	4,000	3,500	4,000

Thus, the area for using temperate zone forages such as alfalfa, etc. is very limited. Major attention has therefore been devoted during the past two years to collecting and testing tropical and sub-tropical grasses and legumes.

Forage Crop Observation Nurseries have recently been established at ten different locations. These range in elevation from 50 meters to 1,750 meters above sea level. All legumes and grasses having forage or soil conservation possibilities have been collected from local as well as from many foreign sources. A total of 100 legumes and 96 grasses are included. These have been seeded in single rows six to eight meters long. They are being observed under varying climatic and soil conditions and the more promising ones are selected for more intensive testing and extension to farmers. A list of the species being tested and the number of varieties or strains of each included is as follows:

Common name	Scientific name	No. of strains or varieties
Tropical or sub-tropical grasses		
Paragrass	Panicum purpurascens	3
Guinea grass	Panicum maximum	4
Blue Panic grass	Panicum antidotale	1
Dallis grass	Paspalum dilatatum	2
Scrobic grass	Paspalum scrobiculatum	1
Bahia grass	Paspalum notatum	2
Pangola grass	Digitaria decumbens	6
Digitaria grass	Digitaria herpaclados	1
African blue grass	Digitaria pentzii	1
Bermuda grass	Cynodon dactylon	6
Star grass	Cynodon plectostachyum	3
Napier grass	Pennisetum purpureum	2
Kikuyu grass	Pennisetum clandestinum	2
Buffel grass	Pennisetum ciliare	1
Rhodes grass	Chloris gayana	2
Carpet grass	Axonopus affinis	1
Imperial grass	Axonopus scoparius	1
Pampas grass	Cortaderia selloana	1
Alabang X	Andropogon nodosus	1
Seacoast bluestem	Andropogon littoralis	1
King Ranch bluestem	Andropogon annulatus	1
Native Andropogon	Andropogon sp.	2
Japanese lawn grass	Zoysia Japonica	2
African pigeon grass	Setaria sphacelata	1
Molasses grass	Melinus minutiflora	1
Weeping love grass	Eragrostis curvula	1
Willaman love grass	Eragrostis superba	1
Delhi grass	Dicanthium annulatum	.1
Temperate zone perennial grasses		
Brome grass	Bromus inermis	3
Orchard grass	Dactylis glomerata	4

Common name	Scientific name	No. of strains or varieties
Tall Fescue	Festuca elatior var arundinacea	4
Timothy	Phleum pratense	1
Harding grass	Phalaris tuberosa var stenoptera	1
Reed Canary grass	Phalaris arundinacea	1
Kentucky blue grass	Poa pratensis	1
Annual Grasses		
Rye grass	Lolium multiflorum	4
Sudan grass	Sorghum vulgare var sudanense	2
Pearl millet	Pennisetum glaucum	1
Oats	Avena sativa	13
Rye	Secale cereale	2
Teosinte	Euchlaena mexicana	1
Perennial Legumes		
Alfalfa	Medicago sativa	6
Birdsfoot trefoil	Lotus corniculatus	4
Big trefoil	Lotus uliginosus	2
Ladino clover	Trifolium repens	3
White clover	Trifolium repens	1
Strawberry clover	Trifolium fragiferum	2
Sericea lespedeza	Lespedeza cuneata	3
Kaimi clover	Desmodium cannum	1
Intortum clover	Desmodium intortum	3
Distortum clover	Desmodium distortum	1
Diffusum clover	Desmodium diffusum	1
Stylo	Stylosanthes gracilis	2
Townsville lucerne	Stylosanthes sundaica	1
Tropical kudzu	Pueraria phaseoloides	4
Native kudzu	Pueraria thunbergiana	1
Centro	Centrosema pubessens	1
Calopogonium	Calopogonium mucunoides	1
Rhodesian kudzu	Glycine Javanica	1
Sulla	Hedysarium coronarium	1
Creeping Indigo	Indigofera endecaphylla	1
Indigofera	Indigofera suffruticosa	1
Sesbania	Sesbania aculeata	1
Biennial Legumes		
Red clover	Trifolium pratense	2
White sweet clover	Melilotus alba	1
Yellow sweet clover	Melilotus officinalis	1
Summer Annual Legumes		
Sweet clover	Melilotus alba	1
Bur clover	Medicago hispida	1
Alyce clover	Alysicarpus vaginalis	1

Common name	Scientific name	No. of strains or varieties
Sesban	Sesbania aegyptica	1
Sesbania	Sesbania exaltata	1
Sunn hemp	Crotalaria juncea	1
Crotalaria	Crotalaria usaramoensis	1
Crotalaria	Crotalaria striata	2
Crotalaria	Crotalaria lanceolata	1
Crotalaria	Crotalaria mucronata	1
Kobe lespedeza	Lespedeza striata	1
Korean lespedeza	Lespedeza stipulacea	4
Phasemy bean	Phaseolus lathyroides	1
Tapilan	Phaseolus calcaratus	1
Victor cowpea	Vigina sinensis	1
Guar	Cyamposis psoraloides	1
Hyacinth bean	Dolichos lablab	1
Winter Annual Legumes		
Austrian winter pea	Pisum arvense	2
Common vetch	Vicia sativa	2
Hairy vetch	Vicia villosa	2
Purple vetch	Vicia atropurpurea	2
Chinese milk vetch	Astragalus sinicus	1
Crimson clover	Trifolium incarnatum	4
Subterranean clover	Trifolium subterranean	2
Berseem clover	Trifolium alexandrium	1
Persian clover	Trifolium resupinatum	1
Yellow lupine	Lupinus luteus	2
Blue lupine	Lupinus angustifolius	2

Most Promising Perennial Grasses

A. Pangola Grass (*Digitalia decumbens*):

Pangola grass appears most promising and has been the most spectacular of all the forages tested for general use in areas from sea level to about 1,000 meters. During the height of the growing season on good soil some of the runners (stolons) grew more than three feet in length in a week's time. When adequately fertilized, it out-yields most other varieties, has a higher protein content, and is likewise a very palatable grass. It also produces a dense cover which suppresses and keeps out all weeds. While it is very prolific, there is little danger of it becoming a serious weed in cultivated fields because it produces little if any viable seed and has no rhizomes. The top growth can be easily controlled by cultivation.

Strain differences have been noted in Pangola. Of two strains introduced two years ago, one brought to Taiwan from the Philippines has proved superior. The other strain obtained in Hawaii looked very promising at first but after the first year has been attacked by what appears to be leaf hoppers. These have drastically reduced production and in some cases almost eliminated stands. The Philippine strain appears resistant to this insect. Recently four additional strains have been introduced but must be tested further before their adaptability and productivity can be determined.

Some indication of the productivity of this grass can be gained from the results of an experiment conducted at the Hsinhua Livestock Research Institute at Tainan to determine the comparative yields of seven grasses. These grasses were planted on April 1, 1958 and following are the yields of four cuttings made between June 27, 1958 and Nov. 17, 1958. At the time of planting, fertilizer was applied at the rate of 250 kg. of ammonium sulphate, 400 kg. of 20% superphosphate and 150 kg. of potassium chloride per hectare. A top-dressing of 100 kg. per hectare of ammonium sulphate was made following each cutting.

Air-dried Weight of Grasses in Grasses (in Kilograms per Hectare)

Variety	Cutting Dates, 1958				
	June 27	Aug. 1	Sept. 18	Nov. 17	Total
Pangola grass, Philippine	9808	3697	5629	4940	24,074
Pangola grass, Hawaiian	9089	3939	5875	3911	22,814
Para grass	7858	3949	6748	6188	24,743
Rhodes grass	7807	2610	4979	4926	20,322
Alabang X	2882	3249	6514	4319	16,964
Coastal Bermuda	7742	2954	4408	3741	18,845
Suwannee Bermuda	7212	2380	3465	3543	16,600

The yield of the Philippine pangola grass and para grass were about the same but the pangola is a much more nutritious and palatable forage, and is reputedly about one and one half times as high in protein as paragrass. The Hawaiian and Philippine strains were about equal in yield for the first three cuttings but the Hawaiian strain was damaged severely by insects prior to the last cutting and the yield and stand were materially reduced. The rainfall pattern at Hsinhua is seven months of wet weather and five months of almost complete drought. The above yields were for the wet season and therefore represent most of the production for one year.

At Hwalien, in eastern Taiwan where rainfall is quite evenly distributed throughout the entire year, Philippine pangola planted on November 29, 1957, produced 197,400 kg. of green forage in six cuttings made between April 25, 1958 and February 27, 1959. During this same period paragrass produced 186,900 kg., African blue grass (*Digitaria pentzii*) 150,400 kg. and Rhodes grass 139,500 kg. No air dried yields were obtained, but if fed green at the rate of 50 kg. per head per day, this production of pangola would be sufficient to support more than nine mature cows on each hectare of land for an entire year.

B. Para grass (*Panicum purpurascens*):

Para grass as indicated by the yields above, is a very productive grass. It is exceptionally well adapted to wet, poorly drained sites and heavy soils. Like pangola it produces no seeds and has no rhizomes which would make it a pest. It also does best at elevations up to 1,000 meters.

Compared to pangola, however, para grass is very coarse, and stemmy and relished much less by livestock. Analyses made in Hawaii indicate that on the average it contains only 6.4% crude protein on a dry weight basis as compared to 9.9% for pangola. Observations are that after several years stands tend to thin out and become weedy.

C. Kikuyu Grass (*Pennisetum clandestinum*):

Two strains of this grass were recently introduced and appears particularly promising for use on steeper, thinner soils which will never be cultivated. It spreads very rapidly and while it does not produce seeds, it has vigorous, persistent rhizomes which could cause it to become a pest.

Kikuyu may be one of the most drought resistant grasses for sub-tropical conditions. One strain was introduced from the vicinity of Bagiuo (elevation 5,000 feet) in the Philippines where it was found to be the only green vegetation following five months of one of the severest drought on record. This was in April, 1959.

D. Star Grass or Pilger's Dogtooth Grass (*Cynodon plectostachyum*):

Star grass is another rather recent introduction to Taiwan from East Africa by way of the U. S. Department of Agriculture. Three strains have been tested and all are different in their growth habit and productivity. The most vigorous and productive strain has been selected for further yield studies. This grass produces seed but the amount and the percentage of viable seed is low. Consequently it is largely propagated from stem cuttings.

Observations indicate this grass to be easily established, fast growing and very productive. Tests are now underway to determine its forage producing ability in comparison with pangola and other grasses.

One drawback concerning this grass has been reported from India and other countries. This is that it contains cyanogenetic substances which may be dangerous to grazing animals. However, this point has been investigated in some detail at the Regional Experiment Station at Biloela in Central Queensland, Australia, where laboratory investigations and actual grazing trials on the species were carried out at different stages of its growth. During the periods of grazing the grass did not prove toxic and the animals did not show symptoms of poisoning when grazed on star grass pasture. Such trials were conducted consecutively for three seasons and no casualty was reported. It was concluded that the risk involved in grazing this otherwise useful species is no greater than with numerous other cyanogenetic species, e.g. sudan grass or sorghums extensively used for grazing. Limited observations of feeding star grass to animals on Taiwan substantiate these findings.

E. Napier Grass (*Pennisetum purpureum*):

Napier grass has been used for many years on Taiwan as a cut-forage for feeding cattle, chiefly dairy cows. Two strains have been tested and one recently introduced from Hawaii appears to be superior to the strain which has been grown in Taiwan for some time. This strain has larger stems, is leafier and remains productive longer in the cold winter months in northern Taiwan.

Napier grass is a very productive grass when managed properly on good soils. However, it is questionable if it is as good as pangola grass even as a cut-forage. While in some cases, yields of Napier may be higher than pangola grass, the protein content is lower and the fiber content higher. In Hawaii (3) average protein content of Napier grass was 4.4% on a dry matter basis as compared to 9.9% for pangola. On poorer soils pangola grass will normally out-yield Napier grass. Annual green weight yields from large fields cut for forage at the Taipei Dairy Farm in northern Taiwan averaged 75,000 kg. per hectare for pangola and only 60,000 kg. for Napier in 1958. Production costs were much lower since it was not necessary to weed pangola whereas cultivation was needed between the rows of Napier grass after each cutting to control the weeds. Pangola also provides better erosion control because of its dense sod forming characteristic.

F. Other Perennial Grasses for Special Purposes:

Several other grasses appear promising only in specific locations and for certain particular purposes. Among these :

a. Alabang X (*Andropogon nodosus*) appears promising as a pasture grass only in extreme southern Taiwan at low elevations. It appears well suited to tropical conditions and is one that is widely used in the Philippines.

b. Buffel grass (*Panicum ciliare*) is a fast growing grass and appears to be suitable for planting as a cover on sandy soil and on sandy and droughty soils as a forage crop.

c. Blue Panic grass (*Panicum antidotale*) develops rapidly from seed and thrives well in the shade. It may serve a useful purpose as a forage grass under Acacia trees.

Annual Grasses

Major attention with annual grasses has been focused upon finding suitable species and varieties which can be seeded in rice paddies for winter forage during the period from December to March. During this period feed for farm animals is normally in short supply, and rice paddies are for the most part idle. Winter oats has been found to be very suitable as a forage during this period. Thirteen varieties were tested during the past winter and one un-named variety imported several years ago from southern United States has proved superior in forage production to all others at elevations up to 400 meters. Above 400 meters, Mustang, a newly developed variety from Oklahoma appears very promising.

One of the problems in this connection is seed production. Farmers cannot afford to leave the oats to mature seeds in their paddy fields because they would lose a rice crop. Consequently, a hundred tons of winter oat seeds are imported each year. The cost of this seed to farmers is very high. During the past two years trials were conducted to determine whether oat seed could be produced on upland soils at an elevation of 500 meters. Very satisfactory yields were obtaind and seed will be extended to farmers in this area for multiplication in 1960.

Two varieties of rye, Elbon and Albruzzi, were tested this past winter and were not productive at lower elevations. However, at 500 meters elevation yields of Elbon rye were very good and seed of this variety will be multiplied and extended to areas above this elevation.

Ryegrass has proved unproductive at elevations below 1,000 meters. However, production at one station having an elevation of 1,000 meters and another at 1,750 meters was very good. The Italian variety appears to be superior to the other varieties tested and should fit in as a cover and forage crop at higher elevations.

Of the summer annual grasses, sudan grass appears to have the most promise. Piper sudan outyields sweet sudan and is more rust resistant. Sudan can be used as an emergency or temporary forage on paddy fields during dry periods when irrigation water is insufficient to produce a rice crop.

Perennial Legumes

The universal problem in tropical and sub-tropical areas remains that of finding suitable productive forage legumes and particularly legumes that will grow in association with grassess. No great progress has been made in Taiwan to date in the solution of this problem. However, there are several legumes which appear promising, at elevations up to 1,000 meters, but before they can be used on a widespread basis must be tested more thoroughly and many aspects of how to properly manage them nust be worked out.

A. Intortum Clover (*Desmodium intortum*):

This is a very palatable legume, that seems to grow best on soils with moderate to high fertility level and where rainfall is moderate but well distributed. In Taiwan it seems to grow best in eastern and central Taiwan at elevations up to about 800 meters, particularly where the soils are not too acid. Trials are underway to determine if it can be satisfactorily grown in mixtures with pangola grass.

Strain differences are evident in the three strains under observation. All appear different and have different growth characteristics. A strain introduced from the Philippines, and which probably originated in Guatemala, appears more productive and covers the ground better than a strain introduced from Hawaii. Both of these will be tested further, however, before one is recommended over the other.

B. Tropical Kudzu (*Pueraria phaseoloides*):

Tropical kudzu is better adapted to southern Taiwan at elevations below 300 meters. In northern Taiwan it loses all of its leaves in the winter months and has difficulty recovering productiveness in the spring. In the south, it grows very dense and produces an abundance of seeds. It will undoubtedly find a place as a legume for limited grazing during the rainy season with the maximum growth held in reserve as carry over in the dry season. It may also be grown in combination with Napier or Guinea grass.

Four strains have been tested and no differences have been noted in three of them. However, one strain from Hawaii does not seem as productive as the others.

C. Centro (*Centroserma pubescens*):

Centro like Kudzu is a creeping legume that has some promise as a forage plant for southern and central Taiwan at elevations up to 300 meters. It is more drought resistant and will tolerate lower temperatures than will tropical kudzu.

D. Stylo (*Stylosanthes gracilis*):

Limited observations indicate this legume has possibilities for forage production at lower elevations. While it is rather slow in establishing itself, stylo is very productive after the first year and appears to be very drought resistant.

E. Koa-haole (*Leucaena glauca*):

This is a common legume all over the tropics and sub-tropics. On Taiwan it is found on soils that are not too acid and at elevations blow 800 meters. It is a woody shrub that produces good forage if it is cut before it reaches 1.5 meters in height. Koa-haole contains a toxic substance called mimosine and can only be fed to poultry and hogs in limited quantities. This legume will probably be used extensively on gravelly river bottoms and on steep slopes on the East Coast where the soils are not too acid. Here it can be established simply by broadcasting the seed during the rainy season.

F. Perennial Legumes for Higher Altitudes:

Among the more promising legumes for altitudes above 1,000 meters are alfalfa, ladino clover, birdsfoot and big trefoil and sericea lespedeza. However, only limited observations have been made and more work needs to be done to determine which of these are suitable for specific sites in the mountainous area.

Annual Legumes

Since no perennial or biennial legume has been found which will be productive and persistent in stands of dense growing perennial grasses at low elevations, overseeding with both summer and winter annual legumes appears to be the most promising method at present to incorporate legumes in such stands. Observations to date indicate that Alyce clover (*Alysicarpus vaginalis*) is the best of the summer annuals for over seeding in the early spring in stands of pangola, kikuyu, and stargrass. Where soils are well limed, however, sweet clover can be used for the same purpose. Victor cowpeas can be seeded between the rows of Napier or Guinea grass. At elevations above 800–1,000 meters common or Korean lespedeza can be used.

Berseem (*Trifolium alexandrium*) and subterranean clover (*Trifolium subterranean*) are the most promising of the winter annuals for overseeding in pangola and other dense growing grasses at elevations up to 1,000 meters. Crimson clover does best at elevations of 500 to 2,000 meters for this same purpose, and while it reseeds at lower elevations is not as productive here as Berseem or subterranean clovers. Sweet yellow lupine can be recommended for planting between rows of Napier or Guinea grass during the winter months.

Astragalus (*Astragalus sinicus*) is a winter annual legume now widely used in northern Taiwan as a green manure crop in paddy fields. It is also a good forage crop and has been used as green feed for hogs, poultry and cattle during the winter months. It is easily established simply by broadcasting in the second rice crop about two weeks before harvest in November.

Plant Materials and Seed Multiplication and Distribution

Forage crop development in Taiwan has not proceeded to the stage where seed certification of forage crop seeds has been practised. However, observations of grasses and legumes reported here show that there are distinct varietal and strain differences among many of the more promising of these. This points to the need in the future for a system which will keep these varieties and strains pure and as the forage crop acreage expands there will no doubt be a need for seed certification of these.

The only forage crop and green manure seed that has been multiplied and extended on a large scale is Astragalus. This legume was introduced to Taiwan many years ago, but only in the winter of 1956–1957 was it planted on a field scale. In the 1958–1959 season over 2,000 hectares was seeded. The initial seed was multiplied on government seed farms and in 1957–1958 distributed to selected farmers' extension seed farms for seed increase. In 1958–1959, additional extension seed farmers were furnished seed for multiplication.

Most of the grasses recommended for planting in Taiwan are propagated from stolons. Since there are strain differences in most of these, it is necessary to prevent them from becoming mixed. Initial propagation of these has been done on government livestock stations. Further increase has been done on private livestock farms and at seedling banks established on prefectural government land. Farmers can secure planting materials from these stations and farms.

Future multiplication and seed certification will be necessary for the promising legumes and grasses previously mentioned. These include winter oats, rye, berseem and subterranean clover, Hubam sweet clover, sweet yellow lupine, alyce clover, Victor cowpeas, intortum clover, tropical kudzu, centrosema, stylo, star grass and buffel grass.

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REPORT ON THE WORK PROGRESS OF THE SEED LABORATORY OF THE COLLEGE OF AGRICULTURE, NATIONAL TAIWAN UNIVERSITY (1957-1959)

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I. Establishment of the NTU Seed Laboratory

After the First Far East Seed Improvement Conference of 1956 in Taipei, immediate action to establish a seed laboratory on this Island was started as recommended by the Conference.

Decision was made that the first Seed Laboratory of this Island be established in College of Agriculture, National Taiwan University with the following objectives:

A. To work out standards and procedures to be adopted in our future seed certification;

B. To give training to both students and workers in charge of seed extension and seed improvement on seed certification methods; and

C. To carry out research work relating to seed technology.

Up to the present, a total of US$27,000 and NT$ (New Taiwan dollars) 821,000 has been earmarked to meet the following expenditures:

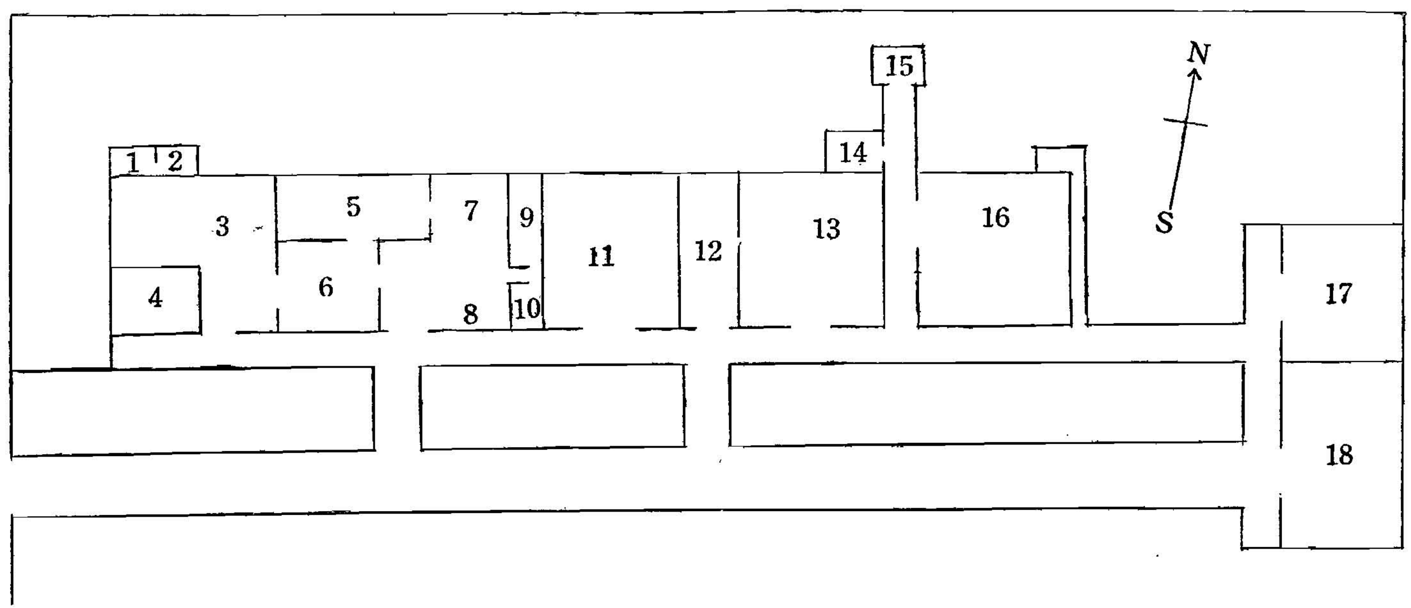
Item	US$	NT$
For Equipment	27,000.00	142,000.00
Supplies	—	48,000.00
Chemicals	—	25,000.00
Operational expenses	—	106,000.00
Remodeling of the Laboratory	—	500,000.00
Total	27,000.00	821,000.00

II. Present Status of the NTU Seed Laboratory

A. Schemes of the NTU Seed Laboratory

The plan on the following page is the schematic drawing of the present NTU Seed Laboratory. It can accommodate a working or training capacity of about 30 persons.

Schematic Drawing of NTU See Laboratory (1:400)



1. Sterilizing Room
2. Storage Place of Sand for Germination Test
3. Germination Test Room
4. Germinator Room Kept in Low Temperature Whole Year Round
5. Purity Analysis Room
6. Weighing Room
7. Moisture Determination Section
8. Sampling Section
9. Office
10. Dark Room
11. Demonstration Room
12. Seed Physiology Research Room
13. Cold Storage Room
14. Motor Chamber
15. Fumigation Room
16. Toilet

17. & 18. Processing and Grading Rooms

B. Equipment Available in NTU Seed Laboratory

Equipment for sampling:

1. Bag trier	6″	2
	9″	2
	11″	2
	12″	2
	18″	2
	30″	2
2. Grain trier		
	40″	2
	51″	2
	63″	2
	66″	2
3. Aluminum grain trier		1
4. Deep bin probes		
	9″	1
	12″	1
	15″	1
	63″	1
5. Iowa ear corn test probe		1
6. Open-end spiral probe		1
7. Peanut trier		2
8. Official cotton seed trier		2
9. Flour trier		2
10. Pelican grain sampler		1
11. Bin thermometer		1
12. Sample bag		2,000
13. Boerner divider		1
14. Precision divider		1
15. Electric blower		1
16. Sampling canvas		6
17. Sample pan		30
18. Sample can		300
19. Storage can		40
20. Desiccator		40

Equipment for purity analysis:

1. South Dakota seed blower

2.	Bates laboratory aspirator	1
3.	Working board for purity analysis	10
4.	Forceps	40
5.	Spatula	40
6.	Magnifier of various types	32
7.	Fluorescent lamp	6
8.	Chemical balance	3
9.	Torsion balance	2
10.	Toledo grain inspection and dockage scale	1
11.	U.S. standard sieves	Complete set
12.	Ro-tap testing sieve shaker	1
13.	Barley sieve	1
14.	Malting barley grading sieve	1
15.	Buckwheat sieve	1
16.	Corn sieve	1
17.	Cotton seed sieve	1
18.	Flax sieve	1
19.	Rice sieve	1
20.	Sorghum sieve	1
21.	Soybean sieve	1
22.	Fine seed sieve	1
23.	Small chess sieve	1
24.	Large chess sieve	1
25.	Weevil sieve	1
26.	Seed specimen bottles	1,000
27.	Stereoscope	2
28.	Microscope	2
29.	Diaphanoscope	2

Equipment for germination tests:

1.	Vacuum seed counter	1
2.	Seed counting board	4
3.	Germinators of various types	12
4.	Daylight germinator	1
5.	Petri dish	2,000
6.	High pressure sterilizer	1
7.	Steam sterilizer	1
8.	Automatic pipetting machine	1

9.	Automatic liquid divider	4
10.	Plastic dishes for sand test	200
11.	Germination media	*
12.	Distillating apparatus	4
13.	Flower pot	400
14.	Other glasswares	*
15.	Continuous temperature changing germinator apparatus	3
16.	Refrigerating cabinet	1

* Enough kinds & quantity for operation.

Equipment for processing, treatment and grading:

1.	Caliper	5
2.	Micrometer	5
3.	Plastic seed measure	1
4.	Weight per bushel tester	3
5.	Filling hopper	1
6.	Specific gravity balance	1
7.	Four-in-one scale	2
8.	Four-purpose grain scale	2
9.	Troemner arbitration scale for grain grading	1
10.	Brauer's grain balance	2
11.	Office clipper tester and cleaner	1
12.	Air oven	2
13.	Water jacketed vacuum oven	2
14.	Brown-Duvel moisture tester	2
15.	Electric moisture tester	2
16.	Pulverizing machine	1
17.	Electric oil tester	1
18.	Stein laboratory mill	1
19.	Seed treater	2
20.	Grain cleaner and grader	1
21.	Grain temperature indicator	1
22.	Seed separator, Krussow double spirals	1
23.	McGill mill for rice	1
24.	Automatic temperature recorder	1
25.	Automatic recording hygrometer	1
26.	Maximum-minimum thermometer	1

27.	Electric rice•huller	1
28.	Peanut grading sieve	4
29.	Motor grinder	1

Other equipment:

1.	Precision Warburg gas apparatus	1
2.	Dehumidifier	2
3.	Air pressure	1
4.	Colorimeter	1
5.	pH meter	1
6.	Constant voltage transformer	3
7.	Electric control clock	2

III. Work Progress of the NTU Seed Laboratory

All work either finished or under progress from October 1957 to present are classified as follows:

A. Work Progress Relating to Seed Testing Procedures

1. Statistical determination on minimum working sample sizes for purity analysis, noxious weed seed analysis and germination test of rice seed:

Since rice is the most important crop on this Island, the above experiment was therefore duly initiated. U. S. official methods were strictly followed in this experiment and statistical analysis based on coefficient of variation and normal curve determination were examined. Results indicate that sample size of 75 grams is minimum for purity analysis, 300 grams for noxious weed seed analysis and 75 grain × 4 replications for germination test.

2. Seed testing procedures for jute seed:

No procedures on this crop is described in the U. S. testing rule. Our results indicate that the minimum working sample size for purity analysis is 10 grams, germination temperature 30°C. constant temperature, first count 3–4 days and final count 6–7 days.

3. Germination comparisons between filter paper and local paper:

Since no germination substrata specified in U. S. seed testing rule are available on this Island, and filter paper of usual laboratory use is too expensive, comparative germination tests between filter paper and various common native paper such as rough bamboo paper, fine bamboo paper and straw paper were conducted with rice, radish, jute, flax, Chinese cabbage, tomato, celery, spinach, soybean, lettuce and mustard seeds. Except spinach seeds, those native paper seemed to be safe and practical in routine germination tests.

4. Alternative method of purity analysis of rice seeds:

In the previous experiment, it was found that the purity analysis method now in use did not satisfactorily express the actual seed quality, so new approach utilizing the specific gravity selection method was planned. Primary results of this new method is satisfactory. Evaluation of this new approach from time and labor consumption as well as variation of results is under progress at present time.

5. Procedures of percentage determination of barn yard millet in rice samples:

Barn yard millet is regarded as noxious weed at present in Taiwan and rice seed containing barn yard millet seed is prohibited for distribution. In present rice trading, analysis of the noxious weed seed has not been inaugurated. Series of experiments were initiated so as to develop a simple, rapid yet accurate analysis method of this noxious weed seed. Blowing tests of South Dakota seed blower with the opening set at 40 seemed to be highly hopeful though further experiments should be exercised before any conclusion can be obtained.

B. Work Progress Relating to Teaching and Training

Up to the present time, three short in-service training classes on seed certification have been held for officers (166 persons) from district agricultural improvement stations and the local prefectural or municipal governments. Besides a general introduction of the seed certification, emphases were placed on the sampling method, especially for those officers from the local governments who were responsible for the collection of official samples, and on the laboratory seed testing methods for those persons from the district agricultural improvement stations.

In the College of Agriculture, 15 senior students took one semester of laboratory course of seed technology, which included practices on seed testing method. More than 150 sophomore students received a 3-week training, and three senior students conducted series of experiments relating to seed technological problems for their graduate thesis.

Discussion meeting on seed testing is usually sponsored by the Provincial

Department of Agriculture & Forestry and the Joint Commission on Rural Reconstruction once or twice every year and information or suggestion inherent to seed testing practice is freely discussed and exchanged.

It has been nearly two years since the beginning of the seed testing practice in this Island. It seems to be opportune to check the personal bias of present seed testing officers. Referee tests on purity analysis and germination tests with rice, peanut, wheat and soybean seeds are expected to be carried out in the near future.

C. Work Progress Relating to Research in Seed Technology

1. Seed quality survey of Taiwan field crops:

In view of the importance of knowing the actual seed quality now being used by farmers before the practice of the seed testing, a survey was programmed. Adequate number of samples from farmers' seed stocks were collected from wheat, sesame, jute, soybean and peanut seeds. Purity analysis, germination tests, moisture content and weed seed analysis were applied to each sample. Due to the long lapse of time from collection to the test, whole lot of wheat seed and germination of peanut samples had to be abandoned. Part of the results as described below clearly indicate the low quality of the present farmers' seed due to the careless handling and poor storage conditions.

Crop	Mode of the frequencies in	
	Purity %	Germination %
Sesame	92-97	65-85
Jute	84-93	40-80
Soybean	90-96	20-80
Peanut	84-98	—

2. Seed quality survey of marketing vegetable seed of Taiwan:

Most of the vegetable seed used by farmers in Taiwan are from seed stores. Therefore, a survey to know the quality of these marketing seeds was started. Samples of Chinese cabbage, radish, spinach, egg-plant, tomato, cabbage, cuccumber, sweet pepper and mustard were collected. Besides purity analysis, weed seed analysis, germination test and moisture content determination are now under progress, and trueness-to-variety test will also be applied in order to evaluate the true value of these seeds.

3. Is One-Half-Seed Rule in purity analysis practical in Taiwan rice production?

Certified seeds should be valuable enough to be used directly as seeds by farmers without any further seed selection practice. From this point-of-view, seeds selected by One-Half-Seed Rule are not practical, at least in Taiwan, where farming is characterized by the intensive cropping system and consequently superior seed is the most important pre-requisite to a good harvest. The reasons for this are that:

a. Though the purity of seeds can reach as high as 98%, yet more than 30% of the pure seeds are valueless;

b. The germination speed is low, and consequently seedlings are poor in uniformity even under favorable condition; and

c. In nursery, particularly under low temperature condition, seedling emergence is very poor and the number of strong seedlings very few.

To develop a new approach of purity analysis of rice seeds is believed the solution to the above.

4. Breaking dormancy of rice grains by sulfuric acid treatment:

Experiences do point out the disturbances of the dormancy on germination tests with the first rice crop seed. Since close association between dormancy and palea and lemma of rice grain was found in previous work, attempt to break the dormancy with sulfuric acid treatment was conducted. On 43 varieties, 16 various seed pretreatment methods to break the dormancy were compared. Sulfuric acid treatment was found to be the most efficient and a 5–10 minute treatment test is recommended for Taiwan rice varieties.

5. Effects of peanut seed size and specific gravity on seedling growth and flowering behavior:

Enough quantity of seed with the following combinations was carefully selected and pot experiment was conducted.

Large seed with specific gravity	over 1.09
Large seed with specific gravity	1.07–1.09
Large seed with specific gravity	1.05–1.07
Small seed with specific gravity	over 1.09
Small seed with specific gravity	1.07–1.09
Small seed with specific gravity	1.05–1.07

Both large seed size and light specific gravity produced better results; however, seed size is much more important than specific gravity. Growth records such as number of normal seedling, plant height and number of leaves as well as flowering record and harvesting records clearly pointed out that large seed with light specific gravity is the best among the above 6 combinations. It is recommended that these two characters be taken into consideration not only in seed testing but also in usual cultural practice. Experiments are now under progress with other oil crop such as sesame, soybean, rape and flax.

D. Other Activities under Progress in NTU Seed Laboratory

In addition to the above work progress, a few long term activities as described below are also under progress in the NTU Seed Laboratory:

1. Weed survey of Taiwan.
2. Specimen collection of weed plants, weed seed and crop seed.
3. Seed referencial card showing the up-to-date information on seed technology of various crops.

A SECOND REPORT ON JCRR ACTIVITIES ON INTERNATIONAL EXCHANGE OF PLANT MATERIALS

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In 1956, a paper was compiled by the Joint Commission on Rural Reconstruction (JCRR) and presented to the First Far East Seed Improvement Conference convened at Taipei on the exchange of plant materials between Taiwan and other countries. During the period from November 1951 to May 1956, over 400 varieties of food crops, fiber crops, forage and cover crops, vegetables, fruits and other miscellaneous crops were introduced to Taiwan for trial and testing purposes. On the other hand, the planting material of 116 local crop varieties were sent to ten different countries in answering to their requests.

From the plant material introduced, the following concrete results have been obtained through testing and research, in addition to the earlier achievement previously mentioned in our first report:

Results Obtained from Introduced Plant Materials

A. Food Crops

1. Rice: Among the introduced Japanese rice varieties, Norin 21, Norin 39 and Norin 41, are found quite promising for their earliness, good yielding capacity and non-sensitivity to day-length. The Aus varieties introduced from E. Pakistan when crossed with Ponlai varieties are found to have given higher rate of fertility than the cross between Ponlai and native rice. It is quite hopeful that these varieties may be of significance as breeding stock in the future rice improvement program of Taiwan.

2. Sweet potato: Okinawa 100 has been found very promising in Taiwan. It is now being included in the Island-wide regional test. This variety is of good quality, good yield and high content of dry matter (giving a high percentage of dried sweet potato chips) and is very hopeful as a commercial variety.

3. Soybean: The efforts made in introduction and testing good foreign soybean varieties have brought remarkable results. Sankuo and Shihshih from Japan and Palmetto from the USA are rapidly changing the entire picture of soybean production in Taiwan. Sankuo is a yellow seed type of soybean with high yielding capacity and is adopted for summer planting (July-November) in northern and eastern Taiwan. The Shihshih is a dwarf type soybean which requires only around 80 days to mature in fall planting. Its earliness makes it especially suitable for planting in central area of Taiwan as a winter crop on paddy field. It has been put under extension since 1958 and predicted to become more and more popular in years to come. Palmetto is a yellow seed type, a high yielder and matures earlier than native varieties in southern Taiwan. It has been put under extension since 1957 in Pingtung and Kaohsiung and has expanded rapidly to an estimated 16,400 ha. in 1959. The acreage of the three new soybean varieties in 1959 is estimated to be more than 28,000 ha., or over 50 percent of the total soybean acreage of Taiwan.

4. Wheat: Wheat is planted on paddy field in Taiwan as a winter cash crop after the harvest of the fall rice crop (or 2nd rice crop). All the commercial wheat varieties now being grown in Taiwan are more or less susceptible to rusts, so the breeding for rust resistance has become the main objective in our present wheat variety improvement program. Since 1953, the rust resistant varieties such as New Thatcher, Timstein and Selkirk introduced from the United States have been crossed with the local varieties for obtaining resistant strains. At least four new strains obtained from the original cross between the (Timstein × New Thatcher) and Taichung 31 have been found more resistant to rust than all the native varieties. Preliminary regional tests conducted at five localities indicated that these four strains are highly resistant in all localities under test. The trial is still under-way.

5. Peanut: Among the introduced peanut varieties, two of them, namely Spanish White and Improved Sp. 2-B-48-1 both introduced from the United States, were found to give better yield than the local check variety, Tainan Peiyutou No. 1. The introduced varieties are being included in the regional varietal test in 1959.

Another two varieties, NC-2 (resistant to Sclerotium Wilt) and C-37 (resistant to Cercospora leaf spot), introduced from the United States have been used to cross with the native varieties for breeding of disease resistance.

6. Corn: Since 1952, a corn improvement program has been started, using introduced and native inbred lines to form single and double crosses. To date, three lines introduced from the United States (Ohio 43, Ohio 45, A 385) are found

to be the best in crossing with four native inbred lines for the production of commercial hybrids. Another four introduced lines (Ohio 51, Ohio 26, Indiana WF 9 and H 19) are being used in the production of experimental double crosses. A male sterile inbred line (Ohio 51A^{T}) is being used by the local breeders for the development of male sterile inbred lines. And a dwarf inbred line, No. 77 also introduced from the USA, is used to cross with normal inbred lines in the hope that a dwarf hybrid corn can be produced for windy area and for intercropping.

B. Miscellaneous Crop

Barley: The varieties, Nungyien No. 2 and Nungyien No. 3, are introduced from India. They have been found very promising through years of trials conducted by the Taiwan Provincial College of Agriculture in Taichung. These varieties will be released for an initial extension of 150 hectares in 1960.

C. Fiber Crops

1. Ramie: There were four varieties of ramie roots introduced to Taiwan in 1957 through the kind assistance of Mr. James M. Demsey, Fiber Consultant to the USOM/Vietnam. After receipt of these ramie roots, they were handed over to the Tainan Fiber Crops Experiment Station for trial planting. The preliminary results indicate that the introduced ramie varieties gave very promising performance in comparison with the local check variety. The test is still under-way.

2. Paw Keo: Paw Keo is a new fiber crop introduced from Thailand to Taiwan in 1957. According to the report of the Thai Government, the crop is of the species *Hibiscus pungens.* Its retted fiber can be used as raw materials for making gunny bags in the place of jute and kenaf (*Hibiscus cannabinus*). After its introduction in 1957, intensive experiments concerning its cultural methods, adaptability, time of planting, rate of fertilization, time of harvesting, method of seed production and pest control were made at various places in Taiwan. Further trial is being made this year so that enough information may be obtained in the nearest future for a careful evaluation of the value of this crop in Taiwan as a jute substitute to be grown to dryland.

D. Horticultural Crops

1. Vegetables: Among the vegetables introduced during the past, quite a few of them are very desirable in the trial plots. The varieties, characteristics and the source of introduction of these promising introduced vegetables are listed in the following table:

Kind	Variety	Promising characteristics	Source of introduction
Broccoli	Texas 107	Wide adaptation	USA
	Green Italian	Wide adaptation	USA
Carrots	Chantenay	High yield	USA
Snap bean	Asgrow Stringless	Stringless, early maturing	USA
Sweet pepper	Ruby King	Good shipping quality	USA
Watermelon	Sugar baby	High sugar content, good shipping quality	USA
	Iron armor	ditto	Japan
Tomato	Manalee	Heat resistant	USA
	Manalucie	Wilt resistant	USA

Theabove varieties have not only entered smoothly into commercial production in Taiwan, but are also good for seed production (with the only exception of carrot which can not produce seeds in Taiwan).

2. Fruit trees:

a. Orange: Among the introduced citrus fruits, the Valencia late, a late maturing sweet orange, proved to be very desirable under the local conditions. The native oranges are of the loose skin type and ripen from November to January. They do not keep well under natural condition and diminish from the market in April. To prolong the supply season of oranges, the Valencia late has been extended for commercial planting in eastern Taiwan. The fruits produced are of good quality and have already enjoyed a good market price. Future expansion of its acreage is very hopeful.

b. Mangoes: In 1954, five mango varieties were introduced to Taiwan from Florida, USA, for trial planting. Among which two varieties, i. e., Irwin and Zill, are the most promising ones. These trees have already reached bearing stage and are very hopeful for future extension.

Work Progress since the First Far East Seed Improvement Conference

The exchange of plant materials among countries is of both scientific interest and economic significance to all concerned. In the First Far East Seed Improvement Conference (FESIC) held in June 1956 in Taiwan, this topic had aroused the interest of all participating countries. In the past, the introduction of plant materials from the United States or other western countries to Asian countries has been made quite extensively while the interchange of plant materials and information among countries in Asia was comparatively small. It was generally agreed that this kind of activities should be strengthened in the future so that the Asian countries could be benefited by the exchange of materials already available in these areas. Therefore before the closing of the FESIC, a recommendation was unanimously passed. The salient points are as follows:

A Seed Exchange Center be established in one of the countries in this area to render the following services to FESIC countries:

A. To collect, compile and keep up-to-date information on crop varieties with useful characters adaptable to various countries and make such information available to all FESIC countries.

B. To serve as a clearing house for seeds from different FESIC countries in case "observation plot" of uniform sets of crop varieties are to be established in different countries, i.e., to receive seeds from different countries, re-distribute them in equal amounts to different countries, and suggest uniform field design and cultural methods, standard form covering, standard field notes, methods of evaluation, etc., for the "observation plots".

C. To follow up the results of seed exchange among countries, to compile results of the "observation plots" in different countries, and to make available such information in the form of reports to all countries concerned.

D. ICA/W be requested to support the operation of such a seed exchange center in this area by providing financial assistance, seeds and information on crop varieties, and other technical assistance as may be needed.

After the First Seed Conference, steps were taken in Taiwan to strengthen the international seed exchange program. Based upon the information supplied by the Taiwan Agricultural Research Institute and its sub-stations and the seven district agricultural improvement stations of the Provincial Department of Agriculture & Forestry (PDAF), the Plant Industry Division of JCRR published the "List of Plant Materials in Taiwan Available for International Exchange" in November 1956. Copies of the list were distributed to all delegates of the First Seed Conference and to the various USOM in Far East Asian countries for reference.

In April 1959, the list was revised and brought up-to-date and are being distributed as a part of the supplementary report of the Chinese Delegation to the Second Far East Seed Improvement Workshop.

Meanwhile, the Plant Industry Division of JCRR has been serving as a seed exchange clearing center of Taiwan by handling the introductions from abroad as well as by sending out plant materials from Taiwan. Introduced planting materials were sent to different district agricultural improvement stations of PDAF or sub-stations of the Taiwan Agricultural Research Institute according to its kind and the function of the station for conducting trial planting or observational test. JCRR keeps in close contact with the recipient agricultural stations on their progress of testing and helps evaluate the results and possibility of extension of the introduced crops or varieties in Taiwan. To date, a total of 379 varieties of planting materials were introduced from 17 different countries to Taiwan since the First Seed Conference in June 1956. (See the attached List I.)

Internationally, the JCRR also works as a medium in supplying plant materials from Taiwan by contacting the local agricultural stations for the requested materials. In some instances, information about the cultural practices, rate of seeding, etc., of the plant material were also supplied to foreign countries upon request. From June 1956 to date, a total of 179 varieties of planting materials were sent by JCRR to 17 different nations from Taiwan. (See the attached List II.)

Both List I and List II do not include plant materials introduced or sent out directly by some of the agricultural stations or individuals.

Attachment to:

A SECOND REPORT ON JCRR ACTIVITIES ON INTERNATIONAL EXCHANGE OF PLANT MATERIALS

List I. Introduced Planting Materials from Foreign Countries

(June 1956—April 1959)

Crop	Source
Food Crop	
A. Rice seeds:	
Padin Kling, Asd 8, Kolamba 184, Ch 45, T 136, Adt 16, Asd 5, Mtu 3, BR 4, Milfor, Ptb 10, Dulor, Ch 47, Asd 2, Ch 62, Kolamba 540, Jhanji 34, T 1145, Rak Pai, Tkm 3, Ch 2, Kala Dumai, Adt 20, Ptb 2, T 3.	FAO/Bangkok
Pokkali	India
Kumari, Dalashaita, Dharial, Kangni, Boro 5, Boro 8, Johna, Palman	FAO/Bangkok
Blue Bonnet, Sun Bonnet	Jamaica
Likuobanei 132, Norin No. 17, Toumoui-masali	Japan
Kataktara, Hatisail, Nazir sail, Badsa Vog, Latisail, Indrasail	East Pakistan
B. Peanut seeds:	
NC-1, NC-2, C-37	North Carolina, USA
Chiba No. 74, Chiba No. 55, Chiba Semi-erect, Tachi-rakuda No. 1, Sakazuki-sei, Java 13	Chiba, Japan
Surin, Chiengmai	Thailand
Native white, Native brown, Tirik, E. G. Red	Philippines
C. Soybean seeds:	
Jackson, Lee, Dorman	Arkansas, USA
Kin, Kanrich	Iowa, USA
Suzunari, Tokachi-hadaka, Pan-yu No. 65, Tokachi-nagaha	Hokkaido, Japan
Norin 1, Norin 2, Norin 3, Tamamusume, Shinmeziro, Kimusume Ibaraki No. 1, Akazaya, Ojiro, Asahi No. 60, Ani, Fuji No. 4	Ibaraki, Japan
Ohojyu, Tokachi-hagada, Oyachi No. 2, Mansokin, Waseitsurunoka, Tokachi-hadaka, Shizunaidaizu, Gindaiza, Lincoln, Marukotsubu, Banseihikarikuro, Richland	Hokkaido, Japan
Soybean (var. unidentified)	USOM/Bangkok
D. Wheat seeds:	
Ramona, Onas 53	USDA, USA
Heines Peko, Nos Nordgan	West Germany
E. Corn seeds:	
Double crosses:	
Minhybrid 512, 608, 609, 711, Experimental CB 2310, Experimental M 119	Minnesota, USA
Inbred lines:	
A340, A334, A203, A116, D5, A264, A556, A392, A218, A208, A509, A265, A427, A357, A344, W9, W59M, A239, A495, A385, A96, MS1334, A251	Minnesota, USA

List I. (continued)

Crop	Source
Cornelli 11, Cornelli 54	ICA/Washington, USA
Philippine Hybrid No. 1a, Philippine Hybrid No. 1c, Philippine Hybrid No. 2, Philippine Hybrid No. 3a, Philippine Hybrid No. 3b, Philippine Hybrid No. 7	Philippines
Philippine Hybrid (yellow) No. 16, White Hybrid (L316×L317) (A211×A213) White Hybrid (L316×L317) (A200×A216) White Hybrid (L316×L317) (A200×A204)	University of Philippines
West Branch Sweep stakes variety Inbred, Oh51A[T] Eight Rowed, Flint variety Single Cross hybrid Inbred, IOD50 Inbred, IOB8 Inbred, NY16 Single cross hybrid (Oh51A×IOB8) Single cross hybrid (NY3×IOD50) Inbred, NY3 Inbred, Oh51A	Cornell University, USA
62-556-59 Ohio W64-12, 62-556-59 Indiana 419a-12 62-556-59 AES 702-12 62-556-59 Indiana 252a-12 Iowa 4570	Iowa, USA
USDA 34 corn, Hawaiian sugar corn, Pajimaca corn	Hawaii
F. Popcorn:	
C-1-Hybrid, C-5-319, C-5-428, C-5-423, C-7-300	Iowa, USA
Miscellaneous Crop	
A. Sorghum:	
Norghum, Reliance Frontier Hybrid grain sorghum 400B Frontier Hybrid grain sorghum 410B Frontier Hybrid grain sorghum 410C Frontier Hybrid grain sorghum S-210	USA
B. Barley:	
Ackermanns MGZ, Heines Pirol	West Germany
C. Sesame:	
Rio Sesamum (PQ×59761), Delco Sesamum (PQ×59761), Palmetto sesamum (PQ×57469)	USDA, USA
D. Cassava stems:	
Santo No. 120, Guaxupe No. 454, Aipim Paraquaio Preto No. 524, Peroqununga No. 637, Cosmopolis No. 744	USOM/Rio de Janeiro
San tan, San Do, San Trang, San Tay, San Trung-Tan, San Blao, Ban gon, Ban TA, Ban mi	Vietnam

List I. (continued)

Crop	Source
Valanca, Mangi, Valanca No. 2, Bitawi No. 123, Mangi No. 4	Indonesia
E. Patula seeds	University of Philippines
F. Sun flower seeds	Vietnam
Fiber Crop	
A. Cotton:	
Deltapine staple, Deltapine smooth leaf, Deltapine 15, Deltapine 1279, D & PI Fox	USA
Stoneville 7, Stoneville 3202, Storm proof, Pope	USA
B. Jute:	
Corchorus capsularis D154, Corchorus olitorius	Dacca, E. Pakistan
C. Kenaf:	
18-3042-1, 18-2058a, 18-1526-1, 18-1436-16, 18-353a-2, 18-14656, 18-691-2, 18-977a, 18-916a, 18-1012a, 18-1254d-1, 18-1440a, 18-2054a, 18-107a-2, 18-101c-2, 18-97g-1, 18-96a-1, 18-93i-1, 18-20276, 18-20329-1, 18-2061a, 18-2045d, 18-2050a, 18-3329-2, 18-3012, 18-3005, 18-3030, 18-3020, 18-3019, 19-41, 19-42, 19-45, 19-51, 19-90, 19-92, 19-131, 19-961, 19-120, 19-124a, 19-125e-1, 19-126h-2, 19-130a, 19-1126, 19-115d, 19-121d, 19-125c, 12040, 19-1003, 19-149, 19-1126c, 19-1087, 19-3041, 19-1002-0, 19-34, 19-136, 19-1124, 19-44, 19-50c, 19-50e, 19-50b, 19-52a, 19-1125a-2, 19-2015-1(a), 19-517, 19-3003-1, 19-3013, 19-920, 19-2030, Cubano, Cuba-108, 19-2032a	Cuba
D. New Zealand Flax:	
Var. unidentified	USA
273×P. colensoi, Wollam seeds P36	USA
E. Paw Keo:	
Paw Keo	Thailand
F. Ramie:	
Murakami, Tatsutyama, P.I. 87521, E53-55	USDA, USA
G. Miscellaneous:	
Thespesia lampas	Laos
Keo Yai Nai Pa	Thailand
Forage and Cover Crop	
Zoysia Tennifolia, Molasses grass, Alabany X, Para grass, Pensacola Bahia, Pangola grass, African Blue grass	USOM/Philippines
Clitoria rubiginosa, Colopogonium mucunoides, Flemingia congesta, Psophocarpus palustris, Desmodium ovalifolium, Pueraria phaseoloides, Centrosema pubescens, Crotalaria anagyroides, Tephrosia candida	Kuala Lumpur, Malaya
Dhaincha	Dacca, E. Pakistan
Horticultural Crop	
A. Vegetables:	
Tropical cabbage	Brazil

List I. (continued)

Crop	Source
New Zealand Spinach	USA
Cowpea, California Black eye	University of Philippines
Irish potato	
Kenrebec, Norin No. 1, Mary Queen	Japan
Cauliflower	Dacca, E. Pakistan
Lettuce	ditto
Radish	ditto
Garden pea	ditto
Tomato	ditto
Spinach	ditto
Ladies finger	ditto
Gram, Lentil, Khesari, Mungbean, Mati kalai, Rahar, Field pea	ditto
Kwantung mustard	
Medium var., late var., 80 days var.	Hongkong
Pea, Manao sugar strain A	Hawaii
Black-eyed pea	Vietnam
B. Fruit trees:	
Coffee:	
Seeds (unidentified)	Hawaii
S-195, S-446, S-333, S-288	Philippines
S-795	India
Cowgill-Wellmen Collection No. 205 112, No. 205 939	USA
Coconut:	
Laguna, San-Ramon, Coconind, Java Dwarf, Davao	Philippines
Chestnut:	
Nanking, Abundance, Meiling	USA
Macadamia nuts:	
Nuuanu, Kakea, Keauhou, Ikaika	Hawaii
No. 246, No. 425	
Kohala No. 386, Keauhou No. 246, Pahau No. 425, Kakea No. 508	
Almond trees	USA
Walnut trees	USA
Jujube trees	USA
Peaches:	
Boholink, Red wing, Robin, Valigold, Springtime	USA
Plums:	
Sierra	USA
Burbank plum-Blueblood hybrid	
Nectarine:	
Panamint	USA
Mango:	
Carabao	Philippines

List I. (continued)

Crop	Source
Musk melon:	
Var. unidentified	Greece
Pistachio nuts:	
Pistacia mutica, Pistacia terebinthus, Pistacia atlantica, Pistacia vera	USA
Cashew nuts	Vietnam
Industrial Crop	
Oil Palm seeds:	
E268, Dumpy seeds (P570), Dumpy Tenera seeds (3/5 & 29, 36)	Kuala Lumpur, Malaya

List II. Planting Materials Sent to Other Countries

(June 1956—April 1959)

Crop	Country[1]
Food Crop	
A. Rice seeds:	
Taichung Special 6, Taichung 65, Taichung 122, Taichung 150, Taichung 153, Taichung 171, Taichung 176, Taichung 178, Taichung 179, Taichung glu. 46, Taichung Native No. 1, Chianan 2, Chianan 8, Chianung 242, Chianung 280, Hsinchu 50, Hsinchu 56, Kaohsiung 10, Kaohsiung 24, Kaohsiung 27, Kwangfu No. 1, Kwangfu 401, Pei-mi-fun, I-kung-pao, Wu-jin No. 2, Kaohsiung Ta-li-ching-yu, Mingtang, Shuen-chiang, Ko-tze, Ma-tze, Dwarf Wu-jin, Pei-ko-early, Natabashme, Kwantung 51, P_i No. 1, Pai-kei-tou, Wu-hsiang-ken, Chungnung No. 4, Ching-lien-sticky, Ryushu	Philippines; Senegal, French West Africa; Cambodia, FAO/Rome, Italy; Iraq; Hongkong; Malaya; E. Pakistan; Vietnam; Tunesia; Ryukyu; Thailand
B. Peanut seeds:	
Tainan Pei-yu-tou No. 1, Tainan Pei-yu-tou No. 2, P-49B-146, Kinarales, Tsingtao, Tainung No. 1	USA, Indonesia, Iraq, Vietnam, Ryukyu
C. Soybean seeds:	
Sankuo, Glycine tomentella, Glycine formosana, Shih-shih, Palmetto	Indonesia, USA, E. Pakistan, Ryukyu
D. Wheat seeds:	
Taichung 2, Taichung 23, Taichung 29, Taichung 31, Taichung 32	Philippines, E. Pakistan
E. Sweet potato:	
Tainung 10, Tainung 45, Tainung 58 (P30), Tainung 31, Tainung 54, Tainung 55, Tainung 57	Philippines, Vietnam, Ryukyu
Miscellaneous Crop	
A. Corn:	
Inbred corn OH45, Inbred corn OH43, Inbred corn 50-14-1, Inbred corn 54-6, Inbred corn 53-5-1-2, Inbred corn W-M13R, Inbred corn A385, Inbred corn A556, Inbred corn TN51-8, Open pollinated corn (white dent)	Vietnam

List II. (continued)

Crop	Country[1]
B. Barley seeds:	
Taichung Special No. 1	Philippines
C. Sorghum seeds:	
Redbine, Westland, Martin, Combine Kafir 60, Midland, Shallu, Caprock, Hegari, Arizona 7078	Vietnam
D. Tobacco	
Vamorr 48, 402, Hicks 41A, Bright yellow, Bottom special, Vesta 64, Virginia gold	E. Pakistan
E. Sesame:	
Tainan Black No. 1, Tainan Black No. 2, Tainan Black selected, Tainan White No. 1, Tainan White No. 2, Chukao T'so Tsailai White, Chukao T'so Tsailai Black, Kweijen Tsailai White, Tainan Tsailai Black, Yenhsing Tsailai White.	Thailand
F. Cassava:	
Wuge, Taipa, Chichao, Hungpe	Brazil
Fiber Crop	
A. Cotton:	
Coker 100 Wilt, Coker 100 Staple, Empire, Kwantung 119	Vietnam, Philippines
B. Jute:	
Huwei green bark No. 7, Taichung Special No. 1, Shuishang green bark, Helmaheira, Peilu	Cambodia, Malaya, Vietnam, Ryukyu
C. Kenaf:	
Cuba A	E. Pakistan
D. Ramie:	
Miyazaki 112, Teh-hsien-tze, Ti-shen, Tainan white skin, Nanhua green skin, Aho white skin	Cambodia, Vietnam
E. Cotton Rose (Hibiscus mutabilis L.)	Vietnam
F. Flax:	
Taichung selected No. 1	Ryukyu
Forage and Cover Crop	
Astragalus, Soybean, Sesbania, Radish, Brown bean, Tephrosia, Mucana, Crotalaria, Cowpea, Poona pea	USA, Laos, Thailand, Vietnam, Hongkong, Philippines
Horticultural Crop	
A. Vegetables:	
Cabbage: Fengshan Paitsai Broad bean: Hsinchu No. 2, Hsinchu No. 6 Cauliflower: Fengshan Hsiashang, Fengshan Extra Early Eggplant: Pingtung Black Long Green pea: Taichung No. 9 Tomato: Taichung No. 3, Victor Snap bean: I-li	Cambodia, USA, Vietnam, Philippines, Thailand, Malaya

List II. (continued)

Crop	Country[1]
Pumpkin: Improved Long type	
Cucumber: Native, First of autumn, Fu-shi-na-li	
Pickling melon: Green skin	
Soup celery: Early green, Yellow heart	
Water convolvulus: Big leaf	
Edible Amarath: Native white	
Vegetable sponge: Taiwan Native	
Broccoli: Italian green	
Wax gourd: Taiwan native	
Asparagus bean: Native green pod	
Paitsai: Taiwan native summer	
Sweet pepper: Ruby King	
Wild ginger: Asarum caudigerun Asarum leptophyllum Asarum grandiflorum Asarum macranthum	
Field pea: Pie-hue-chuen-cha	
Watermelon: Ta-ho yellow, Ta-ho Iron Rind	
B. Fruits:	
Cacao: Kreolen, Fremdling, Ai-mei-row-na-dao	Philippines, Cuba, USA, Thailand, Japan
Papaya: Taiwan Native 1, Native 2, Native 3	
Wild strawberry	
Orange: Ponkan	
Lichi: Wu-yeh	
Apple: Native var.	
C. Miscellaneous crops:	
Orchid	USA
Bamboo: Phyllostachys sp.	USDA, USA
Water lemon: Eugenia aquea	USA

1 Name of foreign country receiving one or more varieties within each group.

LIST OF PLANT MATERIALS IN TAIWAN
AVAILABLE FOR
INTERNATIONAL EXCHANGE

Compiled by

Plant Industry Division, JCRR

Variety	Desirable characteristics	Undesirable characteristics	Period of growth in Taiwan	Season of seed supply
I. Farm Crops				
A. Corn				
Four inbred lines (C,D, F and H)	Early maturity; drought resistance, high combining ability.	—	Year round.	Year round.
B. Jute				
1. Huwei green bark No. 7	Medium maturity; high yield; ability to thrive well in moist area; resistance to Anthracnose; no axil bud.	Sensitivity to photo-period.	Apr.-Sept.	Dec.-Feb.
2. Shuishang green bark	Late maturity; non-sensitivity to day length; less branches; resistance to Anthracnose; high yield.	Less seeds; not performing well on poor soil.	Mar.-Sept.	Oct.-Nov.
C. Peanut				
1. Tainung No. 1	Wide adaptability; large kernel; good quality; high yield; adaptability for both spring and fall plantings.	Thick shell.	Spring planting: Mar.-July Fall planting: Aug.-Dec.	Aug.-Oct. Jan.-Mar.
2. Tsingtao	Good quality; high yield; adaptability for both spring and fall plantings.	Limited regional adaptability.	—ditto—	—ditto—
3. Tainan Pei-yu-dou No. 1	Short and plump kernel with high oil content; high yield; adaptability for both spring and fall plantings.	—	Spring planting: Feb.-July Fall planting: July-Dec.	Aug.-Oct. Jan.-Mar.
4. Tainan Pei-yu-dou No. 2	Flattened kernel with high oil content; high yield.	Limited regional adaptability.	—ditto—	—ditto—
D. Ramie				
Nanhua green bark	Medium maturity; high yield; ability to thrive well in drought season; good fiber quality.	—	Year round.	Nov.-Feb.
E. Rice				
1. Chianan 2	Wide adaptability; resistance to blast; tolerance to heavy fertilization; stiff straw; not shattering easily.	Medium quality.	1st corp: Feb.-June 2nd crop: July-Nov.	July December
2. Chianan 8	High yield; wide adaptability; resistance to diseases; stiff straw; not shattering easily; heavy bearing.	Susceptibility to Sclerotium disease.	—ditto—	—ditto—
3. Chianan 14	Early maturity; stiff straw; resistance to disease; excellent table quality.	Susceptibility to blast; shattering easily.	—ditto—	—ditto—
4. Chianung 242	High yield; resistance to blast; wide adaptability.	Less tillering.	1st crop: Jan.-June 2nd crop: July-Dec.	July December
5. Hsinchu 50	Large and long head; good quality; high yield.	Long straw; lodging easily.	1st crop: Feb.-July 2nd crop: Aug.-Dec.	August December
6. Hsinchu 56	Medium resistance to disease; medium quality; stiff straw.	Long bearing.	—ditto—	—ditto—

(continued)

Variety	Desirable characteristics	Undesirable characteristics	Period of growth in Taiwan	Season of seed supply
7. Kaohsiung 10	Long head; heavy bearing; resistance to Sclerotium disease; good table quality.	Susceptibility to blast.	1st crop: Jan.-May 2nd crop: July-Oct.	June November
8. Kaohsiung 18	Long head; medium bearing; resistance to Sclerotium disease.	—ditto—	—ditto—	—ditto—
9. Kaohsiung 22	Long head; heavy bearing; high yield; adaptability to heavy fertilization; resistance to blast.	Medium table quality.	—ditto—	—ditto—
10. Kaohsiung 24	Medium maturity; adaptability to heavy fertilization; high yield.	Susceptibility to blast disease.	1st crop: Jan.-May 2nd crop: June-Nov.	June November
11. Kaohsiung 27	Long head; heavy bearing; adaptability to heavy fertilization; high quality; resistance to blast.	—	1st crop: Jan.-May 2nd crop: July-Oct.	June November
12. Kaohsiung 53	Medium maturity; adaptability to heavy fertilization; resistance to blast disease; high yield.	—	1st crop: Jan.-May 2nd crop: June-Oct.	June November
13. Kwangfu 1	High resistance to blast; high yield.	Less tillering.	1st crop: Jan.-June 2nd crop: July-Dec.	July December
14. Nungyu 1804	Long head; heavy bearing; early maturity; medium resistance to blast.	Limited adaptability.	1st crop: Jan.-July 2nd crop: July-Nov.	August December
15. Nungyu 1805	Long head; heavy bearing; early maturity; medium resistance to blast; high yield; adaptability to heavy fertilization.	—ditto—	—ditto—	—ditto—
16. Taichung 65	Very wide adaptability; high yield; stiff straw; large head; heavy bearing; good table quality.	Susceptibility to disease.	1st crop: Jan.-July 2nd crop: Aug.-Dec.	August December
17. Taichung 122	High yield; medium head; medium bearing; stiff straw.	—	—ditto—	—ditto—
18. Taichung 150	High stalk; medium tillering; large head; early maturity; medium resistance to diseases.	—	—ditto—	—ditto—
19. Taichung 153	High yield; resistance to disease.	Medium table quality.	—ditto—	—ditto—
20. Taichung 178	Medium maturity; adaptability to heavy fertilization; good table quality; resistance to blast disease.	—	1st crop: Feb.-June 2nd crop: July-Oct.	July November
21. Taichung 179	Resistance to blast disease; adaptability to heavy fertilization; good table quality; more tillers.	Lodging easily.	—ditto—	—ditto—
22. Taichung glutinous 46	Adaptability to heavy fertilization; long head; medium bearing; round and glutinous rice.	Susceptibility to disease;	1st crop: Jan.-July 2nd crop: Aug.-Dec.	August December
23. Taichung Special 6	Early maturity; poor adaptability to heavy fertilization; short awn.	Susceptibility to disease.	—ditto—	—ditto—

(continued)

Variety	Desirable characteristics	Undesirable characteristics	Period of growth in Taiwan	Season of seed supply
24. Taipei 127	Adaptability to heavy fertilization; medium resistance to diseases; medium bearing.	—	1st crop: Mar.-July 2nd crop: July-Dec.	July December
F. Soybean				
1. Palmetto	Early maturity; high yield; adaptability for spring, summer and fall plantings.	—	Spring, summer and fall	July, October and February
2. Sankuo	High yield; medium maturity; good adaptability for summer planting.	High sensitivity to photoperiod.	July-Oct.	Nov.-June
3. Shih-shih	Early maturity; fair yield; good adaptability for fall planting.	Not a high yielder unless closely spaced; susceptibility to purple speck disease.	Spring, summer and fall	July, October and February
G. Sweet potato				
1. Tainung 10	High yield; wide adaptability; late maturity.	—	Aug.-Mar.	Tubers can be supplied from Feb. to Mar.
2. Tainung 17	High starch content; good table quality; adaptability for summer planting; medium maturity.	Medium yield.	July-Aug.	—ditto—
3. Tainung 31	High yield; wide adaptability; medium resistance to drought; late maturity.	Poor adaptability for summer planting.	Aug.-Apr.	Tubers can be supplied from Apr. to June.
4. Tainung 45	High yield; resistance to diseases; early maturity.	—	Aug.-Mar.	Tubers can be supplied from Feb. to Mar.
5. Tainung 57	Good table quality; golden color flesh; early maturity; high yield; wide adaptability.	—	August	—ditto—
6. Tainung 58	Early maturity; high yield; adaptability for spring planting.	Poor adaptability for summer and fall plantings.	Mar.-May	Tubers can be supplied from Oct. to Dec.
H. Wheat				
1. Taichung 2	Medium resistance to rust disease; high yield.	Late maturity.	Oct.-Feb.	Feb.-Sept.
2. Taichung 23	Medium resistance to rust disease; early maturity.	Medium yield.	—ditto—	—ditto—
3. Taichung 29	Resistance to rust disease; early maturity.	Shattering easily; susceptibility to wind damage.	—ditto—	—ditto—
4. Taichung 31	Wide adaptability; high yield; medium maturity.	—	—ditto—	—ditto—
5. Taichung 32	High yield; resistance to rust disease.	Late maturity.	—ditto—	—ditto—

(continued)

Variety	Desirable characteristics	Undesirable characteristics	Period of growth in Taiwan	Season of seed supply
II. Fruits				
Papaya				
1. Solo-1	Heavy bearer; large fruit; good flavor and high sugar content; early maturity.	Over-crowded bearing habit.	Year round.	May
2. Solo-Hawaii 9	Medium fruit; heavy bearer; good flavor; early maturity.	Thin flesh; poor shipping and storage quality; slender leaf stalk; susceptibility to wind damage.	—ditto—	—ditto—
III. Green Manure Crop				
Milk vetch	A leguminous green manure crop; high yield in green matter.	—	Nov.-Feb.	March
IV. Stimulant Crop				
Tea				
1. Tainung 8	Vigorous growth; high yield.	Medium quality.	Perennial.	Seedlings can be supplied from Jan. to Mar.
2. Tainung 29	Vigorous growth.	—ditto—	—ditto—	—ditto—
V. Vegetables				
A. Broadbean				
1. Hsinchu-yu 2	Large seed; good flavor; good table quality.	—	Sept.-Mar.	April
2. Hsinchu-yu 6	Small seed; suitability for green manure crop.	—	—ditto—	—ditto—
B. Cauliflower				
1. Fengshan Hsiashang	Early maturity; resistance to warm climate.	Medium yield; fair quality.	Apr.-Oct.	Feb.-Mar.
2. Fengshan Extra-early	—ditto—	Medium yield.	—ditto—	—ditto—
C. Eggplant				
Pingtung Black long	High yield; resistance to disease; good flavor and keeping quality.	—	Apr.-May	Aug.-Mar.
D. Green pea				
Taichung 9	Early maturity; large seed; suitability for both table and canning purposes.	—	Oct-Jan.	Feb.-Apr.
E. Pai-tsai				
Fengshan Pai-tsai	Resistance to warm climate; good quality; desirable leaf color and plant shape.	Poor tolerance to cold weather.	Apr.-Sept.	Jan.-Mar.
F. Tomato				
Taichung 3	Early maturity; high yield; thick flesh with less seed; suitability for both table and canning uses.	Undesirable fruit shape.	Oct.-Jan.	Mar.-Apr.