

CHINESE-AMERICAN
JOINT COMMISSION ON RURAL RECONSTRUCTION

Plant Industry Series No. 22

CROP AND SEED IMPROVEMENT IN TAIWAN,
REPUBLIC OF CHINA

May 1959 - January 1961



TAIPEI, TAIWAN, CHINA

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FOREWORD

This report contains 25 papers presented by the Delegation of the Republic of China to the Third Far East Seed Improvement Workshop held at Manila, Philippines, from January 31 to February 21, 1961, under the sponsorship of the International Cooperation Administration of the United States Government. The First Workshop was held from June 25 to July 14, 1956, at Taipei, Taiwan, Republic of China, and the Second Workshop from May 11 to 30, 1959, at Tokyo, Japan.

H. T. Chang
Chief
Plant Industry Division

May 1961

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SUMMARY REPORT ON CROP AND SEED IMPROVEMENT IN FREE CHINA, 1959-1960

H. T. Chang

Chief, Plant Industry Division
Chinese-American Joint Commission on Rural Reconstruction

This report is divided into two main parts. Firstly, what China has done in pursuance of the recommendations of the Second Far East Seed Improvement Workshop held in Tokyo in May 1959; and secondly, the progress made in the seed improvement program for various crops since the last Workshop. This report presents only the highlights, while the details are expected to be taken up in different work groups and panel discussions.

I. Actions Taken in Pursuance of the Second FESIW Recommendations

A. An official representative of the Republic of China has been appointed by the Government to the Standing Committee of the Far East Seed Improvement Workshop.

B. A list of our important commercial varieties of crops available for international seed exchange has been prepared according to the contents headings adopted by the Second Workshop and sent to Dr. Louis N. Wise, Executive Secretary of the Standing Committee, and member countries in September 1959. The list has recently been brought up-to-date for presentation to this Workshop.

C. In the fall of 1959, Dr. Don F. Grabe and Mr. C. Hunter Andrews of the Mississippi State University were invited to come to Taiwan and advise on our seed certification program. The two of them, with Mr. Andrews arriving before Dr. Grabe left, stayed in Taiwan for a total of about five months. During their stay, they carefully examined our entire seed multiplication and certification system, made specific suggestions for changes, advised on seed research projects and conducted a four-week training course for our senior seed laboratory workers.

D. Procedures and standards for the certification of ten kinds of field crops and nine groups of vegetables have been finalized with reference to the rules and methods of the International Seed Testing Association and technical advices from

the Mississippi State University team, officially promulgated by the Taiwan Provincial Department of Agriculture & Forestry and put into actual practice. Copies of our procedures and standards will be presented to this Workshop as one of our papers.

E. From August 29 to September 24, 1960, the Republic of China sponsored the first Far East Seed Technology Training Course which was attended by 18 participants from six Far East countries, namely, Korea, Japan, Philippines, Thailand, Vietnam and China. Dr. James C. Delouche, Director of the Mississippi State Seed Laboratory, and Mr. C. Hunter Andrews were invited to be the instructors. A report on the training course has been prepared by the Mississippi State University. We deem this training course a very successful one, and shall be most happy to offer our facilities for the use of similar training courses in the future.

F. A study of the effect of the methods of packing and storage on seed viability has been initiated. A part of the experiment is conducted with local seeds and material, and another part done cooperatively with the Mississippi State University from which three kinds of seeds were packed in 12 different ways and shipped to Taiwan by commercial ocean freight for testing in Taiwan. The Mississippi seeds arrived on June 15, 1960, and monthly tests are being made with samples taken therefrom. The experiment is still under-way. We hope to obtain basic information and gain experience from conducting this type of experiment. In the future, it may be feasible for countries in this area to conduct similar cooperation studies on the effect of shipping through the tropical waters on the quality of seeds.

G. The Taiwan Agricultural Research Institute has been officially designated by our government as the agency to handle international seed exchange with other countries. In the past two workshops, the Chinese Delegation has successively presented two reports on our records of international seed exchange. To this present workshop, we are presenting a third report which brings our records up-to-date. Since June 1959, China has sent out seeds of 158 varieties belonging to 22 crops to 25 countries and has received from 13 countries seeds of 4,205 varieties belonging to 18 crops. The large number of varieties received include 2,949 of soybean variety collection and 1,140 of flax variety collection, both from the United States.

H. With regard to imparting seed improvement information to farmers, the following specific improvements have been made:

1. In the Second Workshop, we have reported on the organization of three crop improvement conferences, i. e. those of rice, upland food crops and vegetables;

by the Taiwan Provincial Department of Agriculture & Forestry. The functions and activities of these three conferences have been further expanded and systematized. And, they are given the specific responsibility of screening and approving varieties for demonstration, multiplication and extension. In the term used by the Work Group No. III in the Second Workshop, these conferences actually perform the duty of the "National Seed Improvement Committee".

2. Under the planning of these conferences and also the Provincial Extension Education Committee, the following numbers (localities) of field demonstrations were carried out on the improved varieties:

Crop	1959		1960	
	By experiment station	By extension service	By experiment station	By extension service
Rice				
<i>japonica</i>	624	415	640	223
<i>indica</i>	—	—	26	—
Sweet potato	86	162	98	79
Soybean*	252	138	260	65
Peanut	120	102	120	22
Wheat	17	—	10	—
Sorghum	12	—	12	—
Barley	20	—	20	—
Corn (hybrid)	50	—	30	—
Rapeseed	60	—	60	—
Vegetable varieties	20	124	20	67
Cotton	26	74	26	87

* New varieties and their cultural practices.

3. As of June 1960, 1,839 farm discussion groups and 3,940 4-H project clubs were organized in Taiwan, with 32,103 and 48,316 members respectively. These groups and clubs conduct meetings regularly at least once a month. Seed improvement program is among the most important items discussed and promoted by them.

II. Progress of Seed Improvement Programs for Various Crops

A. Rice

In the Second Workshop, we reported that our new emphasis of rice breeding was being placed on the resistance to the blast disease, positive response to heavy manuring, stiffness of straw and early maturity. Specially designed greenhouses

and incubation room have been built in 1959 and completed in 1960, wherein seedling reaction to blast can now be studied under controlled temperature and humidity. The technics in determining varietal reaction to rice blast, both by studying seedling reactions and by field observation in disease nurseries, have been further improved. The breeding procedures for *japonica* rice have been overhauled; and more wide crosses, especially those crossed between *japonica* and *indica* varieties, are being made. During 1959-1960, nine new varieties (8 *japonica* & 1 *indica*) from hybridization programs were released for seed increase and extension.

In 1959, a major policy change in rice improvement was decided upon. Ever since the pre-war days and throughout the post-war years, the rice improvement work in Taiwan has been focused on the *japonica* varieties. In view of the fact that the tendency of acreage shift from *indica* towards *japonica* varieties has gradually come to an equilibrium and the acreage of the latter still occupies 35 percent of our total rice acreage, we decided that the *indica* variety improvement should from now on receive equal attention. Field experiments and demonstrations were started in 1960. We look forward to closer exchange of information and germplasm in the future with many of you in this new work of ours.

One important change also took place with regard to the rice seed multiplication program in Taiwan. In the past, our rice extension seeds (from the third and last level of seed farms) were freely exchanged between the seed growers and other farmers with 0-20 percent premium to be decided by the seed growers. Beginning with 1960, the Taiwan Provincial Food Bureau has offered to buy from seed growers, who are willing to sell, all rice extension seeds duly certified by the Taiwan Provincial Seed Testing Laboratory at 15% premium price, store them in warehouses of the local farmers' associations and distribute them to farmers by bartering for common paddy at 1:1 ratio. The local farmers' associations are paid by the Food Bureau a 3% commission for doing this job. This administrative measure gives us added assurance that the improved seeds laboriously multiplied through the 3-level system are in the end fully used for benefitting the farmers needing them. It should be pointed out, however, that this measure becomes practicable only after we have established a sound seed certification system.

B. Sweet Potato and Corn

In the Second Workshop, we reported on the selection for the first time of improved sweet potato varieties of yellow flesh, which are hybrids from local white varieties and Nancy Hall from the United States; and on the successful production also for the first time of our own double-cross hybrid corn varieties from U.S.

inbred lines and our local inbreds. One colored and three white sweet potato varieties were released for extension during 1959 and 1960. In 1960, the yellow sweet potato variety, Tainung No. 57, has reached an acreage of 2,000 hectares. Our health people analyzed it and gave it a high rating in vitamin content in comparison with the existing white varieties, and our home economics workers have joined in the extension of this new celebrity. However, since there are 230,000 ha. of sweet potatoes in Taiwan, this is a mere beginning. In the fall of 1960, 3 hybrid corn varieties, Tainan Nos. 1, 3 and 5, have also reached an acreage of 2,000 hectares equalling to already 20 percent of the existing corn acreage. To strengthen the hybrid corn program, a Corn Improvement Center was established in the summer of 1960 at Putze Township of Chiayi Prefecture under the direction of the Tainan District Agricultural Improvement Station where the work on hybrid corn originated. Laboratory, curing house, seed granary, drying equipment, and dormitories for corn workers were constructed. Our animal industry men are taking an active interest and energetically helping in the hybrid corn extension work.

This moderate start of the extension of colored sweet potato varieties and the hybrid corn marks the beginning of a long range plan for gradually shifting the staple starch feed for hogs in Taiwan from sweet potato to yellow corn and elevating sweet potatoes from mainly a hog feed crop to a supplementary human diet, which, in turn, would help relieve the pressure for rice production increase exerted by our rapidly expanding population.

C. Soybean and Peanut

These two crops are similar in that they both supply edible oil for human consumption and pressed cakes as protein feed for hogs, and both are widely eaten as food.

The improved soybean varieties, Sankuo, Palmetto and Shihshih, released for extension during 1956-1958 have reached a total acreage of 33,490 hectares as of 1960, or over three-fifths of the total soybean acreage. These varieties are adaptable for spring, summer, fall or winter planting at certain localities. In 1960, two more introduced varieties, Acadian from the United States and Wakashima from Japan, were released for extension as varieties for late-fall planting on paddy field in southern Taiwan. Another introduced variety, Dortchsoy from United States, after two years of field testing, is found to be adaptable for spring planting in northern Taiwan. Small scale extension of this variety, the first variety ever recommended for spring planting in the north, will be started this year. The selection of these varieties has a special significance in that, with our intensive cropping

system, it is highly desirable to have varieties of a same crop that can be grown in different seasons of a year so that farmers can choose and fit them into their jig-saw puzzle of growing 3 or 4 crops a year.

So far, the improved soybean varieties released for extension are all introduced varieties; but we have not neglected the indigenous breeding work. Cross breeding work was started by our two agricultural colleges since 1953 and has now reached the stage of the advanced yield test. The progenies show good promises. The irradiation breeding materials, consisting of 10,000 seeds of two varieties sent to the Brookhaven National Laboratory in the United States for treatment with X-rays and thermal neutrons in 1957, have now reached R_6 generation. Thirty-one selected strains have been put into comparative yield test at 6 localities in northern Taiwan in the summer of 1960, and 18 of them are found to be more resistant to *Sclerotium* wilt than the present varieties.

In view of the gradual shifting of our soybean seed improvement program from relying on introduced varieties to developing locally bred ones, effort has been made to enrich the available germplasm for breeding work. We are indeed fortunate and grateful to the Crop Research Division of USDA and its Soybean Regional Laboratory that we were benefited by them in 1960 with some 2,949 soybean varieties, representing a collection from 36 countries in the world and including all ten groups of soybeans planted from north to south in the continental United States. These varieties were planted in southern Taiwan in November 1960; and, rather to our surprise, a great majority of them have set seeds, though they represent a widely varied ecological background. We shall make good use of them in our soybean research program.

Two new varieties of peanut, Tainan Nos. 6 and 7, were released for extension in 1959. They yield about 10 percent better than the native varieties in areas where they are being extended. Our irradiation breeding material of peanut, started also in 1957, has reached R_6 generation in the spring of 1960. Eight lines selected therefrom are proven to be more resistant to *Sclerotium* wilt than the existing varieties and have now been put into comparative yield test.

D. Wheat and Barley

These two crops are being imported every year, wheat for the local flour industry and barley for beer brewing industry. Two new drought resistant varieties of wheat, Tainan Nos. 2 and 3, and three new varieties of barley, Nungyien Nos. 1, 2 and 3, were released for extension in 1960. Another four new wheat varieties,

developed from original crosses made in 1953 between local varieties and American varieties with known rust resistance, and later alternatively back-crossed and selfed three times to local parents, are now in their second year of comparative yield test. They are proven to be more rust resistant than their local parents.

E. Jute and Kenaf

Jute has been the only fiber crop grown commercially in Taiwan for making gunny bags for the export of sugar and rice and for local uses. Kenaf is being planned as a substitute crop for jute on poorer grades of land in the future. A new strain of jute, Y-6-466, developed from pure line selection from an original selection of 11,037 plants made in 1952, has been proven to have taller stem, more resistant to Anthracnose disease, less sensitive to photoperiod and of higher yielding capacity. It will be multiplied for extension in 1961.

Through field tests in the last three years since its first introduction from Thailand in 1957, *Hibiscus pungenis*, now commonly called Thai kenaf in Taiwan, has been found out-performing jute in dryland areas outside of the present jute-growing areas. Though giving a coarser and harder fiber than jute, it possesses a valuable characteristic in that it has so far been immune to nematode disease which attacks both jute and *Hibiscus cannabinus*, the common kenaf. The introduced variety, after purification, may soon be multiplied and extended as it is. A breeding program for this Thai kenaf has been started for further improvement.

Varietal experiment on common kenaf, including both introduced varieties and locally selected strains, has reached the stage of regional test.

F. Sugarcane

Three new varieties were released for extension in 1959 and 1960. F146 is considered the best of all and an initial extension of 3,000 hectares is planned for the 1961-62 crop. In 1960, a total of 113 sets of regional varietal tests of various kinds was carried out by the Taiwan Sugar Experiment Station at 22 localities. Efforts are still being continued to find varieties better than NCo 310, which since 1955 has been the king of cane varieties in Taiwan.

G. Rapeseed

Rapeseed has always been a minor winter green manure crop on paddy field in northern Taiwan. Its seed improvement for oil production was started in 1953 by introduction of foreign varieties and selection from local varieties. After six years of observation, testing and demonstration, three improved varieties, Nungling

No. 20 from Japan, Taichung Series No. 1 and Hsinchu Series No. 1, were selected for seed multiplication and extension in 1958 and 1959. With simultaneous extension of improved cultural practices, the seed yield of the improved varieties is 4 or 5 times more than the farmers' crop and also has a higher oil content. Their acreage expanded rapidly. By 1960, it is already over 70 percent of the total rapeseed acreage in Taiwan. It is moving into new areas where it has never been grown before. It is another crop, following soybean and corn, that emerged from obscurity into prominence during a short span of time as a result of a breakthrough in seed improvement.

H. Pasture Crops

A total of 284 species and varieties have been introduced. After quarantine and close observation, the new introductions are distributed to regional observation nurseries at different localities for adaptation test.

In addition to those promising strains reported at the Second Workshop, several more grasses and legumes have been recognized for their outstanding performance. They are: *Setaria sphacelata*, Woolly finger grass, Guinea grass (Makarikari strain), two strains of *Glycine javanica*, Lana vetch and Papago peas.

Varietal tests made in 1960 indicate that the A24 pangola grass is still the leading grass and Bermuda grasses are adaptable to dry sandy soil. *Setaria sphacelata* A68 outyields guinea grass and has more consumable forage than Napier grass and should be used more widely as a soiling crop on level or gently sloping land. Among the seven strains of cowpea, the Groit and Victor cowpea are the most promising ones.

Fertilizer and cutting tests of pangola grass show that, with adequate fertilizing, pangola grass cut at 40 cm. high can support 8 to 10 animal units to the hectare for from 7 to 12 months, depending upon soil, rainfall and temperature conditions.

Multiplication and extension of planting material have been systematically planned. Training on the improvement of pasture has been conducted for both the farmers and college students.

PROGRESS REPORT ON THE SEED CERTIFICATION PROGRAM OF TAIWAN DURING 1959-1960

C. I. Lin and T. Y. Sung¹

I. Strengthening of the Seed Certification Systems and Organizations

A. Completion of the Provincial Seed Testing Laboratory in Taichung

The First Far East Seed Improvement Conference held at Taipei in 1956 served as a milestone for the seed program on the Island of Taiwan. It exerted a great stimulus and created a new interest for the production of quality seeds for general planting by farmers.

Upon conclusion of the First Far East Seed Improvement Conference, it was decided that two seed laboratories be established in Taiwan, one in the College of Agriculture, National Taiwan University (NTU), for conducting research and training programs concerning all phases of seed technology; and the other under the Taiwan Provincial Department of Agriculture & Forestry (PDAF) serving as a regulatory laboratory to implement the part of laboratory analysis work of the seed certification system. Before the regulatory laboratory was formally established in 1959, the seven district agricultural improvement stations strategically located at various spots of the Island were temporarily assigned with the duty of performing the seed analysis work within their respective areas. Their duty of seed analysis terminated upon the formal inauguration of the seed regulatory laboratory.

During 1957-1958, a complete set of laboratory equipment, which was recommended by Dr. Don F. Grabe, former Seed Technologist of the Mississippi State University, was procured from abroad for use. In 1959, the Chinese-American Joint Commission on Rural Reconstruction (JCRR) granted NT\$450,000 to the PDAF for constructing of the seed regulatory laboratory which was completed and formally inaugurated in September 1959.

¹ Associate Professor, College of Agriculture, National Taiwan University, and concurrently In-charge of NTU Seed Technology Laboratory; and Specialist, Chinese-American Joint Commission on Rural Reconstruction, respectively.

The laboratory is located in Taichung City. Its building has an area of 396.3 square meters and is divided into seven partitions as follows: (1) office and conference room, (2) registration room, (3) sample dividing and moisture determination room, (4) purity analysis room, (5) germination determination room, (6) sand-beds room and (7) cold storage rooms. The temperature of the cold storages is constantly maintained at 5°C. The laboratory is designed for handling 25,000–30,000 samples a year; and it is now equipped with 2 Steinlite moisture testers, 2 South Dakota blowers, 1 Gamet precision divider, 1 Boerner sampler, 2 torsion balances, 4 Mangelsdorf germinators, 1 Console germinator, 2 vacuum counters, Dodder sieves, triers and other smaller attachments and equipment enough to meet the requirement of a seed regulatory in normal operation. The laboratory is now regularly staffed with 4 college graduates and 3 graduates from agricultural vocational schools. Temporary helpers are hired during rush seasons.

One of the special features of the laboratory is the use of sand and bamboo paper in large amounts for the germination test of seeds. The sand-bed germination room, equipped with rectangular aluminum cases serving as containers for storing sand, is capable of conducting germination test of around 800 samples at a time.

B. Strengthening of Seed Multiplication Program

In order to strengthen the present rice improvement program, a rice improvement (annual) conference was established under the PDAF. Its chief goals are: (1) to study and review all phases of the rice improvement work on rice breeding, cultivation and extension during the past year; (2) to integrate the works done by various agricultural agencies; and (3) to plan and to set up the working directions for rice production. In order to achieve such goals, six working committees are established under the conference. One of the committees is in charge of the seed multiplication, extension and testing. The working committees are responsible for studying the problems concerned and making suggestions to the conference for approval and action. It is constituted by specialists of various pertinent agricultural agencies and of the JCRR. The committee members hold meetings, whenever deemed necessary.

Similar to the nature of the rice improvement conference, there is an improvement conference organized on upland food crops which include sweet potato, peanut, soybean, wheat, corn, sorghum, barley and rape. There is also a working committee on seed technology under the upland food crops improvement conference.

The establishment of the working committee on seed technology under the rice and upland food crops improvement conferences is aimed at the following objectives:

1. To review the certification standards and results and to make suggestions on necessary adjustments in order to cope with actual situation.
2. To study the procedures and regulations concerning various crops and to make whatever recommendations deemed necessary for more efficient operation.
3. To recommend the varieties and quantities of seeds to be multiplied.
4. To map out research plans concerning specific problems on seed testing.

C. Strengthening the NTU Seed Technology

Laboratory and Its Activities

A large scale remodelling of the NTU Laboratory for a modern seed technology laboratory, which took a one full year and costed nearly NT\$ 800,000, was completed in September 1959. Consequently, much improvement was materialized as regards the laboratory's working space, electricity and water supply, and also sanitary conditions.

Besides the various equipment described in details in a report previously presented by the co-author (C.I. Lin) to the 2nd FESIW, many new facilities and equipment are now available in this laboratory. Among them, seed processing machineries, consisting of five different sets of laboratory scale processing equipment, vitascopes for rapid viability test, outside sand-bench for sand germination test, seedling beds with heating and hydroponic devices, are very useful for research and teaching purposes.

The laboratory has a regular staff of 10 (4 college graduates and 6 high school graduates) working on various aspects of seed technology.

The laboratory activities may be briefly described as follows:

1. Training and teaching. Short seed testing training courses are continuously offered to officers of the concerned government agencies and farmers' associations; and special training course may be given to any group interested in seed problems upon request. Recently a short training course was offered particularly to selected technical personnel of the Taiwan Provincial Bureau of Inspection & Quarantine following the International Rules and Regulations in order to strengthen the inspection of seeds for international trade. Two courses, one on seed technology and the

other on weed control, were also offered to agricultural students (graduates and senior students only, occasionally one or two students working on their graduate theses).

2. Research activities. Besides those assignments as described in the foregoing section which are assigned by the working committees of the rice and upland food crops improvement conferences, certain research activities are under progress in this Laboratory. Some of them are outlined briefly as follows:

- a. Storage experiments on important field and vegetable seeds in Taiwan—covering all experiments on moisture content of seeds, relative humidity, storage temperature and packing materials, either separately or in combination.
- b. Experiments on transporting and storage of seeds conducted in cooperation with the Mississippi Seed Technology Laboratory—covering three kinds of seeds, three levels of moisture contents and four kinds of packing materials all in combination.
- c. Effects of seed uniformity on subsequent growth and yield under different spacing—covering five kinds of crops with detailed analysis of growth and yield factors recorded to clarify the competition among crops for nutrition and soil moisture.

3. Extra-service. Any requests relating to seed technology either from public or private organizations or individuals are always welcomed by this Laboratory. Experiments will be conducted, whenever necessary and materials and equipment are available, with free or sometimes minimum charge.

II. Revision of the Rules and Regulations Governing Seed Certification

The most important advancement in streamlining the rules and regulations governing seed certification on this Island is the adoption of the international rules of seed testing as adopted by the International Seed Testing Association. The definitions of terms in seed analysis, such as "pure seed", "normal seedling", etc., which were quite confusing to the seed analysts in the past, are standardized and unified. All the related workers are now familiarized with the new definitions of the terms.

When the seed certification program was started in Taiwan, Ponlai rice was the first crop included in the program. The regulations, procedures and methods

of implementation and the minimum seed standards for Ponlai rice were drafted and promulgated for adoption. Following the rice crop, wheat, sweet potato, soybean and peanut were also included in the seed certification program. Consequently, another set of regulations, procedures and methods of implementation and minimum seed standards for these 4 kinds of crops were drafted and put into effect.

Since 1957, the seed certification program has been expanding very rapidly. In addition to Ponlai rice, wheat, sweet potato, soybean and peanut, five more crops and nine groups of vegetables are also being included. For certifying each crop, there is, of course, a set of regulations governing its operation, procedures and methods of implementation. Since all the regulations, procedures and operations for the different crops are quite similar, it is deemed necessary to amalgamate them into a whole set. Moreover, possible revisions could be made on the rules and regulations in the course of amalgamation. The revised "Rules and Regulations Governing Seed Certification in Taiwan" is a single set consisting of the following:

- A. Regulations governing the certification of crop seeds
- B. Regulations governing the implementation of seed certification
- C. Standards (minimum) of seed certification of various field crops and vegetables

III. Present Status of Seed Multiplication and Progress of Seed Certification in Taiwan

The seed multiplication of various crops in Taiwan continues to maintain the three-level system, i.e., foundation seed, stock seed and extension seed. Due to the expansion of the seed certification program, there are at present ten different crops under this program. By the spring crop of 1961, nine groups of vegetables will also be included in the certification program.

The following tables indicate the present status of seed multiplication and certification progresses and also the number of seed samples tested each month by the Provincial Seed Testing Laboratory of PDAF in Taichung.

Table 1.
Present Status of Seed Multiplication and Certification of
Various Crops in Taiwan

Kind of crop & crop season	Level of multiplication farms	Seed multiplication status				% Certified		
		Total acreage (ha.)	No. of farms	Average farm size (ha.)	Quantity of seed produced (kg.)	Field inspection	Laboratory testing	
Rice 1959 2nd crop	Foundation seed farm	3.10	7	0.48	4,560	96.7%	93.3%	
	Stock seed farm	36.14	116	0.31	86,736	97.3%	69.7%	
	Extension seed farm	1,356.05	2,913	0.47	3,254,520	92.7%	50.9%	
	1960 1st crop	Foundation seed farm	1.80	6	0.30	2,694	100%	100%
		Stock seed farm	42.81	119	0.36	101,744	99.17%	84.21%
		Extension seed farm	852.10	1,996	0.43	2,045,040	82.56%	77.27%
Sweet potato 1960	Foundation seed farm	4.05	10	0.41	45,400 ¹	100%	88.1%	
	Stock seed farm	2.96	29	0.30	4,269,500 ²	100%	100%	
	Extension seed farm	63.88	408	0.64	64,351,700 ²	100%	100%	
Wheat 1959/1960	Foundation seed farm	3.85	4	0.96	4,431	100%	100%	
	Stock seed farm	54.90	190	0.29	104,358	99%	94%	
	Extension seed farm	872.91	2,046	0.43	1,526,071	97.4%	97.1%	
Peanut 1959 winter crop	Foundation seed farm	3.35	8	0.42	3,350	100%	100%	
	Stock seed farm	21.95	42	0.52	27,705	78.6%	94.4%	
	Extension seed farm	124.70	313	0.40	123,904	77%	92%	
	1960 spring crop	Foundation seed farm	3.75	8	0.37	3,750	100%	90%
		Stock seed farm	20.09	46	0.44	29,329	100%	74.4%
		Extension seed farm	86.00	202	0.42	109,832	94%	89.4%
Soybean 1959 summer crop	Foundation seed farm	1.05	7	0.15	1,111	100%	100%	
	Stock seed farm	18.20	31	0.59	18,300	97%	75%	
	Extension seed farm	366.80	631	0.58	380,600	95.9%	52.9%	
	1959 winter crop	Foundation seed farm	0.10	1	0.10	120	100%	100%
		Stock seed farm	3.40	10	0.34	3,840	100%	81.8%
		Extension seed farm	66.00	267	0.25	119,000	100%	83.3%
	1960 spring crop	Foundation seed farm	0.70	5	0.14	805	100%	90%
		Stock seed farm	9.80	23	0.43	10,340	100%	81.8%
		Extension seed farm	148.00	311	0.48	119,400	100%	84.2%
Sorghum 1959 winter crop	Stock seed farm	0.30	1	0.30	300	100%	100%	
	Extension seed farm	23.00	1	23.00	23,000	100%	100%	
	1960 spring crop	Stock seed farm	0.25	1	0.25	250	100%	100%
Hybrid corn (Double-cross) 1960	Extension seed farm	38.67	7	5.52	58,805	100%	100%	
Rape 1959	Foundation seed farm	0.25	—	—	260	—	100%	
	Extension seed farm	11.30	13	0.87	10,177	100%	91%	

¹ Weight of tubers

² No. of cuttings

Table 2.
Number of Seed Samples Tested in 1960 by the Provincial
Seed Testing Laboratory, PDAF, Taiwan

Upper fig.: No. of samples received
Lower fig.: No. of samples certified

Kind of crop	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Rice	7	—	—	—	44	277	478	—	—	388	938	778	2,910
	2	—	—	—	33	227	378	—	—	267	783	581	2,269
Peanut	185	22	7	19	—	—	119	6	16	4	5	23	406
	168	22	7	19	—	—	117	6	14	4	5	23	385
Soybean	36	89	32	—	19	83	54	—	—	4	3	51	371
	36	88	32	—	19	74	41	—	—	3	2	44	339
Wheat	—	—	981	261	2	—	—	—	171	2	—	—	1,417
	—	—	958	248	2	—	—	—	141	1	—	—	1,350
Corn	—	—	—	—	—	—	3	—	—	—	—	—	3
	—	—	—	—	—	—	3	—	—	—	—	—	3
Rape	—	—	—	10	7	1	8	4	—	—	—	—	30
	—	—	—	9	7	1	8	4	—	—	—	—	29
Sorghum	2	—	—	—	—	—	1	—	—	—	—	—	3
	2	—	—	—	—	—	1	—	—	—	—	—	3
Barley	—	—	—	—	—	—	—	3	—	—	—	—	3
	—	—	—	—	—	—	—	3	—	—	—	—	3
Total	230	111	1,020	290	72	361	663	13	187	398	946	852	5,143
	208	110	997	276	61	302	546	13	155	275	790	648	4,381

IV. Training of Seed Certification Officers

Undoubtedly, the success of seed certification program depends upon the quality of the inspectors. Therefore, one or two personnel are sent to the U. S. to receive advanced training on seed technology every year.

Among the various short seed testing training courses offered during the recent years, the following two courses are of particular significance:

A. 1959 Brief Training Course on Seed Testing

After the 2nd FESIW held in Tokyo in 1959, it was the policy of the concerned authorities in Taiwan to invite seed technology specialists from the U. S. to Taiwan to evaluate the over-all seed certification and improvement programs, which had been under progress for several years on this Island.

Consequently, Dr. D. F. Grabe and Prof. C. H. Andrews of the Mississippi Seed Technology Laboratory were sent to Taiwan in July 1959 under a contract between ICA/Washington and the Mississippi Seed Technology Laboratory.

After an extensive survey of the existing conditions of the seed multiplication system, storage facilities of seed farms, field inspection practices and laboratory seed testing methods, and laboratory facilities and equipment, many suggestions were made by Dr. Grabe and Prof. Andrews and improvement measures following their suggestions were immediately put into practice.

During their 5-month stay in Taiwan, several questionnaires on seed testing practices and also referee samples were sent to the district agricultural improvement stations (DAIS), which were then responsible for seed testing, for their answers and test results. And it was felt that one short but intensive in-service training course would be helpful for improving the laboratory testing situation. A small group of officers from each DAIS were given a short training especially on laboratory seed testing by Dr. Grabe and Prof. Andrews at the NTU Seed Laboratory. Repeated practices and referee tests were the most outstanding characters of this training course; and the success was great as could be seen in the uniform results of the final referee test.

B. 1960 Far East Seed Technology

Training Course

One of the recommendations made in the 2nd FESIW was to request ICA/Washington to make available, as before, third country training program on seed technology. The training should be given in the U. S. A. or other countries where advancement in this field has been attained. It was also recommended that emphasis should be placed on giving opportunity to trainees to gain experiences through actual practices during the training.

In view of the felt need for training on seed technology by all the concerned Far East countries, it was deemed important to conduct a short training course in this area. Since Taiwan had already established a seed laboratory with adequate seed testing equipment and had started the seed certification program for some years, it was felt that Taiwan would offer an ideal training site for the FE countries. Through the initiation and repeated correspondence of the JCRR with ICA/Washington and the Mississippi State University, a seed technology training course for the FE countries was inaugurated on August 29, 1960 and concluded on September 24, 1960. Two seed technologists, Dr. James C. Delouche and Mr. C. Hunter Andrews of the Mississippi State University Seed Technology Laboratory, were invited to serve as instructors of the course. A total of 18 participants from 6 FE countries attended the course with the number of participants from each country as follows:

Country	No. of participants
Japan	1
Korea	1
Philippines	3
Thailand	2
Vietnam	2
Republic of China	9
Total:	18

The course offered three weeks of class lectures and laboratory practices and one week of field trip to observe various seed farms, multiplication systems, field inspection practices, and harvesting, processing and storage of seeds. Four Chinese assistant instructors were also engaged to help conduct the preparatory works and take care of the miscellaneous matters.

The course was designed to train the participants on the methods, procedures and techniques of seed testing and analysis with regard to seed certification. It is the first of its kind ever held in the Far East and is considered a successful training as the participants have not only learned the techniques of seed testing but have also gained experiences in dealing with seed problems frequently encountered in their respective countries.

A THIRD REPORT ON INTERNATIONAL EXCHANGE OF PLANT MATERIALS IN TAIWAN

H. S. Chang

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To the First and the Second Far East Seed Improvement Workshops (FESIW) convened at Taipei, Taiwan (1956), and Tokyo, Japan (1959), the writer has presented two reports on the activities of the Chinese-American Joint Commission on Rural Reconstruction (JCRR) on international exchange of plant materials, respectively. The first report covered the international exchange of plant materials between Taiwan and other countries during the period from November 1951 to May 1956 and the second paper from June 1956 to April 1959. Since the Third FESIW will be held in the early part of 1961 in Manila, this report is prepared mainly for submitting to the Workshop for the reference of the delegates from the participating countries.

During the period from May 1959 to December 1960 covered by this report, a total of 158 varieties of seeds or planting materials of various crops was sent, upon request, to 25 countries for their trial planting and observation. Meanwhile, seeds or planting materials of 4,205 varieties from 13 countries were introduced to Taiwan for experimentation.

Among the vast number of introductions made in this duration, there were 2,950 varieties of soybeans and 1,140 varieties of flax seeds introduced from the U.S., the former being introduced by Mr. Y. W. Cheng of the Taiwan Agricultural Research Institute (TARI) and the latter by Mr. C. Y. Chi, Director of the Tainan Fiber Crops Experiment Station.

Pursuant to the second report, the following are some of the important results obtained through testing and research out of the total introductions.

I. Food Crops

Rice. The introduction of rice varieties from foreign countries is mainly for their specific characteristics possible to be combined with the promising characteristics of the native rice varieties so that new varieties possessing both lots of

desirable characteristics could be obtained. For obtaining the characteristic of stiff straw, Magnolia and Arkansas Fortuna were introduced for breeding purposes; for earliness, Norin 15, 17 and 20; and, for blast resistance, Milfor, Pi Nos. 1 and 4. The program is still in progress.

Sweet Potato. Okinawa 100 was developed in Okinawa from a cross between two sweet potato varieties called Chi-fu and Chou-chow. It was introduced to Taiwan by the Chiayi Agricultural Experiment Station after World War II. After preliminary observation and province-wide regional varietal tests during 1956-58, it was found that Okinawa 100 is especially good for spring planting and adaptable in a wide range of soils. In the spring of 1959, it was tried over 31 localities through the Island. The results show that, out of these 31 localities, Okinawa 100 outyielded the locally grown varieties in 24 places in tuber production and 26 places in chip production. In the second report, it had been indicated that this variety would be a very hopeful one as a commercial variety. In the fall of 1959, it was included into the seed multiplication list for seed propagation. In 1960, seed material was distributed for planting.

Soybean. Through introduction and testing of promising foreign soybean varieties, remarkable achievements have again been obtained in Taiwan. Following the successful extension of the three soybean varieties, Palmetto, Sankuo and Shih-shih, two new varieties, Acadian introduced from the U. S. and Wakashima from Japan, have been released for extension in the fall of 1960 because they are not as sensitive as and yield better than Palmetto when taken for late fall planting either in paddy field or on dryland. Another new variety, Dortchsoy, introduced some years ago from the U. S., has also been found very promising for spring planting in Miaoli and Hsinchu areas. It was, therefore, decided that a small acreage of about 50-100 hectares be tried with this new variety in the spring of 1961.

Through the request made by Mr. Yu-wei Cheng of TARI when he visited the Soybean Regional Laboratory in Illinois and the arrangement of the Plant Industry Division of the United States Department of Agriculture in Beltsville, Maryland, a total of over 2,950 soybean varieties were introduced to Taiwan in 1960. These introductions are now under seed production and will be systematically listed for their adaptability and resistance to rust. The possession of these genetically diversified materials of soybean is considered a new wealth for Taiwan as far as soybean research and improvement works are concerned.

Peanut. During the past three seasons since the spring of 1959, two of

the introduced varieties, Spanish White and Improved Sp. 2-b-48-1, were proved to be consistently better in yield than the native varieties and Tainan Pei-yu-tou No. 1. These two varieties were introduced previously from the U.S. In cross breeding work, several introduced varieties were used to cross with Tainan Pei-yu-tou No. 1 and Tsingtao. Florispan Runner and Virginia Bunch 67 were proved to be good combiners, especially the former one. Several disease resistant lines developed from these combinations have been put into yield tests at present.

II. Miscellaneous Crops

Corn. Three hybrid corn varieties developed from the crosses between the introduced inbred lines from the U.S. and inbred lines of native origin were released for commercial planting in the fall of 1960. These three corn varieties are Tainan No. 1 (Oh 43 × Oh 45) × (H × F), Tainan No. 3 (Oh 43 × Oh 45) × (H × C) and Tainan No. 5 (Oh 43 × Oh 45) × (D × C), Oh 43 and Oh 45 being Ohio lines and C, D, F, and H the local inbred lines. A total of about 2,030 hectares were planted in the fall of 1960.

Sorghum. During the past two years, several introduced varieties of hybrid sorghums were tested in Taiwan. Three of them have been found to outyield the current standard variety Westland in a very grand margin. These three varieties are 67E Hybrid {72E × (SA 6645-27-4-3 × DDE Hegari)}, 78E Hybrid (72E × Early Hegari) and 88E Hybrid (72E × Combine Bonita). They all were introduced from the U.S. in 1958.

III. Industrial Crop

Sugarcane. Another sugarcane variety introduced from Natal, South Africa, was released for commercial planting in Taiwan in 1959. This variety is called NCO 334, which was introduced to this Island in 1953 by the Taiwan Sugar Experiment Station. According to the regional varietal tests conducted during 1957-58 and 1958-59, this new variety has, in some places, outyielded NCO 310 by about 10 percent. NCO 310 is at present the leading cane variety in Taiwan, occupying more than 90 percent of the total cane acreage during the past four or five crop years.

IV. Horticultural Crops

Vegetables. In the second report submitted to the Second FESIW held in

Tokyo, Japan, there were nine varieties belonging to six kinds of vegetables proven quite promising and hopeful in the trial plots. Among these, the broccoli of the variety Texas 107 has been found of wide adaptability and been put into demonstration plot; the Chantenay, a variety of carrot, proven to be of high yielding capacity, has entered the stage of commercial production; and Sugar Baby, a watermelon variety, and Manalee, a variety of tomato, have also been planted for commercial production. The Sugar Baby is of high sugar content with good shipping quality while the Manalee is of heat resistant character suitable for planting under the subtropical climate of Taiwan.

Fruit Trees.

A. Mango: Among the five introduced mango varieties, Irwin and Zill were the most promising ones according to the previous report. After they reached the bearing stage, fruits were examined, rated and found desirable. In August 1960, scions of these two mango varieties together with another promising variety, Hayden, were top-worked on native mango trees. Each variety was grafted on 100 native trees. It is expected that enough scion wood will be obtained from these trees after two years for propagation purpose.

B. Coffee: Among the several rust resistant coffee strains introduced from Hawaii, the Philippines and India, HAES 6550 and S-333 are found quite promising due to their high yielding capacity and rust resistant character. Trials are still under-way.

V. Fiber Crops

Jute. Most of the jute varieties introduced from foreign countries to Taiwan did not perform very well as the selected native lines. However, one variety, Solimoes, introduced from the U. S. seemed to be non-sensitive to photoperiod, a very desirable character not frequently found on jute varieties. Further trial will be continued in 1961.

Kenaf. Kenaf is a desirable jute substitute in supplying raw fiber for making packaging materials. Among the 81 new strains introduced to Taiwan in 1957, BG-52-7 has been selected as one of the best strains adaptable to the local climatic conditions. In 1960, this strain was included in a regional trial conducted at 7 localities in Taiwan. The result indicated that BG-52-7 was one of the three best strains under trial. Demonstration and extension will be made in 1961.

Flax. Through the arrangement made between the Tainan Fiber Crops Experiment Station and the United States Department of Agriculture, a set of the world collection of 1,140 varieties of both fiber and seed flax was introduced to Taiwan. This set of genetically diversified materials of flax has benefited Taiwan with another rich resource in the flax research and improvement program.

Paw Keo. Paw Keo was introduced to Taiwan from Thailand in 1957. After its introduction, intensive studies concerning its adaptability and cultural practices have been made. The results indicated that this crop thrives well on less fertile soil with no irrigation facilities and is adaptable to a fairly wide range of areas; particularly in places of dryland condition with good drainage. The maximum fiber yield is resulted after a growing period of 195 days. However, under the multiple-cropping system now being practised in Taiwan, the recommended date of harvesting should not be longer than 150 days after planting; otherwise, the other crop following Paw Keo will be affected.

The introduced seed of Paw Keo was found badly mixed, so a pure line selection program has been started since 1960. The work is still under-way.

Paw Keo is a very hopeful crop due to its wide adaptability and potentiality to replace a part of the jute acreage. It is expected that this crop will be extended for general planting before long.

Recent Progress in International Seed Exchange Activities

During the First Far East Seed Improvement Conference, a resolution was made that recommendation for the establishment of a Seed Exchange Center in one of the Far East countries be made to ICA/Washington for final decision. However, till 1959, such a needed Seed Exchange Center had not yet been established since the recommendation made in 1956. Then, in the Second FESIW, it was generally felt that a further recommendation should be made to this effect. Meanwhile, all the participating countries were asked to take the following necessary actions:

1. To prepare a list of the important commercial varieties of crops available for international exchange; and
2. To assign in each country a responsible agency for handling the exchange of crop seeds and planting materials with other countries.

Upon conclusion of the Second FESIW, Taiwan has prepared a list of available planting materials for international exchange and sent to Dr. Louis N. Wise, ICA consultant to the Workshop, in accordance with the resolution made in the Second FESIW. Moreover, the TARI has been designated as the responsible agency to handle the exchange of crop seeds and planting materials with other countries. The TARI International Exchange Center has started to operate in the fall of 1960. Since then, the responsibility of the Plant Industry Division of JCRR to serve as a seed clearing center of Taiwan by handling the introductions into and sending out planting materials from Taiwan has been shifted to TARI.

The kinds of exchanged materials and the names of exchanging countries for the period from May 1959 to December 1960 are compiled in the attached Lists I and II.

Attachment to:

A THIRD REPORT ON INTERNATIONAL EXCHANGE
OF PLANT MATERIALS IN TAIWAN

List I. Planting Materials Introduced from Foreign Countries

(May 1959—December 1960)

Crop	Source
Food Crops	
Rice seeds:	
Norin 12, Norin 15, Norin 18, Towada, Fuzisaza No. 5, Monogolian Rice, Jadukan (Philippines), Pi No. 3, Pi No. 4, Milfor 6(2), FB76, Untung 588 (Bulu type), Nahda, Aga, Mont No. 1, Gulfrose	Japan, Philippines, Pakistan, Egypt, U. S. A.
Soybean seeds:	
Green Higu, Dwarf ando, Norin No. 3, Ani, 2,960 var. (Introduced by TARI)	Okinawa, Japan, U. S. A.
Peanut:	
Kurome No. 3	Japan
Sweet potato:	
Kyushu No. 27, Kyushu No. 28	Japan
Miscellaneous Crops	
Corn:	
Oh43 Dw, Oh51 A Dw, B8 Dw, W10 Dw, Ny10 Dw, Ny17 Dw, 59-459 × (B8 Dw × Oh51 A Dw) × Dwarf single cross 58-589 × 590 (Oh43 Dw × Oh51 A Dw)	U. S. A.
Horticultural Crops	
Fruit:	
Cantaloupe	
Apple (<i>Malus spp.</i>)	Japan, Philippines, Korea
1. Ben davis	
2. White winter pearmain	
Pear (<i>Pyrus communis, L.</i>)	
1. Bartlett	
2. Clapp's favorite	
Grape (<i>Vitis spp.</i>)	
Black Hamburg	
Vegetables:	
Bean	Japan, Thailand
Brassica Japonica	
Cabbage	
Chinese cabbage	
Cucumber	
Eggplant	
Kohlrabi	
Lettuce	
Melon	
Pepper	

List I. (continued)

Crop	Source
<p>Celery Kale Pumpkin Radish Solanum Tomato Turnip Vicia Watermelon Carrot Bean (Yard long) red seeded Sanjyaku Paitsai Rape</p>	
<p>Ornamental plants:</p>	
<p>Celosia Chrysanthemum Coleus Freesia Petunia</p>	<p>Japan</p>
<p>Medicinal plants (seedlings or rhizomes):</p>	
<p>Chenopodium ambrosioides L. (var. Anthelminticum A. Gray) Celosia argentea L. Coptis Japonica Makino Scroghularia Buergeriana Miquel Pana Ginseng C. A. Meyer (var. Kam San) Angelica dahurica Bentham Et Hooker Angelica acutiloba Kitagawa Cnidium officinale Makino Lavan dula Sibiricus L. Scutellaria baica Linsis George Digitalis purpurea L. Platycodon Grandiflorum De.</p>	<p>Korea, Thailand</p>
<p>Fiber Crops</p>	
<p>Hemp: Minami-Oshihara No. 1</p>	<p>Japan, Vietnam, France , U. S. A.</p>
<p>Ramie: Shirakawa-shu, Saikeseishin-shu</p>	
<p>Jute: Local var., Branca, Rofa, Jute (Brazil)</p>	
<p>Flax: 1,158 varieties</p>	
<p>Industrial Crop</p>	
<p>Castor bean: Dawn, Baker 296, Dwarf Cimarron</p>	<p>U. S. A.</p>

List I. (continued)

Crop	Source
<p>Forage Crop</p> <p>Leucaena glauca (Bald Hills strain, El Salvador strain, Guatemala strain, Hawaii strain, Peru strain, Rhodesia strain)</p> <p>Vigna vexillata PRI5058</p> <p>Desmodium gyroides</p> <p>Desmodium supina PRI 1195</p> <p>Desmodium gyrans PRI 1197</p> <p>Desmodium distortum PRI 1196</p> <p>Paspalum notatum va. Common O. P. Plot 5-D</p> <p>Paspalum notatum va. Common × Pensacola O. P. Plot 23-A and a dozen sprigs of Carib grass (<i>Eriochloa polystchaya</i>)</p> <p>Diamant oats (<i>Avena sativa</i>)</p> <p>Orchard grass strain C. B. (<i>Dactylis glomerata</i>)</p> <p>Perennial rye-grass pasture type strain C. B. (<i>Lolium perenne</i>)</p> <p>Perennial rye-grass hay type strain C. B. (<i>Lolium perenne</i>)</p> <p>Italian rye-grass strain C. B. (<i>Lolium Multiflorum</i>)</p> <p>Rye-grass Westernwolph strain C. B. (<i>Lolium multiflorum Westerwoldicum</i>)</p> <p>Neven sweet yellow lupine (<i>Lupinus luteus</i>)</p> <p>White clover for permanent pasture strain C. B. (<i>Trifolium repens</i>)</p> <p>White clover hay type strain C. B. (<i>Trifolium repens</i>)</p> <p>Timothy strain C. B. (<i>Phleum pratense</i>)</p> <p>Meadow fescue hay type strain C. B. (<i>Festuca pratensis</i>)</p> <p>Meadow fescue pasture type strain C. B. (<i>Festuca pratensis</i>)</p> <p>Negro vetches (<i>Vicia sativa</i>)</p> <p>Fall turnips half long purple top strain C. B. (<i>Brassica campestris var. rapa</i>)</p> <p>Fall turnips half long broad leaved strain C. B. (<i>Brassica campestris var. rapa</i>)</p> <p>Fall turnips Novitas clubroot resistant tetraploid broad leaf (<i>Brassica campestris var. rapa</i>)</p> <p>Red clover strain C. B. (<i>Trifolium pratense</i>)</p>	<p>Australia, Puerto Rico, Rotterdam</p>

List II. Planting Materials Sent to Other Countries

(May 1959—December 1960)

Crop	Country ¹
Food Crops	
Rice seeds:	
Pei-mi-fun, Hsinchu 50, Hsinchu 56, Chianung 242, Kun-shan-wu-shaung-gan, Pi-gan-tao, Pi No. 1, Kwangfu No. 1, Taichung Chalai No. 1, Nungyu 1805, Taichung 65, Taichung 150, Taichung 153, Taichung 160, Taichung 178, Taichung 179, Taichung Glutinous 46, Kaohsiung-yu 71, Kaohsiung 10, Kaohsiung 22, Kaohsiung 24, Kaohsiung 27, Kaohsiung 53, Kaohsiung 64, Kaohsiung 68, Chianan 2, Chianan 8, Chianan 14, Taipei 127, Bir-co, Kwangfu 401, Tainan No. 1, Tainan No. 3, Dee-geo-woogen, Kaohsiung Da-li-chin-yu, Liuchow, Taichung Special Nos. 1 & 6	Pakistan, Ceylon, England, Madagascar, South Africa, Thailand, Italy, Korea, Australia, United Arab Republic, Brasil, State of Israel, India
Sweet potato tuber:	
Tainung 10, Tainung 17, Tainung 31, Tainung 45, Tainung 57	Korea, East Pakistan
Wheat seeds:	
Taichung 2, Taichung 23, Taichung 29, Taichung 31, Taichung 32, Taichung-yu No. 108, Taichung-yu No. 135	Pakistan, Okinawa
Soybean seeds:	
Shihshih, Sankuo, Palmetto, Green bean, Black bean	Pakistan, Australia, India, British North Borneo
Peanut seeds:	
Taichung No. 1, Taitan Bir-yu-bean	East Pakistan
Miscellaneous Crops	
Corn seeds:	
Inbred lines (C. D. F. H)	East Pakistan
Barley:	
CA No. 1, CA No. 2	India
Buckwheat:	
Hainantau, Peihaitau, Kuanchyaumei, Kausbi No. 2, Takan	U. S. A.
Cassava:	
Tall type, Dwarf type	Vietnam
Sorghum:	
Pei-sao, Penghu (native) sorghum	India
Millet:	
Chia-nuo, Kuo-hsiang	India
Forage Crops	
Centrosema pubescens C25	U. S. A., Puerto Rico, Columbia
Stylosanthes gracilis C45	
Glycine jauanica C47	
Desmodium Intortum C50	
A23 Pangola grass, Digitaria decumbens	
A24 Pangola grass, Digitaria decumbens	
A69 Prewar digitaria, Digitaria sp.	

List II. (continued)

Crop	Country ¹
Green Manure Crops	
Sesbania esculata	Thailand, Japan
Astragalus sinicus	
Lupinus	
Crotalaria juncea	
Industrial Crop	
Sugarcane:	
F 135, 136, 137, 138, 139, 140, 143	Natal, South Africa
Fiber Crops	
Fiber flax seeds:	
Taichung Special No. 1, 2-127, 2-192	Brasil, Vietnam
Jute seeds:	
Hu-wei green bark No. 7, Shui-shang green bark, Taichung Special No. 1, Hsinfeng green bark	Philippines, Vietnam, Thailand
Kenaf seeds:	
Cuba C	Japan
Paw Keo seeds:	
Hibiscus Sabdariffa, L.	Japan, U. S. A.
Ramie roots:	
Murauchami, Kawaminami No. 1, Kawaminami No. 2, Kawaminami No. 3, Steel wire, Nanhua green bark	Korea
Horticultural Crops	
Fruit:	
Papaya	Japan, East Pakistan
Dwarf form, Solu 1, 9	
Vegetables:	
Cucumber (1st of Autumn)	France, Laos, North Borneo, East Pakistan, Vietnam, U. S. A.
Pickling melon (Green skin)	
Water convolvulus (Big leaf)	
Edible Amaranth (Native white)	
Asparagus bean (Native green pod)	
Pai-tsai (Fengshan)	
Tomato (Victor)	
Radish (Taiwan native summer)	
Sweet pepper	
Broad bean (Hsinchu-yu 6, 2)	
Milk vetch (Astragalus sinicus)	
Eggplant (Pingtung long)	
Chinese cabbage (Heading type)	
Nakaoka Hybrid No. 2	
Kohlrabi (Kinmen Early variety)	
Spinach (Taiwan Native variety)	
Rape (Native 60 days-rape)	
Kale (Native White Flower)	
Garland Chrysanthemum (Tiger Ear)	

List II. (continued)

Crop	Country ¹
Balsam Pear (Taiwan Native variety) Broad bean (Hsinchu-Yu No. 2) Chinese cabbage (Chang-Pu Early) Leaf mustard (Flesh Skin) Jack bean (Canavalia ensiformia) Yam bean (Tuberosus) Goa bean (Psophocorpus tetragonolobus) Soup celery (Early green) Pole bean (Kimugasa) Broccoli (Italian green) Cauliflower (Yan shai) Sweet pepper (Ruby king) Cabbage (Taiwan native)	
Ornamental plants:	
Lotus Orchid Pot flowers African Marigold China Pink Larkspur Paris Daisy Pot Marigold Snapdragon Straw Flower Date Palm Azalea Camellia Japonica, L. Gordon Anomala Spr. Pieris Japonica D.	Costa Rica, Japan, U. S. A.

1. Name of foreign country receiving one or more varieties within each group.

SOME DATA PERTAINING TO THE EXTENSION EDUCATIONAL
PHASE OF THE SEED IMPROVEMENT PROGRAM IN
TAIWAN, 1959-1960

Agricultural Extension Division

Chinese-American Joint Commission on Rural Reconstruction

I. Demonstration Plots and Demonstration Meetings

A. January-December, 1959¹

Kind of demonstration plots	No. of plots	Acreage (ha.)	No. of demonstration meetings held	No. of persons participated in demonstration meetings
For good rice varieties	415	47.60	260	20,733
For new sweet potato varieties	162	224.88	87	6,222
For good peanut varieties	102	29.14	141	3,935
For good vegetable varieties	124	9.58	52	2,600
For good cotton varieties	74	12.98	37	2,556
For good soybean varieties	138	15.45	76	4,740
Total	1,015	339.63	653	40,786

¹ In 1959, since many demonstration plots were destroyed by the severe flood in August, it was impossible to conduct demonstration meetings.

B. January-June, 1960

Kind of demonstration plots	No. of plots	Acreage (ha.)	No. of demonstration meetings held	No. of persons participated in demonstration meetings
For good rice varieties	223	26.76	226	18,081
For new sweet potato varieties	79	110.60	51	3,573
For good peanut varieties	22	5.94	27	817
For good vegetable varieties	67	5.36	44	2,236
For good cotton varieties	87	15.22	20	1,651
For good soybean varieties	65	7.28	61	3,622
Total	543	171.16	429	29,980

II. Recommended Technics for Rice Seed Improvement Adopted by Members of Farm Discussion Groups in 1959

Kind of practices	Before joining the group (persons)	After joining the group (persons)	Percentage increased (%)
Good varieties	8,158	15,720	92.7
Selection of seeds	5,521	13,867	151.1
Disinfection of seeds	5,410	15,462	185.8
Improved-type seedbeds	5,909	12,497	111.6
Thin sowing	4,869	12,464	156.0

III. Basic Organizations of Extension Education as of June 1960

Organization	No. of groups/clubs	No. of members	Remarks
Farm discussion groups	1,839	32,103	The group or club holds regular meetings at least once every month.
Model farmers	—	2,751	
4-H project clubs	3,940	48,316	
Local leaders	—	3,645	
Home improvement clubs	896	15,671	
Home promoters	—	1,367	

IV. Main Assistances Rendered by Local Leaders and Members of the Rural Extension Basic Organizations in the Demonstration Phase of the Seed Improvement Work

A. Model farmers, local leaders and some of the farm discussion group members establish various kinds of demonstration plots, mainly done by model farmers (local leaders in farm extension).

B. Model farmers, local leaders and members of the farm discussion groups give encouragement to the general farmers for their participation in the demonstration meetings.

C. Farm discussion groups or 4-H rice clubs handle the operation of the "adoption of good varieties" and "selection and disinfection of rice seeds" on a mutual basis, for the groups, clubs and the general farmers.

D. Some of the farm discussion groups establish "improved-type mutual rice seedbeds".

E. The extension leaders always encourage the general farmers to do the "exchange of good crop seeds".

F. Four-H members and members of the farm discussion groups very often render the so-called community service on weeding and roguing in the paddy fields.

RECENT ADVANCES IN RICE BREEDING IN TAIWAN

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I. Introduction

The past two years have seen marked changes in the breeding program for Ponlai varieties (*japonica* type) of Taiwan. New emphasis is being laid on resistance to the blast disease, positive response to heavy manuring, stiffness of straw, early maturity, and, of course, the omnipresent factor of yield. Meanwhile, the improvement of Taiwan's native varieties of the *indica* type has been revived. Through frequent inter-station discussion and consultation, new impetus is given to cooperative experimentation and exchange of breeding materials. By financing research projects of an academic nature, renewed vigor has been injected into studies on genetics, cytogenetics, experimental design, radiation breeding, phytopathological and physiological aspects of rice breeding.

As a result of the above improvement, the breeding procedure for Ponlai rice (*japonica* type) has been overhauled, more wide crosses (esp. those of *japonica* × *indica*) are being made, a search into potential sources of disease resistance or other desired traits is being launched, efforts are made to explore and reveal the potential virtues of new lines under varied environmental and cultural conditions, and rice workers are encouraged to communicate with one another and to exchange ideas, views, information and experimental material.

For a comparative studies of the rice breeding program of Taiwan now and then, the reader is referred to the recent paper on this subject presented to the Second Far East Seed Improvement Workshop (Chang, H. S. 1959).

II. Institutions Engaged in Rice Seed Improvement

In past years, the breeding work was carried out by the seven district agricultural improvement stations (DAIS's), the Taiwan Agricultural Research Institute (TARI) and its Chiayi Station (TARI-Chiayi). In recent years, three institutions

have joined the rice breeding program, namely, the Botanical Research Institute of Academia Sinica, National Taiwan University, and the Taiwan Provincial College of Agriculture. The location and scope of work of the 12 institutions are listed as follows:

Institution	Location	Scope of work
1. The Botanical Research Institute of Academia Sinica	Taipei <i>hsien</i> (N. Taiwan) and cooperating institutions elsewhere*	Genetic and cytological studies, inter-specific crosses, biometrical studies, radiation breeding of <i>indica</i> and <i>japonica</i> varieties.
2. National Taiwan University (NTU)	Taipei	Genetic and cytological studies, radiation genetics, breeding for <i>japonica</i> lines less sensitive to photoperiod, pathological studies.
3. Taiwan Provincial College of Agriculture (TPCA)	Taichung (Central Taiwan)	Genetic and cytological studies, inter-specific crosses, radiation breeding, pathological studies.
4. Taiwan Agricultural Research Institute (TARI)	Taipei	Genetic and cytological studies, radiation breeding and genetics, plant introductions and investigations, genetics of disease resistance, regional trials, physiological specialization of the blast fungus.
5. Taipei District Agricultural Improvement Station (Taipei DAIS) and its Lotung Branch Station (Taipei DAIS-Lotung)	Taipei <i>hsien</i> (N. Taiwan) and Yilan (N. E. Taiwan)	Breeding of ponlai rice (<i>japonica</i> type), blast disease nursery.
6. Hsinchu DAIS	Hsinchu (N. W. Taiwan)	Breeding of Ponlai rice.
7. Taichung DAIS	Taichung (Central Taiwan)	Breeding of Ponlai varieties, breeding of native varieties (<i>indica</i> type), blast disease nursery, radiation breeding.
8. Tainan DAIS and its Chiayi Branch Station	Tainan (S. W. Taiwan) and Chiayi (South Central Taiwan)	Breeding of upland rice at Tainan, breeding of Ponlai rice at Chiayi.
9. Kaohsiung DAIS	Pingtung (S. Taiwan)	Breeding of Ponlai rice, blast disease nursery, testing of native varieties, study of nematodes.
10. Taitung DAIS	Taitung (S. E. Taiwan)	Breeding of Ponlai rice, breeding of upland rice, blast disease nursery.
11. Hwalien DAIS	Hwalien (E. Taiwan)	Testing of Ponlai varieties and lines.
12. Chiayi Station of TARI (TARI-Chiayi)	Chiayi (South Central Taiwan)	Breeding of Ponlai rice, blast disease nursery.

* Academia Sinica cooperates with the NTU, TPCA, TARI and Taichung DAIS in various projects, and also operates from a laboratory in Tainan.

For a comprehensive listing of the above activities, the reader is referred to "A Directory to Rice Experiments in the Second Crop of 1960, Taiwan" (Chang, T. T. 1960b).

In addition to the above agencies, the Joint Commission on Rural Reconstruction (JCRR) also plays an active role in the rice breeding program of Taiwan through

its financial assistance and technical advice to NTU, TARI, the seven DAIS's, and TARI-Chiayi. The writer is presently serving as the Convener of the Breeding Committee of the Taiwan Rice Improvement Conference (RIC).

III. Cooperative Planning and Testing

Among the 12 agencies mentioned above, 9 (TARI, TARI-Chiayi and the 7 DAIS's) are under the jurisdiction of the Taiwan Provincial Department of Agriculture & Forestry (PDAF), whereas the NTU, TPCA and Academia Sinica are autonomous institutions. For the 9 agencies under the PDAF, their annual program and budget are studied and screened by the Agricultural Research Council of the PDAF every year. During its annual 2-day sessions, the members of the Council might give directives on cooperative work or initiate new projects. However, owing to the short meeting hours of the Council, time only allows suggestions of a policy-making nature.

Some of the resolutions of the Agricultural Research Council concerning rice were then passed onto the Rice Improvement Work Review Conference which since 1956 held one meeting a year. The Conference was attended by rice breeders and seed workers from all experiment stations of the PDAF, the PDAF itself, and other related governmental agencies such as the JCRR and the Provincial Food Bureau. The coming program for rice seed multiplication, regional trials and demonstrations, and extension is discussed at the Conference for approval. Thus, the meeting of the annual Conference was in certain ways able to meet some of the directives from the Agricultural Research Council. However, there remained the tedious chore of working out detailed plans for projects of a cooperative nature and re-evaluating the present program.

To meet the need for cooperative planning and operations, upon the suggestion of the writer (Chang, T. T. 1960a), the PDAF formally instituted the RIC during April 1960 as a permanent organization under the PDAF to advise on matters related to rice improvement. The membership of the RIC is now enlarged to enroll interested participants from the Academia Sinica, NTU, TPCA, Provincial Water Conservancy Bureau, Taiwan Fertilizer Corporation, the Provincial Food Bureau (PFB), the Provincial Farmers' Association (PFA), and extension staff of local governments. Thus, the working scope of the RIC is extended into the fields of fertilizers, pest control, tillage and seed testing. Moreover, six technical committees have been organized to take care of operational matters in various fields. The technical committees are: Breeding, Seed Multiplication and Extension, Seed Testing and Inspection, Tillage, Fertilizers, and Pest Control. For instance, the members of the Breeding Committee are drawn

from the JCRR, PDAF, TPCA, TARI, TARI-Chiayi, Taichung DAIS and Kaohsiung DAIS. The Seed Multiplication & Extension Committee is comprised of representatives from the PDAF, JCRR, PFB, PFA, TARI and the 7 DAIS's all of which are actively engaged in seed multiplication and extension work.

The mission of the Breeding Committee is (1) to standardize the rice breeding procedure; (2) to revise the procedure as need arises; (3) to study and screen new lines coming up for naming, registration and seed increase; (4) to study and eliminate undesirable varieties from the seed increase list; (5) to screen entries for district yield trials, regional trials and varietal demonstration plots; (6) to formulate new directives on objectives in breeding and to organize cooperative work accordingly; (7) to distribute work-loads for different stations; (8) to inspect the breeding work at each station several times a year; (9) to promote cooperative ventures; (10) to promote the exchange of ideas, information and breeding material; and (11) to review the annual progress in rice breeding for report to the RIC. The work of the Breeding Committee is so closely integrated with that of the Seed Multiplication & Extension Committee that the former acts as a clearance agency for the latter on technical matters concerning varieties for extension. The two Committees have held joint sessions together.

Since its inauguration in April of 1960, the Breeding Committee has met three times and accomplished the following measures:

- A. A revision of the breeding procedure for Ponlai (*japonica*) rice;
- B. Planning of native (*indica*) rice improvement work for 1961;
- C. Planning of district yield trials, regional trials and cooperative tests for Ponlai rice in 1961;
- D. Planning of the testing for early maturing varieties and lines in 1961;
- E. Formulation of the criteria and methodology of rating varietal reactions to the rice blast fungus;
- F. Planning for the utilization of introduced plant material;
- G. Promotion of the exchange of breeding material among the Taichung, Hwalien, Hsinchu and Taipei DAIS's as well as TARI and TARI-Chiayi;
- H. Placing a moderate level of resistance to blast as a "must" in the extension of new varieties, and in making mandatory the regional testing for blast resistance prior to the registration of a new line as named variety; and
- I. Formation of a "third party", a sub-committee under the Breeding Committee,

to inspect the breeding work at the experiment stations at regular intervals and to screen new lines coming up for registration, with members drawn from those institutions (JCRR, PDAF, TPCA and TARI) which are not directly involved in the development of new varieties for extension.

IV. Objectives in Breeding Ponlai Rice

The objectives in breeding Ponlai rice have been re-appraised according to current needs and are given as follows:

A. Earliness

Earliness among rice varieties is gaining new importance in current cropping practices. A shorter growing period is necessary to enable the farmers to produce fast-growing cash crops between the rice crops. In many instances, the farmers are willing to make accommodations to grow high price cash crops at the expense of the rice crop. For the first rice crop, a growing period (from transplanting to maturity) not longer than 110 days is desired; for the second crop, not longer than 90 days.

B. Resistance to Diseases

For the first crop, rice blast (*Piricularia oryzae*) is still the No. 1 villain. For the second crop, sheath blight or the banded sclerotial disease (*Corticium sasakii*) is the chief menace. Varietal resistance to blast is most needed in the Yilan, Taitung, Taichung, Chiayi and Pingtung areas where a resistant variety means built-in insurance for the farmers. Through years of intensive search for resistance to leaf blast, a number of varieties and lines with moderate to fairly high level of resistance have been developed. However, resistance to neck blast and pedicel blast has not been fully incorporated into our Ponlai varieties. As to sheath blight, there appeared to be not a clearcut difference in resistance to the pathogen under field conditions. An intensive study of varietal reactions to this disease will be launched in 1961. Meanwhile, more attention is now given to varietal resistance to *Helminthosporium* leaf spots, a variety of sclerotial diseases, and the white tip disease due to a parasitic nematode (*Aphelenchoides besseyi*).

C. Positive Response to Heavy Manuring

The development of the new variety Chianung 242 induced the breeders to focus attention on one aspect that was overlooked in the past. Chianung 242 is one of

the few varieties that showed a positive response to heavy nitrogen application when the rate of manuring surpassed the level of 100 kg./ha. on fertile soil. Most other varieties showed a decrease in yield after that mark, either due to serious lodging or heavy infection of blast; whereas the yield of Chianung 242 continues to rise until the rate has reached 120-140 kg./ha. On soils of low fertility or under conditions of light fertilizer application, Chianung 242 performed poorly among other varieties. Hsinchu 56 is another variety that can stand up to 120 kg. of nitrogen per hectare. As a result of the above discovery, several stations are now testing their promising lines during the last few years of yield trial under 2 or 3 levels of manuring: the usual rate (80 kg./ha.), 1½ times and 2 times the usual rate. To give truly positive response to heavy manuring, a variety must have two features: resistance to disease (esp. blast) and stiff straw. Chianung 242 has the former, but is deficient in the latter.

D. Straw Strength

Stiff straw is one of the pre-requisites to high yield under heavy manuring. For coastal areas where the monsoons are strong, straw strength is a necessity. Straw strength is actually universally needed in all areas of Taiwan where a heavy shower near harvest time can bring serious lodging to the maturing crop.

E. Superior Performance in a Particular Crop Season

Past breeding work emphasized the development of varieties that are suited for growing in both crop seasons. As a result, many of the older varieties, as typified by Taichung 65, performed fairly well in both seasons. Then, Chianung 242 broke the precedence by behaving predominantly as a first-season crop under ordinary cultural care. In regional trials during 1958, the mean yield of Chianung 242 at 15 locations in the second crop is equivalent to 60.58% of its mean yield at the same locations during the first crop; for Taichung 65, the figure in the same series of trials is 88.42%; for Tainan 1, 86.07%; for Tainan 3, 84.10%; for Kaohsiung 68, 65.91%; for Nungshih 21, 92.00%; and for Nungshih 25, 92.98%. Since one of the main objective in rice improvement in Taiwan is to secure the highest yield per hectare, the breeders must make use of varieties that give superior performance in one of the two rice crop seasons. Thus, a variety like Taichung 65, which give equally fair yield in both seasons, now enjoys reduced favor since our aim is to obtain the maximum yield possible. Since the second rice crop yields 20-40% lower than the first crop on the average, much attention is now given to the development of a predominantly second-season variety or varieties.

F. Wide Adaptability

Wide adaptability in Ponlai varieties was regarded as one of the most important objectives in breeding. While this feature is still basically needed in all new varieties, a lowered interest is given to adaptability since each cropping region needs a particular variety or complex of varieties to suit its special needs. Fortunately, most of our newly-developed varieties, such as Chianung 242 and Tainan 3, have been shown to have wide adaptability.

G. Quality

Rice quality is often overlooked when the impelling force is to gain the highest yield per hectare. The milling and table quality of Ponlai rice is a subject that has yet to be emphasized with practice, although the need for better quality is deeply implanted in the minds of many rice breeders.

H. Yield

Yielding ability was and is the main concern of rice breeders. As yield is actually a cumulative product of all the above factors except quality, breeders are no longer satisfied with obtaining the highest yield under the standard cultural practice, but are exploring the fullest expression of the yielding capacity by varying the environmental factors, e. g., soil fertility, spacing, disease incidence, and time of planting.

V. Breeding Materials for Ponlai Rice

In past years, the most common breeding materials used for the improvement of Ponlai rice were local Ponlai varieties and introduced Japanese varieties of the Horai (*japonica*) type. To insure ease in selection and assurance of obtaining small gains in yield, rice breeders resorted mostly to Ponlai × Ponlai crosses. The practice became so widespread that the variety Taichung 65 is found in the pedigree of nearly every improved variety of the last decade, including Taipei 301, Taipei 306, Hsinchu 56, Taichung 176, Taichung 179, Chianung 242, Tainan 1, Tainan 3, Kaohsiung 53, Kaohsiung 64, Kaohsiung 68, Taitung 18 and Taitung 24. In attempts to develop new varieties that can stand heavy manuring, a number of experiment stations have now crossed their lines with either Chianung 242 or Hsinchu 56, both of which contain Taichung 65 in their pedigrees.

In recent years, with the need for disease resistance, rice breeders are widening their choice of parental varieties to include native or introduced varieties of the

indica type, mountain varieties of Taiwan grown by the aborigines, introduced varieties from mainland China and southeast Asian countries, and improved U.S. varieties and lines. The Taichung, Tainan and Kaohsiung DAIS's have successfully used *japonica* × *indica* crosses in their breeding programs. The Taichung DAIS has made good use of the blast resistance in the Japanese variety, Kanto 55. Both the Taichung DAIS and TARI-Chiayi have crossed Ponlai varieties with C. I. 9155, a U.S. line, and Pi No. 1 and Pi No. 4, both of which are Japanese lines with good resistance to blast. The Taichung DAIS has also used the Italian variety Maratelli to develop early and blast-resistant lines. The Kaohsiung DAIS has crossed the U.S. variety Milfor with two of its new varieties (Kaohsiung 64 and 68). Both the Taichung and Kaohsiung DAIS's have made use of the intermediate types between *japonica* and *indica* types, Aus and Bulu lines, in their breeding programs. Incorporation of blast resistance from *Oryza sativa spontanea* is being attempted by the Taichung DAIS. Stiff straw from U.S. varieties (Magnolia, Zenith, Ark. Fortuna) is being utilized by TARI.

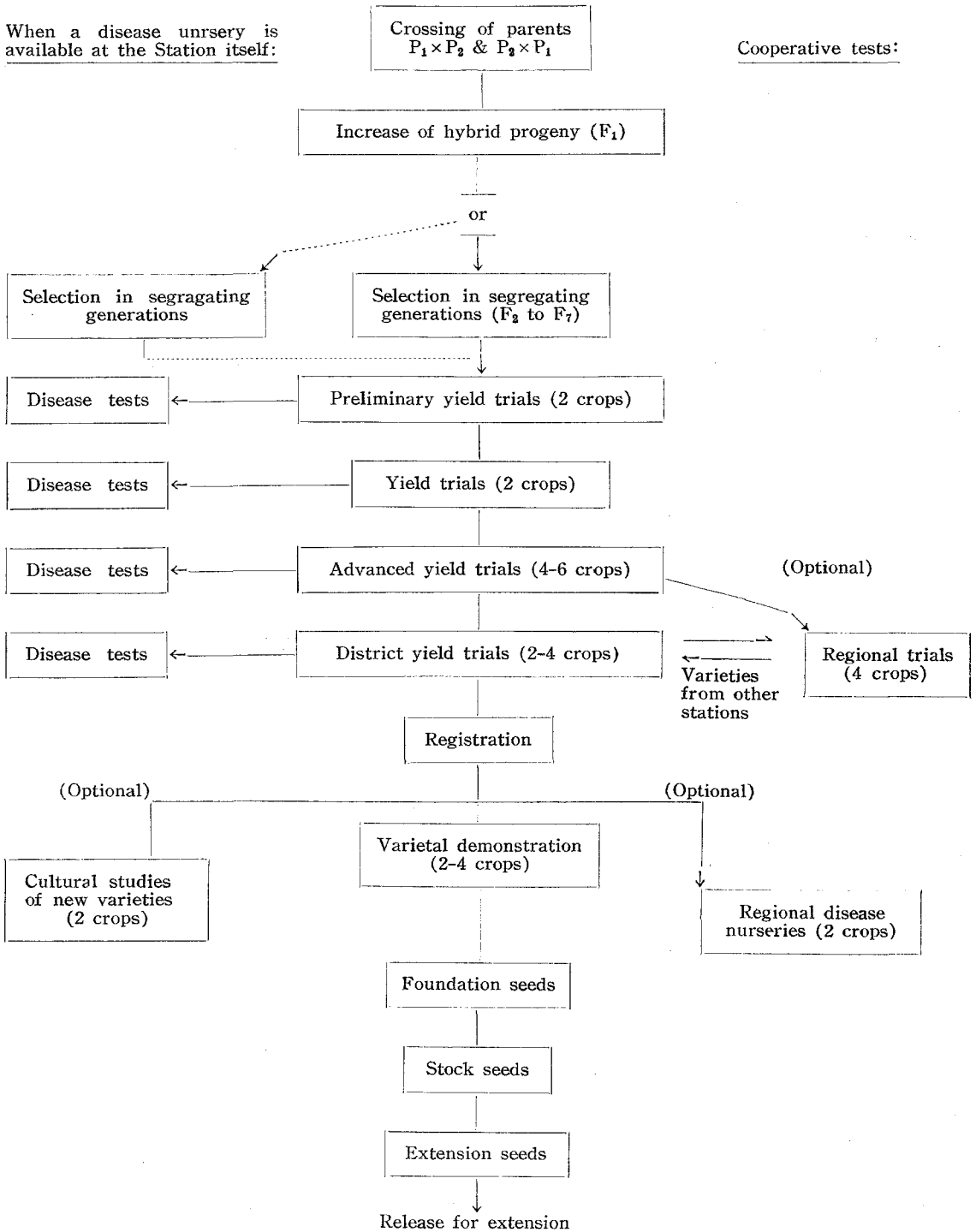
As the TARI is now preserving a total of 2,962 varieties and lines, plans are being made to utilize some of the potentially promising introductions in the collection. The collection included Taiwan's Ponlai and native varieties, introductions from mainland China, Japan, the U.S., various southeast Asian countries, European sources, and mutants of varied sorts. The Plant Industry Division of JCRR is constantly making efforts to add new introductions to this pool of germplasm.

VI. Breeding Procedure for Ponlai Rice

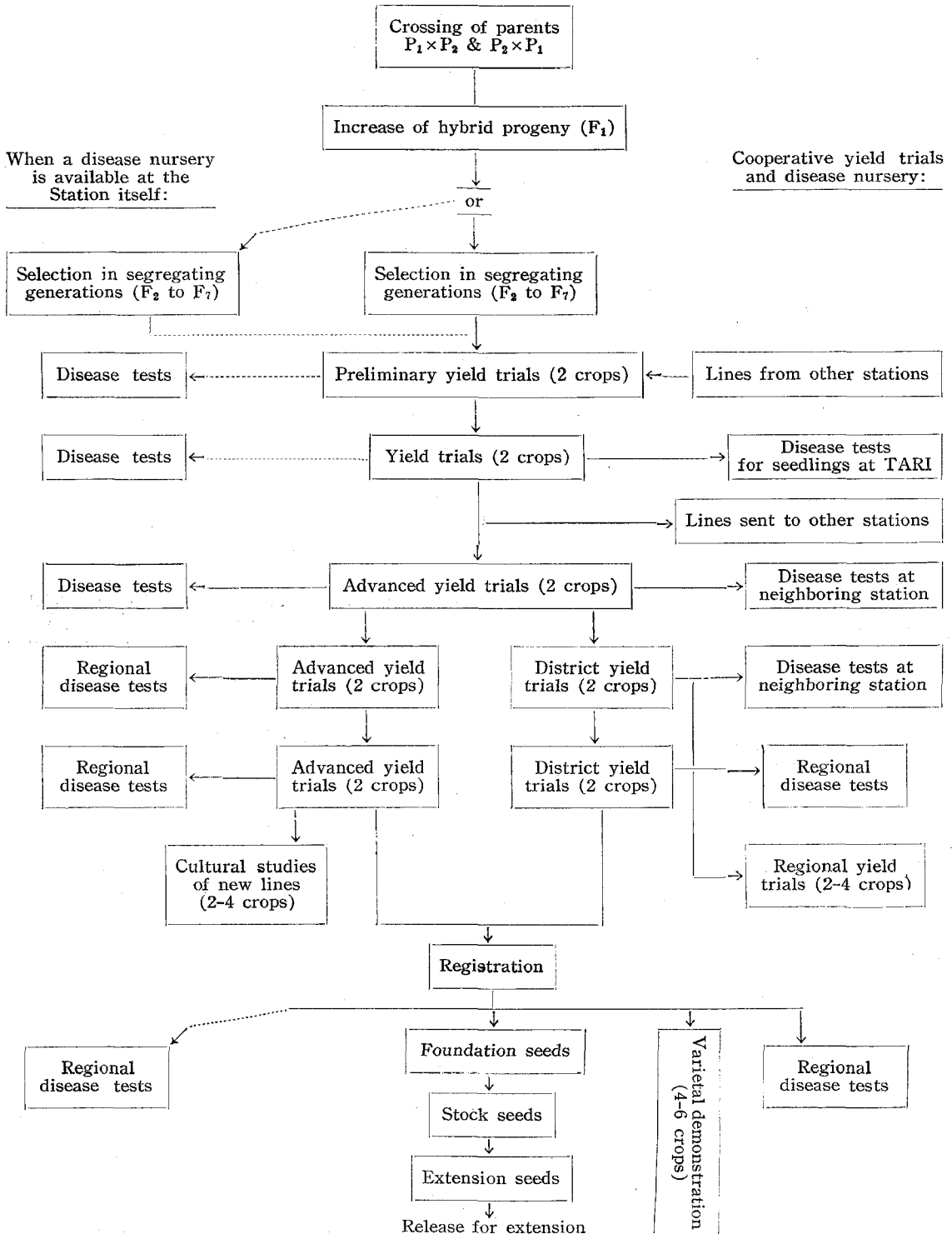
The breeding procedure for Ponlai rice in Taiwan during the period of 1956-1959 has been described in the paper presented at the Second Far East Seed Improvement Workshop (Chang, H. S. 1959). It is briefly summarized in the following diagram:

When a disease nursery is available at the Station itself:

Cooperative tests:



Upon the promotion of the writer (Chang, T. T. 1960a), the above procedure has been reviewed at the meetings of the Breeding Committee of the RIC during 1960 and revised accordingly. The revised procedure is given as follows:



The major revisions in the breeding procedure are:

A. Re-appraisal of breeding objectives and planning of crosses: The objectives in breeding Ponlai rice at each of the 7 DAIS's have been reviewed and re-evaluated at the meetings of the Breeding Committee in the light of current needs. For instance, one of the main emphases at the Taitung DAIS is to develop stiff-straw lines to tolerate gusty monsoon. For the Taichung DAIS, the main objectives are earliness, blast resistance and responsiveness to manuring. When the goals have been set up, the proper choice of parental stocks and crosses follows. For instance, the Kaohsiung DAIS is recommended to specialize in crosses involving some of the introductions from SE Asian countries as one of the parents. TARI-Chiayi is concentrating on U.S. introductions to incorporate both leaf and neck blast resistance into Ponlai lines. The Taipei DAIS is using Japanese introductions extensively to develop early lines. The above distribution of crossing programs is deemed essential to meet the greatly varied ecological conditions and cultural requirements in Taiwan.

B. To incorporate the testing for disease (blast) resistance as a mandatory part of the breeding program: The testing for blast resistance at these stations (Taichung and Kaohsiung DAIS's, TARI-Chiayi) which have the facilities of disease nurseries would commence as early as the F_2 and extend into the last year of yield trial, with progeny selections first made on the basis of plant reactions in the nursery. For those stations which do not have the facilities, selected lines from the preliminary yield trials would be sent to the TARI for greenhouse testing of the seedlings. Entries in the advanced yield trials would be tested in the disease nursery of the neighboring station(s) for field reaction for at least one year (or two crops). For new varieties to be released, these entries must be previously evaluated in disease nurseries on a regional basis (5 locations for the Province) for at least one year or two crops. Beginning 1961, no new lines with the blast resistance rated lower than "moderately resistant" will be allowed for registration, naming and release.

C. To incorporate the determination of cultural requirements of promising lines prior to release as a regular part of the breeding program: During the last few years of the advanced yield trial phase, the promising lines will be tested at two or three levels of fertility to determine their responsiveness to heavy manuring. Such yield trials under a split-plot design would separate those lines that are responsive to heavy manuring from others that are not. Prior to release, the most promising lines would be planted under a variety of spacings to determine the more favorable hill distances. This cultural study is deemed necessary in the case of new lines as little is known about their spacing requirements in two different crop seasons. For instance, the relatively low yield of Chianung 242 in the second crop

may be effectively made up by closer spacing, as this variety gave few tillers per hill during that crop season. For certain areas, it may prove to be useful to determine the optimum length of seedbed culture prior to transplanting since every one of the Ponlai varieties is more or less sensitive to delayed transplanting and that may result in heavy reductions in yield. This study is needed for areas where the irrigation facilities are inadequate, the water supply not dependable and the farmers may postpone the transplanting, while the optimum length of seedbed culture for the first crop is about 30 days for the central zone.

D. To promote the exchange of breeding material early in the breeding program: Prior to 1960, the various rice breeding stations operated in a highly competitive but individualistic manner. There was little exchange of breeding material among stations. Only the named varieties were entered in the province-wide regional trials. A variety from Station 'A' might be adopted for extension in the realm of Station 'B', if the regional trials proved its value in Region 'B'. However, there was virtually no exchange of breeding lines between stations. Since the second crop of 1960, several promising lines from 4 stations have been entered in the regional trials, as a humble start of the new approach. It is expected that more lines of a less advanced standing would be entered in future years. Of course, the above approach would prove its value only when various stations work on crosses of different combinations. This system of establishing a coordinated and synchronized hybridization program among stations has yet to be set up.

E. To prompt the release and extension of truly promising new varieties: Formerly, newly-named varieties, after completing the series of district yield trials, have to go through two years of demonstration before they were allowed to be increased as foundation seeds. This two-year demonstration period was intended to feel out the farmers' reactions toward the new variety and to educate the farmers on the special features of that variety. This process cut down the speed in which a promising new variety could be extended to farmers. The required length of demonstration was cut to one year when the new variety Chianung 242 proved to be so appealing to breeders and growers alike. In the revised procedure, the seed increase of a promising variety may commence simultaneously with the increase of foundation seeds. Meanwhile, a small panel from the Breeding Committee of the RIC would keep a close watch over the performance of the new variety in demonstration plots, seed plots and disease nurseries. Should the new entry turn out to be of doubtful value when hitherto unknown defects or disease susceptibility appears in a serious manner, the seed increase can still be recalled in time and its extension be halted. Of course, under this setup the panel has to act as an objective arbitrator

when controversies arise concerning the new variety.

F. To improve the experimental design and field layout of breeding plots: Most breeding plots suffer from several common flaws: the initial segregating populations are limited in size; entries from the same cross in the preliminary yield trials are limited in number (to about 20-30); yield data are not taken in all preliminary yield trials and much weight is given to visual selection; the plots are apt to be large in size while the number of replications limited to 4-5; and entries in randomized complete blocks may run as many as 40. Initial steps are being taken to improve the design and layout of experiments and to standardize them among stations.

It is expected that the above revisions in the breeding procedure of Ponlai rice would materially aid in realizing a fuller utilization of breeding materials, development of new lines with the desired traits (disease-resistance, response to manuring), greater gains in improvement of yielding capacity, greater despatch in the extension and use of newly developed varieties, and more refined techniques in determining varietal differences.

VII. Recent Advances in Breeding Techniques for Ponlai Rice

Aside from the recent revision of the breeding procedure for Ponlai rice, our rice geneticists and breeders have adopted many of the modern techniques in their breeding programs. Some of the more notable ones are briefly described below.

A. Genetical and Cytological Studies of Sterility in Rice

Through the use of radiation treatment, inversions and chromosomal translocations, our cytogeneticists are probing into several aspects of sterility in rice. H. I. Oka and his associates in TPCA and TARI have made marked advances in the genetic study of sterility (Hsieh and Oka, 1958; Huang and Chang, 1958; Hsieh, Chang and Young, 1959; Chang, 1959, 1960; Chao, Li and Hu, 1960; Hsieh, 1960; Huang 1960).

B. Inter-specific Crosses and Genom Analysis

Oka and his associates at TPCA have made a number of inter-specific crosses in the interest of retracing the evolution and phyllogenetic differentiation of rice (Oka, 1958; Oka and Chang, 1959, 1960; Hu, 1957, 1958, 1960). H. W. Li of Academia

Sinica has started a series of inter-specific crosses to complete the diallel set through the use of tissue culture. Some of the "exotic" species may prove to be a promising source of disease resistance in our future breeding program.

C. Genetic Analysis of Blast Resistance

Previous study indicated that the resistance to leaf blast in Pei-ku × Taichung 65 appeared to be controlled by a single major gene (Oka and Lin, 1957). Recent studies by S. C. Hsieh of TARI suggested that the genetic basis of blast resistance in a number of varieties appears to be more involved than a single locus. For the resistant variety Chianung 242, a multiple-factor hypothesis appears more likely.

D. Biometrical Studies of Quantitative Traits

Statistical studies of quantitative characters like maturity, height and yield have been initiated in recent years by Academia Sinica, TPCA, NTU and TARI (Kao, Hu, Chang and Oka, 1960). The Kaohsiung, Taichung and Taipei DAIS's in cooperation with the JCRR are studying the components of yield among different types of Ponlai varieties: the profuse tillering type, the long and dense panicle type, and an intermediate type between the two.

E. Radiation Breeding

Irradiation with X-ray, thermal neutrons, cobalt-60 and radioactive phosphorus followed by selection in progenies has been successfully adopted to hasten maturity, to enhance blast resistance, to improve straw strength and to improve yielding ability by the TARI, Taichung DAIS and TPCA. For a detailed description of the above experiments, the reader is referred to Huang's paper (1961) in this series of reports.

F. Breeding for Disease Resistance

With JCRR's financing and support, breeding for blast resistance is being undertaken by more experiment stations than a few years ago. In addition to the increase in the number of disease nurseries, more attention is given to the infection types on leaves and the problems of physiological races and predisposition. For a detailed report on the above problems, please refer to a paper on testing for blast resistance in this series of reports (Chang, 1961a).

For the second rice crop, sheath blight (*Corticium sasakii*) is more of a problem in Taiwan. A series of varietal testings for resistance to this disease will be launched in the second crop of 1961 over a number of localities where the disease is a serious menace.

G. Backcross Method of Breeding

The backcross method of adding one or two desired traits into well adapted varieties is becoming a popular practice among breeders. The Taichung DAIS first conducted a backcrossing program in 1956 to add disease resistance from Kanto 55 to the well adapted variety Taichung 65. For the recent years, the same Station is conducting 4 parallel series of backcrossing programs to incorporate one of the following desired traits into Taichung 65: earliness, blast resistance, positive response to heavy manuring, and a big panicle type. For earliness, Japanese, Italian and U.S. varieties are used as the non-recurrent parents; for blast resistance, *indica* varieties, Aus varieties, *O. sativa spontanea*; for response to manuring, Taichung 176 and Hsinchu 56; and for big panicle type, Chianung 242. TARI-Chiayi and the Tainan and Kaohsiung DAIS's also use the backcross approach extensively in their breeding work.

H. Re-evaluation of District Yield Trials

The district yield trials are regional testings within the domain of a DAIS. The average number of district yield trials for one DAIS was around 9 in 1959. Because of the wide spectrum of varied ecological niches in Taiwan, the above number might be rather inadequate. With aid from the JCRR, the total number of trials was increased from 61 to 89. The location of district trials was re-studied and re-distributed, taking into consideration the topography, soil type, water supply and other natural environs in each area so that more ecological zones are represented. The above trials will run for a few years. Meanwhile, the yield data would be summarized and analyzed to provide clues for more effective planning of regional testing in the future.

I. Breeding for Superior Performance of Varieties on a Seasonal Basis

It has been mentioned previously that Taichung 65 performed fairly well in both seasons over many localities. However, Taichung 65 is being rapidly replaced by new varieties like Chianung 242, Hsinchu 56, Taipei 306 and Taichung (native)

1. The two principal contenders, Chianung 242 and Taichung (native) 1, are both "first season varieties", i. e., they give an outstanding performance in the first crop and a mediocre to poor performance in the second crop. We are in need of outstanding varieties for the second crop. To give an opportunity for breeding lines to exercise their maximum yielding capacity, those lines that performed well in one crop season should be retained and re-tested in the same crop season next year to select truly superior lines for that season. In this way, promising lines for the second crop would not be overlooked simply because their mean performance for the two different crop seasons was about average when the first crop usually outyields the second crop by 20-40%.

Upon the suggestion of the writer, the various experiment stations are beginning to select promising lines on a seasonal basis. Under the above scheme, a station would develop three categories of promising lines: those suited for the first crop, those suited for the second crop, and those adapted to both seasons. In the long run, the varietal picture may become somewhat more complicated than the pre-war years, but to obtain the highest yield possible there is little alternative. In fact, many of the conscientious rice farmers are already growing different varieties for the two crops to fit into the multiple cropping system and to derive the most from the same piece of land.

J. Exchange of Breeding Materials

Upon the promotion of the writer, the Taichung DAIS, which has a wealth of breeding materials in its breeding plots, sent 48 selected lines from yield trials to three less well endowed DAIS's for testing in the latter's plots. TARI-Chiayi has also provided the Taipei and Hwalien DAIS's each with 20 blast-resistant lines. Meanwhile, more promising lines, in place of varieties, are being entered into the province-wide regional trials. It is expected that there will be a more free flow of breeding materials among stations.

K. Improved Techniques in Breeding and Biometrical

Interpretation of Experimental Data

During the early spring 1960, with JCRR's aid, a training class for food crop researchers of the PDAF was held in Taipei. It was attended by 48 technicians from various experiment stations. Lectures on genetics, cytogenetics, plant breeding, breeding for disease resistance, radiation breeding, fertilizer experiments, biostatistics, and experimental design and layout were given by specialists from the JCRR, NTU, TARI, TPCA and Taichung DAIS (Chang, 1961b). Discussions were devoted to those problems that the average breeder would encounter in his daily work. As a

result of the above training, the participants are now able to conduct the analysis of variance for randomized complete blocks and split plots and to make ranked comparisons. More training courses on specialized subjects, e.g. rice breeding, would be held in the near future.

L. Study of Rice Quality and Nutrition

Through a JCRR grant, the NTU is studying the problem of quality in rice as related to the contents of amylose and amylopectin and their ratios. It is hoped that rapid and reliable tests may be worked out in determining rice quality to aid in breeding program. The TARI is going to initiate a biochemical study of nutritional aspects of rice in 1961.

VIII. Recent Achievements in Varietal Improvement of Ponlai Rice

A. Replacement of Old Varieties by New Ones

With the development of new varieties, some of the less desirable and older varieties are gradually dropped from the seed increase list, such as Taipei 127, Hsinchu 55, Taichung 160, Taichung 162, Taichung 170, Chianan 2, Kaohsiung 18 and Kaohsiung 24. Meanwhile, newly developed varieties like Taipei 306, Hsinchu 58, Taichung 179, Taichung 181, Tainan 1, Tainan 3, Kaohsiung 64 and Kaohsiung 68 have been added to the foundation seed increase list. During the same period, there is a marked reduction in the acreage planted to Taichung 65, the leading Ponlai variety for the last two decades, and also the rapid rise of Chianung 242 and Hsinchu 56, two top contenders in the heavy yielder group. The change in the varietal picture is illustrated as follows:

Year	Taichung 65		Chianung 242		Hsinchu 56	
	Acreage	% of total	Acreage	% of total	Acreage	% of total
	(ha.)		(ha.)		(ha.)	
1956	110,955	24.61	5,089	1.13	5,517	1.22
1957	105,910	23.07	15,996	3.48	4,777	1.04
1958	97,516	21.17	25,442	5.52	8,638	1.88
1959	84,080	17.59	33,221	6.95	9,663	2.02

In southern areas, Taichung 65 is being replaced by Chianan 8 to a small extent. In parts of central Taiwan, Taichung 65 is replaced by the improved *indica* variety, Taichung (native) 1. It is predicted that the acreage planted to Taichung 65 will continue to drop in size as more blast-resistant and fertilizer-responsive varieties

are being developed.

During 1959-1960, eight new improved varieties of the *japonica* type were released for seed increase and extension. These are: Taipei 306, Hsinchu 58, Taichung 179, Taichung 181, Tainan 1, Tainan 3, Kaohsiung 64 and Kaohsiung 68. All of these varieties represent progenies from hybridization-selection programs.

B. Development of New Blast-resistant Varieties and Lines

Through selection in the disease nursery, the Taichung DAIS, Kaohsiung DAIS and TARI-Chiayi have developed a number of new varieties and lines that are resistant to blast under heavy fertilization. Some of the varieties and lines of more advanced standing are listed below:

Originating station	Variety or line	Parents	Reaction to blast ²			Other features
			Leaf	Neck	Pedicel	
TARI-Chiayi	Chianung 242	(Hsinchu 4 × Taichung 150) × (Taipei 7 × Tainung 45)	MR	MR	MR	Highly responsive to heavy nitrogen application; high yield; medium late in maturity.
	Chianung Yu 280 ¹	(K 2 × Tainung 45) × (Taichung Yu 12 × Ju-wee-tze)	R	R	MR	Stiff straw; late in maturity; high yield.
	C 113 ¹	(K 106 × K 58) × Kaohsiung 27	HR-R	MR	MR	High yield; medium maturity.
Taichung DAIS	Taichung 178	Taichung (glutinous) 46 × Yoshino 1	MR	MS	MR	Medium maturity; tolerant to heavy manuring.
	Taichung 179	Kwangfu 401 × Kwangfu 1	MR	MS	MR	Medium late in maturity; good straw strength; tolerant to heavy manuring.
	Taichung 181	Taichung 65 × Kanto 55	R-MR	MR	MR	Medium maturity; good straw strength; tolerant to heavy manuring.
	Taichung line 47220 ¹	(Taichung 65 × Kanto 55) × Taichung 65 ₂ ³	HR-R	MR	MR	(Yield trials still in progress)
	Taichung line 48212 ¹	(Taichung 65 × Kanto 55) × Taichung 65 ₈ ³	HR-R	R	MR	(Yield trials still in progress)
	Taichung line 48213 ¹ & 48214 ¹	(Taichung 65 × Kanto 55) × Taichung 65 ₂ ³	HR-R	R	MR	(Yield trials still in progress)
	Kaohsiung DAIS	Kaohsiung line 122 ¹	Kaohsiung 27 × Taichung 65	HR-MR	MR	MR
Kaohsiung line 135 ¹		Kaohsiung 24 × Litchi-hung	HR-R	MR-R	MS-MR	High yield.

1. Yu or line denotes a breeding line.

2. HR=highly resistant; R=resistant; MR=moderately resistant; MS=moderately susceptible. For details of the rating system, please refer to the paper on the 'Techniques of determining varietal reactions to rice blast pathogen' (Chang, 1961a) in this series.

3. The subscript numerals refer to generations of backcrossing to the recurrent parent, Taichung 65.

In addition to the above, other experiment stations are in the process of developing resistant lines. With the institution of cooperating testing for blast resistance on a regional basis, it is predicted that all forthcoming new varieties would possess higher levels of resistance than their predecessors.

C. Development of Promising Lines Through Radiation Breeding

Since 1956 several research institutions have started breeding programs by means of irradiation. The details of the above programs are reported by C. H. Huang (1961) in this series of reports. Some of the achievements to date are summarized as follows:

Institution	Material	Source of radiation energy	Traits being selected for	No. of promising lines selected
Taichung DAIS	Taichung 65 Chianung 242	Cobalt-60 (gamma ray) and X-ray	Resistance to blast and other diseases	9
TARI	Taichung 65 Taichung 155 Chianan 8 Chianung 242 Kaohsiung 27	X-ray and thermal neutrons	Earliness High yield Resistance to blast Stiff straw	24 21 101 13

Among the promising lines, yield trials and rigorous selection will be continued to cull the less desirable ones. Some of the selected lines may not be released eventually, but they may serve as crossing stocks in furnishing certain much desired traits, e. g. straw strength and earliness.

D. Development of Early Maturing Lines Non-sensitive to Photoperiod

To fit into the intensive multiple-cropping system, early maturing rice varieties of the Ponlai (*japonica*) type are needed. The most desirable source of earliness may be found in the Japanese varieties. However, about 60% of the Japanese introductions were found to be sensitive to photoperiod when they were planted twice a year according to local practices. To breed early lines that are non-sensitive to photoperiod, the geneticists of NTU with JCRR's financial support have extensively crossed Taiwan's Ponlai varieties with Japanese varieties either in single crosses or in backcrosses with the Ponlai varieties as recurrent parents. Meanwhile, good yielding lines would be selected among the segregating generations. Through a three-year testing in Taipei and Pingtung, 2 early and promising lines have been isolated. Yield trials will be held in 1961. With those lines, it is feasible to plant

a rice crop any time of the year as long as the temperatures permit, thus making possible the growing of three crops of rice a year in southern Taiwan.

IX. Breeding and Improvement of Taiwan's Native Varieties

A. Economic Importance of Native Varieties

Taiwan's native varieties of the *indica* type occupy a sizable portion of the rice acreage in post-war years. Native varieties perform better in those areas where the irrigation facilities are rather inadequate and the supply of water is not dependable when it is most needed for transplanting, or where the soil fertility is relatively low, or where rice blast is a perennial menace to Ponlai varieties. The Taiwan Provincial Government's policy has been directed toward the expansion of Ponlai acreage to replace the lower-yielding native varieties. Efforts in that direction have been only partially successful. The acreage of native varieties remains to stay at an economically significant level, as shown below. Meanwhile, the difference in yield between the two types widened.

Year	% of rice acreage planted to native varieties	Average yield of native varieties as compared with Ponlai varieties (%)
1949	50.34	93.48
1953	44.52	92.32
1958	37.34	91.59
1959	34.76	91.44

During the first crop of 1960, owing to a spring drouth, the acreage of native varieties rose to 35.82% which scored an increase over the 34.01% for the first crop of 1959. It appears that the acreage grown to native varieties is not likely to drop in appreciable extent until the irrigation facilities for many of those areas with undependable irrigation have been improved.

B. Objectives in Native Rice Improvement

Most native varieties have the following drawbacks: narrow range of adaptability, poor performance on fertile soils under intensive care, sensitivity to photoperiod, late maturity, poor straw strength, little or negative response to manuring, poor milling quality, and susceptibility to phytotoxicity by fungicides. Therefore, the most important objectives in native rice improvement are: wide adaptability, positive response to manuring, earlier maturity, straw strength and milling quality.

C. Improvement of Native Varieties

Prior to 1960

Owing to the long standing policy of concentrating on the Ponlai varieties, little attention was given to improvement of native varieties. Nevertheless, in 1949 the Taichung DAIS made five crosses among local breeding stocks, from which one outstanding progeny-line was selected and named in 1956 as Taichung (native) 1. Taichung 1 performed well in district yield trials in Taichung area during 1953-1955. However, its extension was withheld for the reason mentioned above.

Taichung (native) 1 is selected from a cross between Dee-geo Woo-gen and Tsai-yuan-chung, the former being a semi-dwarf *indica* variety and the latter a drouth-resistant stock. The improved variety is awnless, short in stalk, drouth resistant, with a prominent flag leaf. Its principal agronomic features are given below.

Crop	Growing days from transplanting to harvesting	No. of panicles per hill	Plant height	No. of kernels per panicle	Average yield of grains
			(cm.)		(kg./ha.)
I (spring)	123	19.0	83.8	85.9	5,643
II (summer)	97	18.6	84.3	84.3	4,656

Owing to its short culm, Taichung (native) 1 is non-lodging and tolerant to heavy manuring (up to 100 kg. of nitrogen per ha.). It has a high level of resistance to leaf blast and fair resistance to neck blast. As an *indica* variety, it is less sensitive to delayed transplanting than Ponlai varieties. As it is non-sensitive to photoperiod, it can be grown in both crops.

However, Taichung 1 is mainly a first-crop variety. Owing to its susceptibility to bacterial leaf blight (*Xanthomonas oryzae*), sheath spot (*Corticium sasakii*), a variety of sclerotial diseases (*Sclerotium* spp. and *Helminthosporium sigmoideum*), leaf hoppers and stem borers, its performance in the second crop is lackadaisical.

During 1950-1956, the JCRR subsidized the TARI and various DAIS's to conduct yield trials among native varieties and to make pure-line selections among promising ones. The preliminary results have been summarized (Huang, 1957; TARI-PID/JCRR 1960). However, the above work was not carried through in following years.

D. Breeding and Improvement

in 1960

Upon the promotion of the JCRR, the varietal improvement work for native

varieties was resumed in 1960. The JCRR financed the Taichung DAIS to re-commence the breeding program through hybridization. Selection and testing work is made among the offspring of the following categories of crosses: (1) intercrosses between *japonica* and *indica* parents, (2) backcrosses of *japonica* × *indica* hybrids to *indica* parents, (3) backcrosses of *indica* × *japonica* hybrids to *japonica* parents, and (4) intercrosses between *indica* parents. Meanwhile, more crosses are being added to the above.

During 1960, the JCRR also subsidized the PDAF and its Taichung, Tainan and Hsinchu DAIS's to carry out district yield trials for Taichung (native) 1 in the first crop in the native variety dominated villages of the above districts. A total of 26 trials were set up. In those trials, Taichung 1 was compared with one of the most commonly grown native variety in that district (as check) and another popular one for that village. The result of the above district trials is tabulated as follows:

District	Number of test plots in which Taichung 1 yielded			Total No. of plots
	Higher than check	Same as check	Lower than check	
Hsinchu	12	0	0	12
Taichung	7	0	2	9
Tainan	4	0	1	5

The superior performance of Taichung (native) 1 is most pronounced in Hsinchu district where it outyielded the check variety in all cases, with the difference ranging from 10% above to 50% above. In Taichung district, Taichung 1 surpassed the check from 5%–21% in 7 out of the 9 plots established there. For Tainan district, the variety outyielded the check in the range of 1%–17% in 4 out of 5 plots with an average of 3.5%. The highest yield was recorded in Silo *hsiang* (Yunlin *hsien*) where the farmers used a liberal amount of fertilizers: 60.52 kg. of paddy per "are", or about 10,000 Taiwan catties (6,000 kg.) per hectare, which is a very good record even for a superior Ponlai variety. Many of the contract farmers were impressed by the tillering ability of the variety (about 20 tillers/hill), and they were even surprised when they cut and weighed the crop since the Taichung variety is a semi-dwarf and its panicles were usually covered up by its prominent flag leaves. If most of the contract farmers had used more fertilizers or applied fertilizers like they do to Ponlai varieties, they would be more surprised at the grain yield, since Taichung 1 is the only *indica* variety in Taiwan that can stand up to 100 kg. of nitrogen per hectare without lodging or serious infection of rice blast.

In response to the favorable reaction of the farmers and the extension people,

the PDAF has agreed to step up the seed multiplication program for Taichung 1. The foundation seeds have been multiplied during the second crop of 1960, and stock seeds will be increased in the first crop of 1961. A complete seed increase, certification and distribution system for Taichung 1 is being set up, the first of its kind for native rice in Taiwan.

During the second crop of 1960, the Kaohsiung DAIS conducted a varietal trial for second-crop varieties under JCRR support. Native varieties are needed for the Kaohsiung district to cope with a new physiological disorder which has appeared in that district with alarming damage to the rice crop.

During 1957-1960, the Academia Sinica, in cooperation with the Taiwan Provincial College of Agriculture, made extensive selections among progenies of 8 irradiated *indica* varieties (Hu, Chang, Weng and Li, 1960). The mutant traits being looked for are: resistance to blast, tolerance and response to heavy manuring, and non-shattering panicles. The two institutions have succeeded in isolating 5 lines that yielded significantly higher than the mother variety (Liuchow) and 3 non-shattering mutants from the same variety. These non-shattering mutants are of promise in improving the shattering habit of most *indica* varieties.

E. Breeding and Improvement

Work for 1961

The breeding of native rice by the Taichung DAIS will be continued in 1961. Meanwhile, other DAIS's concerned will assist in conducting yield trials to select the most promising lines and varieties from three sources: (1) existing native varieties, (2) pure-line selections from native varieties, and (3) promising progenies of irradiated varieties. The regional testing for Taichung 1 will also be continued in 1961. Meanwhile, demonstration plots will be set up to prepare for its formal release and extension.

X. Summary and Prospect

During the past two years, a new era of rice breeding has dawned. Genetical and cytogenetical studies have been instituted to assist the breeders in coping with problems of sterility, gene identification and analysis, induced mutations and quantitative inheritance. Closer collaboration between breeders and pathologists and physiologists has been realized to attack the problems of resistance and plant nutrition together. Through the Rice Improvement Conference, programs of a cooperative

nature are planned and work-loads duly distributed. Through the same channel, a unified system of planning, screening and distributing work projects has been installed, extending from breeding, through seed multiplication and certification, to extension. Meanwhile, the breeding procedure has been revised to allow speedy release of truly promising new varieties, to utilize more fully the breeding materials, to promote the testing work for disease resistance, and to improve the experimental design and layout of field experiments. The breeding and improvement of Taiwan's native varieties (*indica* type) were revived in the same period. The application of radiation to breeding purposes is also given a vigorous test.

As wider crosses are being made, more emphasis is given to disease resistance, positive response to heavy manuring, stiff straw and early maturity, and as more attention is paid to the cultural requirements of new varieties, greater strides in uplifting the yielding capacity of both Ponlai and native varieties are promised. All these would bring about higher yield per hectare of rice amidst an increasingly intensive cropping system.

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INDUCTION OF MUTATIONS FOR RICE IMPROVEMENT IN TAIWAN

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I. Introduction

To keep up with the present rate of population increase, rice production on the island of Taiwan must be doubled in the forthcoming two decades. One of the most efficient means of increasing rice production is the use of superior varieties. In order to attain this objective, many efforts have been made during the past years. Since radiation treatment was found to increase the variability among crop plants by many research workers in different species and the pioneering work done for years in Sweden reveals that artificially induced mutations are of much practical significance, it seems reasonable that efforts in this direction should be exerted.

In the last ten years, mutation-induction experiments of rice not only for genetic and cytological studies but also for breeding purpose have been conducted by the Taiwan Agricultural Research Institute (TARI) and the Taichung District Agricultural Improvement Station (DAIS) with the financial aid from the Joint Commission on Rural Reconstruction (JCRR). Meantime, the Taiwan Provincial College of Agriculture (TPCA) has cooperated with the Academia Sinica in the work on induced mutations since 1957. A brief summary of these experiments and some of the more important mutations that have been obtained are presented in this paper.

II. The Use of X-ray and Thermal Neutrons in Producing Mutations for Ponlai Rice Improvement

A. Radio-sensitivity of Rice in the First Generation (R_1)

In 1957, foundation seeds of five Ponlai rice varieties (*japonica* type) were sent to the Brookhaven National Laboratory, U. S. A., for exposure to 20 and 25 Kr units of X-ray and 15 and 20 hours of thermal neutron (flux \times time is 3.6×10^{18} and 4.9×10^{18} , respectively). The five varieties were Taichung 65, Taichung 155, Kaohsiung 27, Chianan 8 and Chianung 242.

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The treated rice seeds were sown in the experimental fields of TARI in Taipei on July 12 and transplanted on July 31, 1957. Check plants raised from the untreated seeds of each variety were also planted simultaneously. Among a total of 39,171 treated rice seeds, only 27,182 seedlings were obtained, the rate of surviving seedling being 69.4 percent on the average. Except for the variety Taichung 65, the 20 Kr units of X-ray and 15-hour thermal neutron treatments showed little or no reduction in the number of seedlings emerging from the soil as compared with the check plots. But, the treatments of 25 Kr X-ray and 20-hour thermal neutron did result in a marked reduction in seeding viability.

The vegetative growth of the majority of plants appeared normal. However, weak and abnormal-appearing plants died away during the growing period. Of the 27,182 seedlings, only 26,126 normal plants, i.e. about 96 percent, survived at maturity.

All treatments produced many sterile or partially sterile plants and the degree of sterility increased as the rates of treatment increased. The thermal neutron treatment was more severe than the X-ray irradiation.

The heading date of plants in the treated plots also showed a degree of delay as compared with those in the check plots.

In 1947 and again in 1954, Chang and Hsieh of the TARI also initiated an experiment to treat the soaked seeds of rice with different dosages of X-ray. They reported that the percentage of lethal seedlings in the first generation ranged from 22 to 100 being related with the duration of irradiation. The fertility of treated plants in the X_1 tended to decrease markedly with an increase in the dosage of X-ray.

For the comparison of mutants with their original varieties with respect to radio-sensitivity, an experiment was conducted in 1959. A total of 16 mutants derived from X-ray and thermal neutron treatments and 5 Ponlai rice varieties were treated with different doses of X-ray and gamma ray (Cobalt-60). The preliminary result indicated that mutants, when compared to their original varieties, showed somewhat higher degree of sensitivity to radiation treatment at the seedling stage. However, the fertility of treated mutants is a little higher than their original varieties as compared in each case to the control.

B. Types of Mutations Traced in the Second Generation (R_2)

For the purpose of detection and isolation of beneficial and viable mutations in the R_2 , individual plants of the R_1 generation were harvested separately upon

their maturity in all the treatments. The seeds of each individual plant were sown separately and seedlings transplanted in single rows 3 m. long and 25 cm. apart with one seedling per hill in the first crop of 1958. During the growing period in R_2 , careful investigation was made and emphasis was laid upon the following items.

Early Maturing Mutation. In Taiwan, there is another winter crop grown after the two crops of rice in the same paddy fields. Therefore, early maturing varieties with a fair yield are of practical importance. Of the 403,818 plants of the R_2 generation, 213 plants were without any other marked changes except for heading 5 days or more earlier than the check rows. The 15-hour thermal neutron irradiation seemed to be giving the highest rate of mutation among all treatments. The number of early maturing plants in the various treatments is shown in Table 1.

Table 1.
Frequency of Early Maturing Plants in the R_2 Generation

Variety	Treatment*	Earlier heading as compared with the check row (in days)							Total	No. of plants in R_2
		5	6	7	8	9	10	over 10		
Taichung 65	X-20	1		2	1	1	5		10	17,416
	X-25			4		1	5		10	13,468
	N-15	14	2	5	2	5	3	1	32	21,700
	N-20								0	12,658
Taichung 155	X-20		1						1	22,960
	X-25	1				1		6	8	22,904
	N-15				1				1	20,944
	N-20					1			1	20,972
Kaohsiung 27	X-20	3		8					11	21,924
	X-25	2		1		2		5	10	15,372
	N-15	2		4	5	10		3	27	21,196
	N-20		2				1		3	14,196
Chianan 8	X-20	5	1	3				1	10	24,108
	X-25					4		2	6	22,372
	N-15	12	10	6	3	5		3	39	28,700
	N-20			1		1		1	3	25,536
Chianung 242	X-20	4	1	3				2	10	26,544
	X-25								0	21,924
	N-15	8	16	1	1	1	4		31	18,088
	N-20								0	10,836

* X-20, X-ray 20 Kr; X-25, X-ray 25 Kr; N-15, thermal neutron 15 hours; N-20, thermal neutron 20 hours.

Most of these early mutants bred true in the R_3 ; and those that headed earlier over 10 days than the check can be said to be especially valuable. All of these early mutants have been tested for yield and blast resistance both in the first and second crop seasons of 1959.

Dwarf Types. There are several records of spontaneous dwarf mutations in literature. Chang and Hsieh of TARI also found a dwarf plant as tall as three-fourths of the original variety among the second generation in their experiment.

Most of the induced mutations in this experiment probably fall into this group. The dwarf types also exhibited a diversified mixture of different types, ranging from those differing from the original variety only in a somewhat reduced growth to very short ones which were hardly able to survive in the field. Those very short mutants are mostly found to be reduced in panicle size and to have a dense bearing of grain than that of the mother plant, with some of them having modified kernel shape (from short to round).

The mutation rate of dwarf rice and its relation to the dosage of treatments are presented in Table 2, from which it is evident that the frequency of dwarf mutants is proportional to the dosage and the thermal neutron irradiation seems more effective in producing dwarf mutations than the X-ray treatment.

Table 2.
Frequency of Dwarf Plants in the R₂ Generation

Variety	Treatment	Plant height (cm.)										Total	No. of plants in R ₂
		30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80		
Taichung 65	X-20			2	1			2		1	1	7	1,844
	X-25	1				2	4	5	7	7	8	34	2,651
	N-15	1			5	4	4	7	6	6	13	46	2,570
	N-20		1		1	3	5	15	6	7	5	43	1,875
Taichung 155	X-20	1			3				2	5	3	14	2,421
	X-25	1				1	2	1	2	4		11	2,572
	N-15					1	2	4	1	3		11	2,435
	N-20	2		1	4	2	1			3	5	18	2,392
Kaohsiung 27	X-20	5			2			1	1		2	11	2,590
	X-25				1	1	1	2	1	1	4	11	2,308
	N-15			1	1	1				1	4	8	2,361
	N-20					1	4	4	4	9	4	26	1,736
Chianan 8	X-20						1	1	2	5	3	12	2,409
	X-25	2					3	2	2	8	6	23	2,247
	N-15			2	2	1	4	5	6	6	4	30	2,169
	N-20	1		1	2	5	7	5	10	12	6	49	2,607
Chianung 242	X-20					1			1	1	5	8	2,095
	X-25	1		1					2	2	5	11	2,274
	N-15			1	1		1	1	3	4	7	18	1,841
	N-20		2	3	4				18	16	4	56	1,988

The untreated check plots: Taichung 65—98.8 cm.; Taichung 155—99.1 cm.; Kaohsiung 27—98.2 cm.; Chianan 8—94.2 cm.; and Chianung 242—102.2 cm.

As no data are available in this experiment for the comparison of roentgen unit of X-ray to the corresponding intensity factor (flux) of thermal neutrons, the difference in the effects of X-ray and thermal neutron with regard to the physical nature of radiation or the dose rate cannot be determined.

Chlorophyll-deficiency. Changes or deficiencies in plastids or the plastid-carrying pigment called chlorophyll mutations have been used extensively as test mutations in experimental work. In the first generation, some striate or viridia plants were found and they grew as other normal plants to maturity. In the R₂

generation, one variety, Taichung 65, was taken and the rate of chlorophyll mutations on the panicle-progeny basis was computed. The result is shown in Table 3.

Table 3.
Chlorophyll Mutation of Panicle Progeny in R₂ Seedling Age

Treatment	Panicles tested	Panicle-progenies with chlorophyll-deficiency	Mutation rate (%)
X-20	2,155	122	5.7
X-25	1,950	101	5.2
N-15	3,484	206	5.9
N-20	2,080	107	5.1

Sterility. Sterility was again a pronounced feature in this generation. One hundred plants of semi-sterile nature in the R₁ were taken from each treatment and observed for their sterility in this generation. The results are indicated in Table 4.

Table 4.
Variation of Sterility of Semi-sterile R₁ Plants in the R₂
(number of plants shown in percentage)

Treatment	Sterility (%)									Mean value of sterility (%)
	5-15	15-25	25-35	35-45	45-55	55-65	65-75	75-85	85-95	
X-20	8.3	8.4	8.8	21.8	23.4	11.3	9.0	4.6	4.3	46.2
X-25	7.0	5.4	12.0	18.2	24.4	12.7	9.7	5.0	5.5	48.2
N-15	4.8	6.9	9.1	13.4	17.5	12.1	10.6	9.8	15.9	53.5
N-20	6.4	5.7	6.6	14.5	14.2	13.1	16.1	9.0	12.3	64.6

As many workers have pointed out that semi-sterility was caused by segmental interchanges, it will be segregating semi-sterile and fertile plants in approximately a 1:1 ratio in the subsequent generation. In this experiment as shown in Table 4, the segregation of semi-sterile plants falls in a continuous variation. Chang and Hsieh also described that several semi-sterile plants showed continuous variation of fertility in the X₂ generation. Therefore, the mechanism involved in radiation-produced sterility appears rather complex and remains to be elucidated.

Other Morphological Mutations. Besides the above-mentioned mutations, a number of other mutations such as awned panicles or colored apiculus and glume, narrow leaf, open glume, twisted leaf, spreading habit (lazy type) and changes in grain shape were also obtained. The frequency of such mutations is given in Table 5.

Table 5.
Frequency of Other Drastic Mutations in the R₂

Variety	Treat-ment	Awned	Colored apiculus (at heading)	Colored glume (at ripening)	Narrow leaf	Twist leaf	Open glume	Lazy type	Long grain	No. of plants in R ₂
Taichung 65	X-20	10	10				3			17,416
	X-25	2	3		1					13,468
	N-15	16	5		10	5		2		21,700
	N-20	1			1	9				12,658
Taichung 155	X-20	10	8	1			3	2		22,960
	X-25	2	1		1					22,904
	N-15	2	2	2	4				1	20,944
	N-20									20,972
Kaohsiung 27	X-20	6	4	3						21,924
	X-25		1		1					15,372
	N-15	3	4	7	3			2		21,196
	N-20									14,196
Chianan 8	X-20	2	1							24,108
	X-25					1				22,372
	N-15				1			1		23,700
	N-20				10			4		25,536
Chianung 242	X-20	5	3	1						26,544
	X-25	2								21,924
	N-15	2	1	1	13	4	3	2		18,088
	N-20									10,836

As indicated in Table 5, the 15-hour thermal neutron irradiation seems to produce the highest frequency of these changes.

C. Selection for High Yielding

Mutant Strains

In the R₂ generation, most of the mutants except those with early maturity are of no practical value. However, experience has shown that there is also a considerable number of mutations present that are not easily detected. These mutations may be of great value for breeding purpose. To detect and isolate these mutations, fifty to one hundred R₂ plants which showed fertile, large panicles with dense bearing and many tillers were selected from each treatment under each variety. These selected plants and those early-maturing ones were grown as plant rows in the R₃ generation (second crop of 1958). Most of these mutants were found to breed true and have been put in the preliminary yield trial both in the R₄ and R₅ (first and second crop seasons of 1959) generations. A rod-row test with 3 replications was adopted in this preliminary yield trial. The row is 4 meters long and 0.25 meter apart. Five seedlings make a hill which is spaced 0.20 meter apart. Every 10th row is a check row. Poorly performing strains are discarded on the basis of this trial and, among a total number of 2,100 mutant strains, there were 226 strains in the first crop (R₄) and 532 strains in the second crop (R₅) showing higher yield (3 to 30 percent) than their mother varieties. The frequency and distribution of high yielding mutant strains in each variety is shown in Table 6.

Table 6.
Frequency and Distribution of High Yielding Mutant Strains

Mother variety	No. of strains	Crop season	Strains giving high yield (in %) than the mother variety									Total
			3-6	6-9	9-12	12-15	15-18	18-21	21-24	24-27	27-30	
Taichung 65	410	1st	36	19	6	3		1				65
		2nd	26	24	8	10	3	3	2		1	77
Taichung 155	411	1st	26	9	7	2						44
		2nd	33	28	30	20	17	21	11	6	10	176
Kaohsiung 27	394	1st	13	7	4				1			25
		2nd	15	28	12	8	3	2	4	1	1	74
Chianan 8	436	1st	9	3	2							14
		2nd	30	14	6	1	5	2	1			59
Chianung 242	449	1st	40	22	6	3	6	1				78
		2nd	43	27	20	14	12	9	4	8	9	146
Total	2,100	1st	124	60	25	8	6	2	1			226
		2nd	147	121	76	53	40	37	22	15	21	532

From the result indicated in Table 6, it is obvious that there was seasonal variation in productivity among mutant strains. Many strains outyielded their original varieties in the first crop, but failed to do so in the second crop, or vice versa. Therefore, the following strains selected from the preliminary yield trial of 1959 were again included in larger yield trials for the two succeeding crop seasons of 1960:

1. Strains which yield no less than their original varieties, but head 5 days earlier or more than check plots.
2. Strains with high degree of resistance to rice blast.
3. Strains with the similar heading rate as the check plots and yielding at least 10 percent higher than their original varieties either in the first crop or in the second crop, or outyielding 5 percent in both of the two consecutive crop seasons.

For the above three criteria, a total number of 443 lines were selected and divided into five groups in accordance with their original varieties and placed in the yield tests. A lattice design, replicated twice, was adopted to determine the yielding ability of these selected strains. Result obtained from the first crop of 1960 is presented in the following table:

Table 7.
Variation of Yield of Mutant Strains Selected from the
Preliminary Yield Test of 1959

Mother variety	No. of strains	Yield (in %) as compared with check plots							
		55-65	65-75	75-85	85-95	95-105	105-115	115-125	125-135
Taichung 65	63				13	34	15	1	
Taichung 155	48		2	6	22	18			
Kaohsiung 27	63			1	1	13	38	9	1
Chianan 8	48			1	22	23	2		
Chianung 242	221	5	9	19	20	81	67	10	

The mutant strains selected from the preliminary yield test in 1959 showed a very wide distribution in yield ranging from 35% lower to 35% higher than their mother varieties in 1960. As indicated in Table 7, among the five treated mother varieties, except for those derived from Taichung 155 and Chianan 8, mutant strains from the other three varieties were mostly giving yield as high as their mother varieties or even outyielded them. Several strains which produced about 15 percent or more in grain than their mother varieties are considered promising in practical usage. These promising strains will be tested further in the years to come.

D. Testing of Disease Resistance of Induced Mutant Strains

The rice blast caused by *Piricularia oryzae* is the most rampant and destructive disease in Taiwan, especially in the first crop season. The annual loss caused by this disease is estimated to be no less than 5 percent of the total rice production. Systematic breeding work for blast resistance has been initiated since 1950. The screening technique developed and now in use is to cross various parental stocks in combinations or as back-crosses, followed by selection and regional test among progenies in different regions where natural rice blast epidemic occurs. During the past 10 years, several new varieties with moderate to high resistance have been developed by several district agricultural improvement stations and the Chiayi Agricultural Experiment Station of TARI. Since induction of mutations has been proved to be useful in plant breeding, among the many aspects of the research on induced mutation, its application to induced disease resistance in susceptible varieties would, because of their nature, be one of the most fascinating ventures.

In 1957, seeds of five Ponlai rice varieties (*japonica* type) were treated with different doses of X-ray and thermal neutron for the purpose of inducing blast-resistant mutations. The progress of selection in the R₁ and R₂ has been already mentioned under Parts I and II of this paper. In 1959, mutant strains selected in

the R₂ and tested for breeding true in the R₃ have been tested for leaf blast resistance in both the seedling and adult stages. Resistance of mutant strains in the adult stage was tested in the field near a hillside at Tungshih (Taichung *hsien*) where the development of blast disease was more favorable. Very heavy application of nitrogen fertilizers (160 kg. of N per hectare) was made. In addition, the field was frequently drained to keep it as dry as possible. Degree of disease incidence in the leaf phase is classified into 12 classes based upon the percentage of leaf surface covered by lesion and the number of leaves killed in different stages as listed below:

% of diseased leaf surface	0	0.2	0.5	1	2	5	11	25	55	80	100	120*
Disease index	0	1	2	3	4	5	6	7	8	8.5	8.8	9

* Complete killing of the leaf with lesions extending to leaf sheaths.

The result obtained from the field observation is presented in Table 8.

Table 8.
Variation of Blast Resistance of Induced Rice Mutant Strains
vs. Controls Under the Natural Field Epidemic

Mother variety	Crop season	No. of strains	Grade of disease index							
			1	2	3	4	5	6	7	8
Taichung 65 Check	1st	598		1		1	15	88	296	197
		51					2	22	27	
	2nd	562	3	1		2	12	63	316	165
		49						31	18	
Taichung 155 Check	1st	540				5	43	163	238	89
		51					2	10	28	11
	2nd	494				1	22	124	231	116
		54					1	11	23	19
Kaohsiung 27 Check	1st	557	1		17	58	183	170	113	15
		49				5	16	19	7	2
	2nd	545			1	11	92	179	228	34
		51					3	17	25	6
Chianan 8 Check	1st	578		1	7	34	227	227	75	7
		51				1	27	21	4	
	2nd	546	3	5	8	77	244	166	42	1
		51				1	22	25	3	
Chianung 242 Check	1st	588			1	4	28	189	319	47
		57					6	18	31	2
	2nd	567	1		9	48	175	187	121	26
		58				4	17	29	8	

For the seedling test, fifty seeds of each mutant strain as well as their mother varieties were sown in wooden flats at 0.5 cm.-spaced planting. After sowing, the seeds were allowed to germinate in the greenhouse (the temperature is about 20°C)

for about 3 weeks, then sprayed with a spore suspension two or three times at one-week intervals (at this time the temperature is raised to 25°-30°C). The same method of classifying the disease reaction as described above is used. The result is presented as follows:

Table 9.
Variation in Blast Resistance of Induced Mutant Strains
vs. Controls at the Seedling Stage

Mother variety	No. of strains	Grade of disease index										
		1	2	3	4	5	6	7	8	8.5	8.8	9
Taichung 65	548			1		6	3	2	19	52	129	336
Check	29							1	1	3	7	17
Taichung 155	492			1	1	2	3	12	25	74	201	163
Check	30					1			1	5	12	11
Kaohsiung 27	512		1	2	8	14	11	24	84	130	169	69
Check	26						1	1	4	7	7	6
Chianan 8	528		1	3	7	7	7	15	63	178	180	67
Check	29								5	15	9	
Chianung 242	528	17	38	101	56	25	12	15	41	46	71	106
Check	33		3	6	3	3	2	5	6	2	3	

As indicated in Tables 8 and 9, the mutant strains had an apparently wider range of resistance to leaf blast than that of the untreated mother varieties. Among the mutant strains, a total of 113 strains were found to be resistant to leaf blast and have been tested for breeding true of resistance in the first crop season of 1960. Of these 113 mutant strains, 2 of them are derived from the susceptible variety Chianan 8, 3 strains are induced from another susceptible variety Kaohsiung 27, and the rest are originated from Chianung 242, a resistant variety, but which varies in the degree of resistance at different localities. The experimental result as shown in Table 10 reveals that the resistance due to irradiation is heritable and the 2 highly resistant mutant strains of Chianan 8 origin, a superior Ponlai rice variety for southern and eastern Taiwan, would be especially valuable.

Table 10.
Reaction of Disease-resistant Mutant Strains Selected on the Basis of 1959 Seedling
Tests Through an Artificially Induced Epidemic of Blast Disease in 1960

Mother variety	No. of strains	Highly resistant*	Moderately resistant*	Susceptible*
Kaohsiung 27	3	—	3	—
Chianan 8	2	2	—	—
Chianung 242	108	99	54	4

* The disease index for highly resistant strains is about 1 to 2, for moderately resistant ones 3 to 5 and for susceptible ones 6 to 9.

In 1956, the Taichung DAIS sent rice seeds of the variety Taichung 65, a most widely grown *japonica* variety in Taiwan, to the National Institute of Genetics of Japan for exposure to X-ray and gamma ray (Cobalt-60 source). The X-ray treated rice seeds were multiplied in bulk in X_1 and X_2 . A total of 3,200 heads were selected as separate lines in X_3 . Thirty plants in each line were planted in the disease nursery. One line had been observed to be resistant to leaf blast. For the Cobalt-60 irradiation, 6 plants have been noticed to be resistant among the 5,000 plants in the X_2 generation. In all the selected resistant plants, general agronomic characteristics are very similar to that of Taichung 65 but with a disease index around 4 or 2% leaf lesion. Meanwhile, in the course of the study, it is also noticed that two lines are resistant to *Helminthosporium* leaf spot and a few lines indicated resistance to *Corticium* sheath blight.

In view of these experimental results described above, induced mutation seems to be a promising method in breeding for disease resistance.

III. The Utilization of X-radiation for *indica* Type Rice Improvement

There are two major groups of cultivated rice varieties in Taiwan, one is the Ponlai rice (*japonica* type) and the other Taiwan native rice (*indica* type). In comparison with Ponlai rice, the native varieties of Taiwan, as a rule, suffers from shattering, is liable to lodge and is less responsive to nitrogen fertilizer applications which appear to be the most important means to increase the unit yield of rice in Taiwan. For Taiwan's native rice improvement, therefore, efforts in this direction should be made.

Since 1957, the Academia Sinica in cooperation with the Taiwan Provincial College of Agriculture has made studies on induced mutations to improve the native varieties. Eight *indica* type varieties including 7 native varieties and one Chinese mainland variety were treated with different dosages of X-rays. The purposes of this experiment are to develop (1) an erectile type which is resistant to lodging and responsive to heavier nitrogen fertilizer applications, (2) an early-maturing type to meet the need of multi-cropping rotation system in paddy fields, and (3) non-shattering mutants to reduce loss during the ripening stage.

The treated seeds of each variety were grown in separate plots in 1957 as the X_1 generation and head selections were made at maturity. In the X_2 , plant selection was made in the head-rows. Erectoides, early-maturing plants, plants with large panicles or profused tillerings, and non-shattering types were selected and grown as plant-rows in the X_3 generation. The original varieties were planted simul-

taneously at different intervals as check rows. At maturity, those lines showing no further segregation were harvested and examined.

Preliminary yield trial in randomized block design with two replications of the selected lines were done in the X₄. Those lines showing higher yield than their original varieties were re-selected as "promising lines". Among all treated varieties, except that derived from Liu-chow, mutants induced from other varieties were mostly retrogressive in nature and were subsequently discarded. As indicated in Table 11, one mutant outyielded the mother variety Liu-chow by more than 30%. These promising mutant lines and those other types selected directly from the plant-row test in the X₃ of Liu-chow were again tested with heavy fertilization in the two succeeding crop seasons of 1959. The result is presented in Table 12.

Table 11.
Preliminary Yield Trial of Selected Lines in 2nd Crop of 1958

Serial number	Mutant type	Index (100=original variety)
L. 10- 4- 4	Early-maturing	114.8
L. 10- 1- 3	High-yielding	103.3
L. 10- 3- 1	High-yielding	116.2
L. 10- 4- 1	High-yielding	102.2
L. 20- 2- 2	High-yielding	107.1
L. 20- 2- 5	High-yielding	113.4
L. 20- 6- 1	High-yielding	108.5
L. 25-25-10	High-yielding	125.7
L. 25-25-16	High-yielding	132.3
L. 30-15- 1	High-yielding	122.4
L. 30-21- 2	High-yielding	102.7
L. 30-21-20	High-yielding	108.8
L. 30-10- 4	High-yielding	106.8

Table 12.
Reaction of "Promising Lines" and Other Mutants to Heavy Fertilization

Serial number	Mutant type	1st crop of 1959			2nd crop of 1959		
		(1)	(2)	(3)	(1)	(2)	(3)
L. 25 - 86	Erectoides				93.8	94.1	86.2
L. 25 - 87	Erectoides				102.0	97.6	97.6
L. 25 - 88	Erectoides				91.7	97.0	90.9
L. 10- 4- 4	Early-maturing	92.6	89.0	68.9	115.6	107.3	91.7
L. 20 - 24	Multi-branched				104.6	101.2	111.4
L. 20 - 25	Multi-branched				100.6	94.7	87.9
L. 20 - 26	Multi-branched				110.3	109.7	114.1

(Continued)

Serial number	Mutant type	1st crop of 1959			2nd crop of 1959		
		(1)	(2)	(3)	(1)	(2)	(3)
L. 10- 1- 3	High-yielding	113.2	101.5	88.7	114.1	107.3	99.4
L. 10- 3- 1	High-yielding	87.3	94.1	93.4	128.8	114.1	119.1
L. 10- 4- 1	High-yielding	94.6	85.3	80.9	110.3	99.7	110.3
L. 20- 2- 2	High-yielding	114.5	90.9	77.5	104.1	101.2	111.5
L. 20- 2- 5	High-yielding	91.2	85.5	54.7	100.6	94.7	87.9
L. 20- 6- 1	High-yielding	117.4	113.1	104.7	110.3	109.7	114.1
L. 25-25-10	High-yielding	91.4	100.5	98.1	123.5	120.3	117.9
L. 25-25-16	High-yielding	99.0	88.2	70.1	122.6	114.4	126.7
L. 30-10- 4	High-yielding	100.0	86.0	85.3	112.9	116.2	122.6
L. 30-16- 1	High-yielding	85.1	90.2	93.4	123.2	126.1	122.6
L. 30-21- 2	High-yielding	115.2	107.7	108.4	103.8	109.7	96.5
L. 30-21-20	High-yielding	102.2	115.7	92.4	99.1	45.8 ?	105.3

Note 1: (1), (2) and (3) indicate the level of fertilizer treatment corresponding to 33, 16.5, 16.5; 66, 33, 33; and 100, 50, 50 of N, P₂O₅ and K₂O (kilograms per hectare), respectively.

Note 2: The yield is shown in percent of control.

As indicated in Table 12, the erectile type did not respond to heavy fertilization. Because all the erectoides were susceptible to sheath rot, perhaps this alone could account for their non-responsiveness. The early-maturing mutant, L.10-4-4, also showed little response to nitrogen fertilization, especially in first crop season.

For the "promising lines", several ones showed response in the first crop season but failed to do so in the second crop, or vice versa. Since this test for all mutant lines was preliminary in nature, further investigations are needed. However, several lines such as L. 20-6-1 and L. 30-21-2 showing fairly good response in both the first and second crop seasons were promising for practical purpose.

Except the above-mentioned mutant lines, three non-shattering mutants were also obtained from the Liu-chow variety. Because most *indica* varieties suffer badly from shattering, these mutants are, of course, useful for eventual cross breeding with other *indica* types. Testing for yielding ability and other agronomic characters of these three non-shattering mutants will be pursued later.

IV. The Induction of Translocations for Genetic and Cytogenetic Studies

Translocation can be obtained through induced chromosomal breakage. With the view of utilizing reciprocal translocation method for studying inheritance and linkage relation of genes determining agronomic characters proposed by Burnham (1934, 1946), Yamashita (1949), Kramer (1954) and Rhoades (1955), Chang of TPCA and Hsieh and Huang of TARI have been conducting several experiments on X-

rayed rice for the purpose of gaining information on artificially induced translocation in rice.

According to Chang (1955), more than two hundred semi-sterile lines of Pei-kuh (*indica* type) and Kisshin (*japonica* type) origin have been obtained through X-ray treatment. These lines have been investigated with regard to their fertility and other characters from the second to the fifth generation. The studies revealed that, among these semi-sterile lines when selfed, a large number of lines were found to segregate fertile and semi-sterile plants in the ratio of 1:1. At meiosis, those semi-sterile plants were found to possess quadrivalent chromosomes in rings, chains, or other shapes. The frequency of occurrence of quadrivalents ranged from 2% to 82%, according to different lines. When semi-sterile plants were backcrossed to their original varieties (untreated), the F₁s also gave a 1:1 ratio of fertile and semi-sterile plants. These semi-sterile plants, therefore, would be the translocation heterozygotes attributing to chromosomal interchanges between two non-homologous chromosomes. Translocation homozygotes were then isolated by test-crosses between the fertile plants deriving from translocation heterozygous lines and original untreated varieties. Hsieh and Chang (1959) reported that the X-ray induced reciprocal translocation homozygotes did not show any marked phenotypic change in morphological characters different from the original varieties. Therefore, it seems that no major genic changes was involved in the reciprocal translocation lines. Meanwhile, a total of 27 reciprocal translocation lines, among which 10 lines were induced from Pei-kuh, 10 lines from Taichung 65 and 7 from Kisshin, were tested in a randomized block experiment for the analysis of quantitative characters to determine whether there is any position effect or any genotypic changes accompanying the translocations. The experimental results indicate that the translocation lines are homogeneous in agronomic characters either in morphological or physiological aspects except for translocation. Therefore, the translocation method may be used to some extent for gene analysis and for locating loci on chromosomes.

In 1959, a total of 14 homozygous reciprocal translocation lines were inter-crossed each other by Hsieh to study the interrelation of interchanged chromosomes among these lines. The preliminary result indicated that at least 3 different reciprocal translocation lines out of the total 14 might be identified, and 5 chromosomes out of 12 were found to involve reciprocal translocations. The isolation of more translocation homozygotes and linkage analysis are now under-way.

To obtain double translocation homozygotes, Huang of TARI has made an experiment to treat the single translocation homozygotes with X-rays. In the X₂

generation, the fertile plants derived from semi-sterile strains were again test-crossed with original varieties. The double translocation homozygotes were then isolated.

From the results described above and as Huang has mentioned, it is obvious that the chromosome interchanges in rice are easily induced by irradiation. However, up to now, there is no report of structurally changed chromosomes in naturally occurring strains. Therefore, it may be speculated that there exists in Nature a mechanism to eliminate the translocations.

V. Summary

Since the pioneering work of Gustafsson on induced mutations for crop improvement, there is now sufficient evidence to indicate that beneficial and valuable mutations can be induced through various mutagenic agents. Gustafsson (1947, 1951), Singleton (1954, 1955) and Gustafsson and Tedin (1955) have described in more detail the possibilities and potentialities of induced mutations in plant breeding.

Earliness is one of the most interesting and useful mutations in rice and it was encountered in these experiments reported in this paper. As these early mutants are without marked morphological changes and most of them are normally fertile, it is hoped that some new early strains have the same yielding ability as their maternal stocks could be bred.

As described in this paper, dwarf mutants are often found in the irradiated progenies among all induced mutations. Some of the dwarf mutants derived from the *japonica* varieties are found to be slightly reduced in plant height as compared with their original varieties; and they showed good straw strength which is useful for cultivation in coastal areas where lodging due to gusty wind poses a big problem. The same result is also found in treated *indica* types. Mutants of the erectile type which is lodging-resistant would be especially valuable for *indica* rice improvement.

Several "promising lines" derived from *japonica* or *indica* varieties gave yield higher than their original varieties by more than 10% either in the first or second crop season. If these "promising lines" can be proved to be stable enough, they may be released as new varieties later.

Apart from the above-mentioned mutations, there are two mutant strains induced from the susceptible variety Chianan 8 which showed higher degree of resistance to rice blast. Meanwhile, for *indica* varieties which suffer badly from shattering, three non-shattering mutants induced from the Liu-chow variety appear promising as parental stocks for the improvement of *indica* rice.

Cytological and genetical studies accompanying the breeding program may aid in the analysis and prediction of the behavior of induced mutants. The experiences gained from the investigations reported in this paper reveal that nearly all mutations occurring spontaneously can as well be induced artificially. Considering the important practical problem of whether it is possible to transform at will the cultivated plants to suit our purpose, this series of experiments can be said to demonstrate that mutation breeding has been useful and can further be considerably enriched with more desirable parent materials and more suitable methods.

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TECHNIQUES IN DETERMINING VARIETAL REACTIONS TO RICE BLAST PATHOGEN

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Since 1955 varietal reactions to the rice blast fungus (*Piricularia oryzae*) have been studied in disease nurseries. Beginning in 1960, with the completion of the incubation room and greenhouses specially built for blast study at the Taiwan Agricultural Research Institute (TARI) with JCRR fund, seedling reaction to blast is now being studied under controlled conditions. The techniques involved in determining varietal reactions to the pathogen under field and greenhouse conditions are discussed in the following sections.

I. Seedling Study Under Controlled Conditions

A. Source of Inoculum

The inoculum is composed of a number of isolates taken from diseased leaves that represent samples from various regions of Taiwan. Single-lesion leaf-dics are transferred onto potato-dextrose-agar plates, from which single conidial cultures are isolated. The cultures for inoculation are increased in a medium made from 60 grams of whole, soaked rice panicles and 20 c.c. of 20% glucose solution in 500 c.c. conical flasks. The culture is grown at room temperature for 9-10 days with vigorous aeration provided. The inoculum is applied in the form of a conidial suspension.

B. Inoculation

The rice seedlings are grown in greenhouse soil in galvanized iron flats (30 cm²). Seedlings of different entries are planted in separate blocks in the same flat. About 40-50 seedlings are planted for each entry and replicated 2-3 times. Prior to inoculation, 2% ammonium sulfate solution is top-dressed to the flats twice, at the rate of 250 c.c. per flat for each application. When the seedlings reach a height of 15 cm. (about 3 leaves), they are ready for inoculation.

The inoculation is accomplished by spraying the conidial suspension onto the seedling leaves at the rate of 100–200 c.c. per flat. The flats are then placed in the incubation chamber where abundant moisture is provided by means of an Aerosol humidifier and the temperature maintained around 25–28°C. Meanwhile, artificial light is furnished for 6 hours per day. After 2 days, the mist is provided at longer intervals and the light let on for 8 hours a day. A week after inoculation the flats are moved out of the incubation chamber and placed either under a wire cage or a greenhouse, depending on the air temperature outside. Three or four days later the inoculated seedlings are examined for their reactions.

In case the first inoculation failed, a second inoculation may be made with the same batch of seedlings.

II. Field Study in Disease Nursery

The disease nurseries are set up in those locations where an epidemic of the blast disease can be counted on every year, especially in the first crop season. Most of those locations are found in valleys where the topography favors heavy and prolonged dew formation. In many of those areas, the dews are formed early in the evening (beginning about 6 p.m.) and may last until noon the next morning when the sky is overcast and the air relatively still.

A. Source of Inoculation

To promote a heavy disease incidence, highly susceptible varieties (such as Taichung Special 6, Taichung 65 and Kuanshan Wuhsiang Ken) are grown as spreader-rows around the borders of the plots and also inside the plots among rows of resistant material. The inoculum is furnished from three sources: natural deposits of spores from the air, inoculation with conidial suspensions, or foders of susceptible plants from the previous crops stacked in various places inside the nursery.

B. Layout of the Materials to be Tested

For established varieties or lines, the entries are replicated 2–3 times, with 4 rows to each replicate and 10 hills per row. The arrangement of entries in each replicate is randomized. For testing breeding lines, single rows for each line are planted with 10–20 hills to each row. In the breeding part, more susceptible spreader-rows are inter-planted to provide uniform infection.

C. Management of the Nursery

To induce heavy infection, the fields are flooded and drained as often as possible. Heavier dew formation is generally found in a drained field. The fields were manured with 160 kg. of nitrogen per ha. during 1954-57. Since 1958, the fields were fertilized at the rate of 120-20-8. Since 1960, the nursery for comparing established varieties has been fertilized under a split-plot plan: one replicate is fertilized with the heavier rate (120-20-8), and the other replicate with the usual rate (80-40-40). The heavy rate may affect the physiological constitution of the plants prior to infection (predisposition), thus giving the entries an opportunity to fully express their highest level of resistance. The lower rate would give an indication of the field reaction of the varieties under farmers' cultural conditions.

Cultivation and weeding are practised to keep the nursery clean from weeds. Chemical control of the stem borer is also observed.

For neck, pedicel and glume reactions, determinations are based on field infections only.

D. Recording of Plant Reactions

The leaf reaction to blast is usually investigated and duly recorded 4 times a crop: once in the seedbed, at 35 days, 50 days and 65 days following transplanting. For neck and panicle reactions, recordings are made at 20 and 30 days following heading.

When taking the leaf reactions, 20 plants in the two middle rows are examined. Then the arithmetic mean for the varieties computed. For neck reactions, about 20 plants are examined and all the panicles are counted in each entry, and the mean computed.

III. Rating of Plant Reactions

For leaf reactions, a system for classifying disease incidence according to the percentage of leaf surface area occupied by lesions and the number of leaves killed at different stages has been in use since 1955. The rating system is as follows:

	% lesion area											
	0	0.2	0.5	1.0	2.0	5.0	11	25	55	80	95+	Complete killing
Infection index	0	1	2	3	4	5	6	7	8	8.5	8.8	9 (dead)
Classification	Immune	Resistant (R)			Moderately resistant (MR)		Moderately susceptible (MS)		Susceptible (S)	Highly susceptible (HS)		

To indicate the progress of disease development, the following symbols have been used either singly or in combination to supplement the above percentage figures:

- a —Browning and drying extend to 1 new, upper leaf;
- a' —Browning and drying extend to 2 new, upper leaves;
- a''—Browning and drying extend to 3 new, upper leaves;
- b —Above 20% of the lesions are the expanding and coalescent type; and
- c —Nearly all the new, upper leaves are affected.

Since 1960, upon the suggestion of the writer, more attention is now given to the infection type of the lesions. Inasmuch as the above ratings only indicate the general disease development and the extent of infection over the plant and that these quantitative traits are readily affected by a variety of environmental conditions (other than the genetic constitutions of the host and the pathogen), past studies based on the above ratings have shown marked variations from season to season or from locality to locality or both (Ou and Lin, 1958). For the same matter, circumstantial evidence of the presence of physiological races of *P. oryzae* in the fields could not be verified. With the introduction of the supplementary system of rating infection types, due consideration is given to the specific relationship between the genotype of the host (resistance or susceptibility) and the genotype of the pathogen (virulence or avirulence). It is expected that the present recording system including 3 criteria (disease incidence, development over a lapse of time, and host-pathogen specificity) would yield more useful information.

The classification of lesions is listed below.

Code	Lesion type	Description
I	Immune	No visible sign of infection.
R	Resistant	Small brownish to dark brown lesions or spots.
M	Intermediate	Brownish lesions with a distinct border and a colorless to greyish white center; restricted in size.
S	Susceptible	Large spindle-shaped lesions with greyish-white center, surrounded by brownish bands, water-soaked appearance, often without well-defined border; variable in size, often expanding or coalescent.

An index number indicating the area occupied by lesions is added to the above code letters, e.g., S₃, M₂ and S₃M₂ (for mixed types).

For breeding purpose, a simplified recording system of using the R, S and X (for mixed) symbols in field studies is now in effect.

The neck reaction is determined by the appearance of lesions on the neck or a bent neck at a later stage. A counting of the panicles is made to give the percentage of infection. The system of ranking neck reactions is as follows:

Classification	% of neck infection					
	0-10	11-30	31-50	51-70	71-90	91-100
	HR (highly resistant)	R (resistant)	MR (moderately resistant)	MS (moderately susceptible)	S (susceptible)	HS (highly susceptible)

The pedicel and glume reactions are determined by estimating the percentage of infection. For pedicel reaction, when 2 or more of the branches are affected, the panicle is rated as susceptible.

IV. Related Problems—Physiological Specialization and Predisposition

Previous studies have shown that varietal reaction varied with season, location or both (Ou and Lin, 1958). However, owing to the system of recording based on general infection, the above information could only be regarded as circumstantial evidence for the presence of physiologic races in Taiwan. During the first crop of 1960, heavy infection of the formerly resistant variety Chianung 242 was noted in the Taitung nursery, whereas in the 5 other nurseries elsewhere the same variety retained its resistance. Upon close examining for lesions types, a mixture of resistant and susceptible types was found on the same leaf in the Taitung nursery, with the latter in the majority. This is the first positive evidence of physiologic specialization under field conditions. Meanwhile, the Taiwan Agricultural Research Institute and the Taiwan Provincial College of Agriculture have collected leaf samples from the Taitung nursery for laboratory study.

Based on previous studies, the TARI has determined a number of cultural variants of the blast fungus from various sources in Taiwan. A preliminary study of 6 monoconidial isolates on 16 differential varieties of rice has suggested the division of 5 different pathogenic races. Plans have been made to study all the samples taken in 1959 and 1960, and 80 isolates have been cultured. It is expected that more pathogenic races would be added to the list.

It has been mentioned that, in previous years, a heavy level of manuring was practised in disease nurseries. The problem of predisposition at this high level of manuring was suspected by the writer. Upon the writer's suggestion, the disease nurseries are now fertilized at two levels. Field data from the Yilan nursery during the first crop of 1960 show the following variation in leaf reaction at the 2 levels of manuring:

Disease index	Taichung 65	Taipei 306	Taichung 171	Taichung 178	Kaohsiung Yu 122	Tainan 1
80-40-40 level	7	5	1	1	1	4
120-20-8 level	8.8	8.5	2	4	3	8

It is obvious from the above that resistant lines (Taichung 171 and 178, and Kaohsiung Yu 122) showed little variation in reaction at the two levels of manuring, while the less resistant ones (Taipei 306 and Tainan 1) showed larger variation. Taipei 306, Tainan 1 and Taichung 65 belong to the susceptible to highly susceptible class under heavy manuring, whereas Taichung 178 and Kaohsiung Yu 122 belong to the moderately resistant class. Taichung 171 is rated as resistant at the heavy level of manuring. The two levels also served to separate Taichung 65 and Taipei 306 at the 80-40-40 level as susceptible and moderately resistant varieties, respectively. The difference in field reaction of Taichung 65 and Taipei 306 had been reported by extension staff based on observations in farmers' fields, however, such differentiation could not be confirmed until the two varieties were subject to the same test in the disease nursery as described above. The above test at 2 levels of manuring would settle much of the controversy among stations as to which varieties are more resistant than others under field conditions.

V. Reactions of Taiwan's Rice Varieties Under Extension

Based on years of study in disease nurseries, much information have been gathered concerning the reaction of our rice varieties. A list of those commonly grown varieties and their reactions to blast are given as follows:

Variety	Leaf reaction	Neck reaction
A. Ponlai rice— <i>japonica</i> type		
Taipei 127	S	—
Taipei 177	S	—
Taipei 306	MS--S	S--HS
Hsinchu 56	MR	S--HS

Variety	Leaf reaction	Neck reaction
Hsinchu 58	S-HS	MS-S
Taichung 65	S	HS
Taichung 150	S	S-HS
Taichung 153	MS	MS-S
Taichung 155	HS	HS
Taichung 176	R-S(MR)*	HS
Taichung 178	R-HS(MR)*	R-HS(MS)*
Taichung 179	R-S(MR)*	R-HS(MS)*
Taichung 180	R-S(MR)*	S-HS
Taichung 181	MR-R	MR
Chia-nung 242	MS-(MR)-R*	R-S(MR)*
Chia-nan 2	S	S
Chia-nan 8	MS-S	S
Tainan 1	S-MS	MS-HS
Tainan 3	MS-S	MS-S
Kaohsiung 10	S	S-HS
Kaohsiung 22	MS-S	MR-S(MS)*
Kaohsiung 27	MS-S	HS
Kaohsiung 53	MR-S(MS)*	R-S(MS)*
Kaohsiung 64	S	MR-HS(S)*
Kaohsiung 68	MS-S	MR-HS(MS)*
Taitung 16	MR	HS
Taitung 24	MS	S-HS
B. Native rice— <i>indica</i> type		
Bei-Me-Fen	MR-R	R-MR
Kaohsiung Tali-Chin-Yu	MR-R	R-MR
Yi-Kung-Pao	HR-MR	MR-MS(MR)*
Tsai-Yuan-Chung	HR-MR	R-MR
Taichung (native) 1	R-MR	R-MR
Woo-Tsan	HR-R	MR-MS(MR)*
Tee-Geo-Woo-Tsan	R	MR-MS(MS)*

* The class in () represents a mean value for unstable varietal reactions, varying with year and location.

It should be noted that the above ratings are based on studies in the disease nurseries in previous years where the incidence of disease and the conditions for disease development were more severe than usual. For comparative performance of those varieties under farmers' conditions, the ratings may be generally elevated by one grade, i. e., from "susceptible" to "moderately susceptible", and "moderately resistant" to "resistant".

For a more complete listing of varieties, please refer to "A Key to the Varietal Reactions to Rice Blast (Taiwan)" (Chang, 1960).

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THE SYSTEM OF RICE SEED MULTIPLICATION AND DISTRIBUTION IN TAIWAN

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I. Introduction

Two crops of rice are generally grown in most areas of Taiwan wherever the irrigation facilities permit. For the lowland rice, two types of rice, the Ponlai varieties (*japonica*) and Taiwan's native varieties (*indica*), are the staple ones. For the Ponlai varieties, a well established system of seed multiplication, certification and distribution is in effect. For the native varieties, a similar system for the sole improved variety, Taichung (native) 1, has been started in 1960 and will go into full operation in 1961.

The present seed increase and extension system will be summarized in this report. Emphasis will be given to new operational changes and improvement. For past achievements, please refer to papers by P. Kung (1957) and H. S. Chang (1959). For the current seed certification work, please refer to the paper by Lin and Sung (1961) in this series.

II. Seed Production System

The production of rice seeds in Taiwan follows the conventional hierarchy: foundation seeds, stock seeds (equivalent of registered seeds) and extension seeds (equivalent of certified seeds). The foundation seeds are increased from breeders' seeds by the seven district agricultural improvement stations (DAIS's) of the Taiwan Provincial Department of Agriculture & Forestry (PDAF). The stock seeds are increased by *hsien* (prefecture) or city farmers' associations (FAs) or their contract farmers. The extension seeds are multiplied by contract seed farmers.

The above system is operated as follows:

Class of seed farm	Source of seed supply	No. of seedlings per hill	Projected yield (kg./ha.)	Operator	Operating location
Foundation seed farm	Breeders' seed lots	1	1,500	DAIS	District level
Stock seed farm	Foundation seed farms	3-5	3,600 ¹	<i>Hsien/city</i> FA or contract farmers	<i>Hsien/city</i> level
Extension seed farm	Stock seed farms	3-5	3,600 ²	Contract farmers	Township/village level

¹ The projected yield was raised from 2,400 kg./ha. to 3,600 kg./ha. in the 2nd crop of 1960.

² The projected yield was raised from 2,400 kg./ha. to 3,600 kg./ha. since the 1st crop of 1960.

The DAIS's of the PDAF bear the cost of producing the foundation seeds which are distributed free to the stock seed farms through the *hsien/city* governments and FAs. The PDAF also pays a small subsidy to the stock seed farms (at NT\$ 200 per ha.). Other forms of encouragement to stock seed farms are prizes, storage facilities, and priorities in receiving subsidies for constructing drying grounds or compost houses. The stock seeds produced are purchased from the growers by the *hsien/city* governments. A premium of 20% in cash is given to stock seed farmers. The projected yield of 2,400-3,600 kg. of seeds per ha. is sufficient for planting 40-60 ha. of extension seed farms. The stock seeds are distributed through the township or village offices to the extension seed farms free of charge. The extension seed farmers are allowed to turn in to their respective FAs 3,600 kg. of pure seeds per ha. (sufficient for planting 60 ha. of fields). For the extension seeds which have passed certification standards, the contract farmers are given a premium of 15% by the Provincial Food Bureau (PFB).

III. Planning of Seed Multiplication Work

The planning of seed increase each year with respect to varieties and the amount of seeds for respective varieties is achieved in a two-way traffic: the breeders and extension agronomists of DAIS's decide on the best choice of varieties for seed increase, and the rice farmers through the extension workers of local governments and FAs voice their likes and dislikes. The breeders and the extension workers then meet together once or twice a year to discuss plans for the coming year, and, following the exchange of views and facts, a definite plan is drawn up for each district.

The DAIS's present their plans at the annual meeting of the Rice Improvement Conference (RIC) under the PDAF. The RIC is attended by the staff of experiment

stations of the PDAF, agricultural colleges, JCRR, PFB, Provincial Farmers' Association (PFA), extension staff of *hsien/city* governments and other interested parties. The seed multiplication work for the coming fiscal year is presented by the DAIS's for the approval of the conferees. The key-points discussed in the RIC are (1) the varieties to be increased as foundation seeds, and (2) the respective amounts for different varieties. Since the foundation seed is the start of the entire seed multiplication process, the resolutions of the RIC as to choice of varieties and respective amounts would be carried through in subsequent years.

Since 1960 the screening of the seed multiplication program prior to the RIC meeting is now being undertaken by two technical committees under the RIC: the Breeding Committee which watches over the choice of varieties, and the Seed Multiplication & Extension Committee which studies the distribution of work-loads in seed work. The Seed Multiplication & Extension Committee is composed of representative from the PDAF, its seven DAIS's, PFB, PFA and JCRR, all of which are actively engaged in seed increase and extension work.

IV. Supervision of Seed Multiplication Work

The direction and supervision over seed increase work is also distributed among various government agencies in a hierarchical order: the PDAF over foundation seeds, the DAIS's over stock seeds, and the *hsien/city* governments together with the township and village offices over the extension seeds. The supervision work consists of: (1) selection of sites for seedbeds and seed increase fields, (2) management of the seedlings in seedbed and pest control work, (3) cultivation and weeding work in the field, (4) pest control work in the field, (5) roguing of off-types and barnyard grass, (6) proper harvesting, cleaning and drying of seeds, and (7) storage of seeds. The above supervision work is often integrated with the seed certification work to attain maximum effectiveness.

With JCRR's assistance, the PDAF held training sessions in 1960 for extension staff of local governments on supervision work. Briefing sessions for contract farmers on seed farm management will be held early in 1961. Meanwhile, the PDAF has published a booklet on seed farm management and varietal characteristics to educate contract farmers on the proper ways of running a seed farm and to familiarize farmers with the special cultural requirements of new varieties. For each variety under multiplication, fertilizer rates, pest control measures, irrigation methods and other essential features are given in the said booklet.

V. Seed Certification Work

Since 1960 the seed certification program now covers all classes of rice seed farms in Taiwan. Meanwhile, the certification standards for each class of seeds have been realistically revised. For the revisions and new procedures, please refer to the special article in this series on seed certification (Lin and Sung, 1961). It may be said here that, with the extension of the seed certification work, the quality of seeds produced by all classes of operators has shown marked improvement. The certification work also provides valid basis for the selection of seed farms.

VI. Distribution of Extension Seeds

Prior to the second crop of 1959, all the extension seeds multiplied were allowed to be distributed to rice farmers through a barter system under which the farmers offer paddy for seed at a rate that varies from 1.0 (seed):1.0 (paddy) to 1.0:1.2. The barter usually took place at the home of the contract seed farmers.

Since the second crop of 1959, the PFB has taken over the charge of seed distribution work. The contract farmers are required to turn in their seed lots to the local FA immediately after drying. For seed lots that meet certification requirements, the farmer gets a premium of 15% from the PFB dispensed through the FA. Those farmers who need pure seeds may turn in their paddy to the FA and get the extension seeds there at the exchange ratio of 1:1.

For the second crop of 1960, when the interval between the harvesting of the first crop and the planting of the second crop was short, the PFB made special allowance for rice farmers to barter for seeds at the site of the seed farm under the supervision of a government official. Thus, the extension seed farmers were assured of getting their 15% premium.

VII. Actual Production and Distribution of Seeds

The seed production in Taiwan is gauged to produce sufficient seeds for rice farmers to renew their seed lots once every three years or once in six crops. Thus, the projected amount of seed production for each rice crop is approximately one-sixth of the seed requirement for that crop.

A. Production of Stock Seeds

The production of stock seeds in 1959 and 1960 is summarized below.

Year	First crop			Second crop			Total		
	No. of farms	Acreage	Projected amount	No. of farms	Acreage	Projected amount	No. of farms	Acreage	Projected amount
		(ha.)	(kg.)		(ha.)	(kg.)		(ha.)	(kg.)
1959	129	42.92	120,985	116	47.11	113,064	245	90.03	234,049
1960	119	42.92	158,261 ¹	110	53.70	242,517 ¹	229	96.62	400,778 ¹

B. Production of Extension Seeds

The production of extension seeds in 1959 and 1960 is summarized below.

Year	First crop			Second crop			Total		
	No. of farms	Acreage	Projected amount	No. of farms	Acreage	Projected amount	No. of farms	Acreage	Projected amount
		(ha.)	(kg.)		(ha.)	(kg.)		(ha.)	(kg.)
1959	2,127	1,014.50	2,723,039	2,913	1,663.30	4,147,927	5,040	2,677.80	6,870,966
1960	1,996	923.40	2,911,289 ¹	2,608	1,583.92	5,346,173 ¹	4,604	2,507.32	8,257,462 ¹

¹ The increase in projected seed production for 1960 over that for 1959 is a result of raising the seed production quota from 2,400 kg./ha. to 3,600 kg./ha. in 1960.

C. Renewal of Seeds

The renewal of seeds by rice farmers during 1958-1959 is summarized below.

Year	Projected acreage	Actually renewed	% of success
	for renewal	acreage	
	(ha.)	(ha.)	
1958	95,000	84,221	88.65
1959	95,000	89,864	94.59

VIII. Recent Improvement in Seed Production and Distribution

Some of the recent progress in improving the rice seed production and distribution work in Taiwan are enumerated as follows:

A. Reduction in the Number of Varieties Increased

There are about 60 some Ponlai varieties being grown by Taiwan's rice farmers. In addition, there are a score of native varieties in cultivation. The number of improved Ponlai varieties increased for foundation seeds in 1958-59 totalled 20; 21 during 1959-60; and 19 during 1960-61. During 1960-61, the improved *indica* variety, Taichung (native) 1, was added to the list. About 17 Ponlai varieties will be increased in 1961-62.

The gradual reduction in the number of varieties under the seed program would simplify varietal identification in field and laboratory certification, simplify the recommendation of varieties, simplify the planning of seed increase sites and distribution plans, and promote the extension of new superior varieties to replace less desirable ones. However, owing to the wide spectrum of ecological conditions existing in Taiwan, the two-rice-crop system and the multiple cropping system, there is a limit as to how many varieties can be removed from the list. A study is now underway to map out the regional adaptation of new varieties to fit in the ecological environs and cropping systems so that a province-wide recommendation of rice varieties may be realized.

B. Reduction in the Number of Operating Seed Farms

During 1957-58, there were about 7,000 extension seed farms for the two crops. The number was reduced to 5,112 during 1959-60 and is being further reduced to 4,604 in 1960-61. The projected number is about 3,000 extension seed farms.

The reduction in the number of seed farms is made possible by raising the quota of seed production on each hectare of farm from 2,400 kg. to 3,600 kg. of seeds and the subsequent reduction in the number of seed farms needed on a village basis. During the process, contract farmers have been selected to cull out the uncooperative ones. Meanwhile, conscientious ones are encouraged to devote a larger share of their farms to seed production.

C. Strengthening the Governmental Supervision Over Seed Production and Distribution

During 1960-61, the governmental supervision over rice seed production and distribution is given renewed strengthening through (1) JCRR's assistance in conducting training classes for extension staff of local governments engaged in seed work, (2) PDAF's publication of a booklet on the proper management of seed farms and the cultivation of improved varieties, (3) the JCRR and PDAF's cooperative efforts in enlarging the seed certification program over all seed farms, (4) JCRR's assistance in holding briefing sessions for seed farmers, and (5) the PFB's participation in the seed distribution work by paying a guaranteed 15% premium for extension seeds turned in to the FA. The stronger direction and supervision on the part of governmental agencies and the renewed interest on the part of contract farmers result in a higher quality of rice seeds produced in recent years.

D. Improving the Seed Multiplication System

A new plan is under experimental trial in a few chosen areas to devote the first crop to stock seed increase and the second crop to extension seed production.

By placing the two steps on a seasonal basis, the process simplifies the distribution of seeds and the supervision work. The new process would also ease some of the rush in certifying the large number of extension seed lots during the short interval between the first crop and the second crop.

E. Other Improvements

To promote an early maturing crop, the stock seed farmers of northern areas are encouraged to use plastic covers to protect seedlings from cold injuries and to advance the date of seeding in the first crop. Through the above practice, the date of planting may be advanced by 20-30 days and the time of harvesting by 10-15 days.

To enable stock seed farmers to keep their seeds free from mechanical mixtures, vinyl plastic sheets are given to the farmers to cover up the seed piles during drying. The plastic sheets would be used in place of straw mats (which are liable to carry seeds with them when several lots are dried in succession). Meanwhile, some of the meritorious stock seed farmers are awarded aluminum storage cans to improve their storage facilities.

IX. Summary

The workability of the rice seed production and distribution program in Taiwan is founded on the division of duties among agencies in producing the three classes of seeds as well as the supervision of seed production for each class. The quality of seeds multiplied is improved through the constant selection of contract farmers, strengthened governmental direction and supervision, and the extension of the seed certification program to cover all seed farms. The contract farmers' interest in seed production is enhanced by a guaranteed premium for certified seed lots and the awarding of prizes to superior operators. Constant efforts are being made to produce sufficient quantities of seeds of favored varieties to meet the farmers' demand and preference. The growers' interest in planting certified seeds is hiked by the continuous development of superior varieties to replace the old ones. Seed renewal constitutes the only logical means for growers to obtain seeds of desired varieties at no extra cost. All the above closely integrated efforts result in an extensive use of certified seeds and greater production per farm.

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WHEAT IMPROVEMENT AND SEED PRODUCTION IN TAIWAN

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I. Introduction

The annual consumption of wheat during the past three years has gone up over two hundred thousand metric tons a year as an increase in human consumption and in use for feed and various industrial purposes. Although a greater part of the needed wheat has been provided with imported wheat under the U.S. Aid Commodity Program, effort has been made by the local government to enlarge the local wheat acreage so as to increase the Island's wheat production. The local wheat consumption during the past four years and wheat production goals for the next four years may be shown respectively in the following two tables:

Wheat Consumption in Taiwan During 1957-1960

Year	Local production		Foreign import (m.t.)	Total consumption (m.t.)
	Acreage (ha.)	Production (m.t.)		
1957	19,943	36,129	143,763	179,892
1958	22,706	39,850	223,833	263,683
1959	22,841	43,028	169,962	212,990
1960	25,208	45,574	277,771	323,380

Wheat Production Goals for 1961-1964 in Taiwan

Year	Acreage (ha.)	Production (m.t.)	Yield per ha. (kg.)
1961	34,200	69,768	2,040
1962	36,900	76,752	2,080
1963	39,600	83,952	2,120
1964	42,300	91,368	2,160

Wheat is grown in Taiwan principally in the central part of the Island with some acreage in the southern, eastern and northern parts in Tainan, Taitung and

Miaoli. It is planted mostly on paddy fields during the winter following or just prior to the harvesting of the second rice crop. As it is planted about the same time as other more incentive crops such as tobacco, Irish potato, flax, soybean, etc., are, a drastic increase in wheat acreage has always been found difficult. Although some acreage may be gained by rotation with soybean after the extension of soybean in the north, more work has to be done on varietal and cultural improvement in order to increase local wheat production through the increase in unit yield.

The imported wheat is milled mainly into wheat flour for human consumption, and, it is estimated that, during the past years, several ten thousand metric tons of the flour milled have been further extracted to manufacture monosodium glutamate, an item commonly used by the Chinese people as a condiment for food seasoning. The native wheat is used approximately in the following manner:

For seed	6%
For feed and industrial uses.....	19%
For flour.....	75%

II. Varietal Improvement

A. New Promising Varieties for Paddy

Fields in Central District

The common wheat varieties grown in Taiwan are Taichung Nos. 29, 31 and 32. They occupy nearly all the wheat areas in this Island, except small acreage in Tainan district where native varieties still predominate. The acreage of different wheats as estimated in percentage during the past two years is approximately as follows:

Variety	% among total acreage
Taichung 29	18
Taichung 31	68
Taichung 32	4
Other varieties	10

The Taichung wheat varieties were developed by the Taichung District Agricultural Improvement Station (DAIS) through the uses in cross breeding of the Japanese varieties such as Saitama 27 and Showa wase (Taichung Nos. 29 and 31) and between the American and Japanese varieties such as Florence and Saitama 27

(Taichung 32). They are very good in quality and yield, but, in a year when there is a severe epidemic, the loss due to rusts may be tremendous. To improve the wheat varieties resistant to rust, the Taichung DAIS has started again since 1953 making crosses using known resistant varieties such as New Thatcher, Timstein and Selkirk with the local commercial varieties. At least four new varieties obtained from the original cross between Timstein×New Thatcher and Taichung 31 have been found to be more rust resistant than Taichung Nos. 31 and 32, and some of them do give higher yield than the latter under severe rust condition. These four new varieties were developed after alternate back-crossing and selfing for three times to Taichung 31 following initial crossing between Timstein×New Thatcher and Taichung 31 in 1953. Yield data of these four varieties, as tested in 1959 by the Taichung DAIS at three localities where natural epidemic was considered severe, may be summarized in the following:

Yield of Four New Rust Resistant Varieties of Wheat Conducted at Three Localities in Taichung Area in 1959

Variety	kg./ha.				
	Fuhsing	Hsilo	Yuanli	Average	Index
New varieties					
No. 137	2,708	1,950	1,849	2,169	115.8
No. 138	2,592	2,208	2,487	2,429	135.0
No. 140	1,733	1,833	2,300	1,955	104.4
No. 141	2,192	2,261	2,604	2,352	125.7
Taichung wheat					
No. 31	1,700	1,425	2,494	1,873	100.0
No. 32	1,075	1,248	2,492	1,605	85.7

From the above table, it may be seen that the yields of Nos. 138 and 141 are significantly better than those of Taichung Wheat Nos. 31 and 32 under the epidemic condition. However, as these are only the first year results, further experimentation is still necessary.

B. Extension of New Wheat Varieties for Dryland Area in Tainan District

In Tainan district, wheat is grown mainly on dryland. As Taichung wheats are not tolerant to the winter drought, the varieties adapted there are still the native ones. To improve the wheat yield in that area, two new varieties of wheat were released by the Tainan DAIS in the fall of 1959. They are designated as Tainan Nos. 2 and 3. They were selected through pure line selection from some 1 400 heads of native varieties collected from farmers' fields in Tainan district in

1952. They have been tested since 1954; and the yield of these two new varieties as against that of the native ones at six places in 1958 may be seen in the following table:

Yield of Two New Dryland Wheat Varieties vs. the Native Ones at Six Places in 1958
kg./ha.

Variety	Tainan Prefecture			Chiayi Prefecture			Average	Index
	Hsueh-chia	Pei-men	Chi-ku.	Yi-chu	Tung-shih	Pu-tai		
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

The average length of growth of the native wheat grown in Tainan district is about 143 days. Tainan 2 matures about a week later while Tainan 3 does about a week earlier. Both of them yield about 30 to 40 percent higher than the native varieties with Tainan 3 a little better than Tainan 2.

C. Origin and Characteristics of the Main Wheat Varieties Grown in Taiwan

The origin and characteristics of the main wheat varieties now grown in Taiwan may be summarized in the following table:

Variety	Parentage	Type of wheat	Days to maturity	Resistance to rusts	Tolerance to drought
Taichung 29	Saitama 27 × Showa wase	For paddy fields	107	Resistant	Not tolerant
Taichung 31	Showa wase × Saitama 27	For paddy fields	109	Moderate	Not tolerant
Taichung 32	Florence × Saitama 27	For paddy fields	113	Moderate	Not tolerant
Tainan 2	Selected from native wheat grown in Chiayi	For dryland area	148	Moderate	Tolerant
Tainan 3	Selected from native wheat grown in Yunlin	For dryland area	136	Moderate	Tolerant

During 1958 and 1959; seed samples of wheat varieties of Taichung Nos. 2, 23, 29, 31 and 32 were sent to Professor Juan B. Cabanos of Araneta University of the Philippines for trial planting. Some seeds of Taichung Nos. 29, 31 and 32 had also been sent to East Pakistan in 1959.

III. Wheat Seed Multiplication

A. The Wheat Seed Multiplication System

The wheat seed multiplication work in Taiwan has been carried out since 1950. The system consists of three levels, i.e. foundation, stock and extension seed farms. As wheat is grown only one crop in a year, theoretically, it would take three years

to complete a cycle of the whole wheat seed multiplication system. However, in actual work, all seeds of different levels are multiplied every year, one being followed by the other in that order. The operation of the wheat seed multiplication system may be briefly outlined in the following:

1. Foundation seed farms. With the extension of new wheat varieties for dry-land area in Tainan district, the foundation seed farms are now established at the District Agricultural Improvement Stations in Taichung, Tainan and Taitung and at the Seed & Seedling Multiplication Station at Tungshih, Taichung Prefecture. They are operated by these stations under the supervision of the Taiwan Provincial Department of Agriculture & Forestry. Wheat varieties multiplied at different stations may be shown in the following:

Station	Wheat varieties multiplied	For future extension at
Taichung DAIS	Taichung 29, 31, 32	Taoyuan, Hsinchu, Miaoli, Taichung, Changhwa, and Yunlin Prefectures
Tainan DAIS	Tainan 2, 3	Tainan and Chiayi Prefectures
Taitung DAIS	Taichung 32	Taitung Prefecture
Seed & Seedling Multiplication Station	Taichung 31	Taichung, Changhwa, Miaoli and Hsinchu Prefectures

2. Stock seed farms. The stock seed farms are established at the prefectural level and, at present, operated by the prefectural farmers' associations in Taoyuan, Hsinchu, Miaoli, Taichung, Changhwa, Yunlin, Chiayi, Tainan and Taitung. In case the stock seed farms are operated by contract farmers, these farmers are usually carefully selected. Seeds for stock seed farms are supplied by the district agricultural improvement stations and the Seed & Seedling Multiplication Station with the certified foundation seeds of the adaptable wheat varieties.

3. Extension seed farms. The extension seed farms are established at different wheat-producing townships and operated by contract farmers under the supervision of the township farmers' associations. They are seeded with the stock seeds. The extension seeds are sold or loaned to the farmers for general planting in the following crop season.

As mentioned before, 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 level of seed 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

manner:

Type of seed farms	Operating agency	Seed supplied by	Seed distributed to
Foundation seed farms	District agricultural improvement stations and Seed & Seedling Multiplication Station	Taichung and Tainan DAISs or operating agencies themselves	Stock seed farms at prefectural level
Stock seed farms	Prefectural farmers' associations and contract farmers	District agricultural improvement stations and Seed & Seedling Multiplication Station	Extension seed farms at township level
Extension seed farms	Township farmers' associations and contract farmers	Prefectural farmers' associations	Farmers in general

B. Wheat Seed Multiplication Work

During 1959 and 1960

Wheat seed multiplication work prior to 1959 had been reported in a paper previously presented to the last Far East Seed Improvement Workshop held at Tokyo, Japan, in 1959. The amounts of wheat seeds multiplied by different seed farms in 1959 and 1960 as compared with that of the preceding two years may be shown 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.)
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
1959	4.10	4,500	51.29	112,442	698.01	1,150,459
1960	3.85	4,431	54.90	104,358	872.91	1,526,071

Remark: Wheat varieties multiplied in 1959 and 1960: Taichung Nos. 29, 31, 32 and Tainan Nos. 2, 3. No Taichung Nos. 2 and 23 were further multiplied.

The production of 1,526,071 kg. of extension seeds in the spring of 1960 will be enough for extension of nearly 21,800 hectares in the fall of 1960 at the seeding rate of 70 kg. per hectare. This is about two-thirds of the total acreage of wheat projected for the 1961 crop. The seeds for the other one-third 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 must have already

been removed and cleared. After seeds are harvested, two laboratory inspections are made, one after the harvesting and the other just before the distribution of seeds for next planting season. Field and laboratory inspections of wheat seeds are carried out at present, by the following agencies designated by the Provincial Department of Agriculture and Forestry:

Type of seeds	Sponsoring agency	Field inspection agency	Seed sampling agency	Seed testing agency	Certifying agency
Foundation seeds	District agricultural improvement stations	Taichung DAIS and Provincial Dept. of Agriculture & Forestry	Provincial Department of Agriculture & Forestry	Provincial Seed Testing Lab.	Provincial Dept. of Agriculture & Forestry
Stock seeds	Prefectural farmers' associations	District agricultural improvement stations	District agricultural improvement stations	Provincial Seed Testing Lab.	District agricultural improvement stations
Extension seeds	Township farmers' associations	Prefectural farmers' associations and government offices	Prefectural farmers' associations and government offices	Provincial Seed Testing Lab.	District agricultural improvement stations

Remark: Certified seeds are tagged and sealed before distribution. White tags are used for certified foundation seeds, green tags for stock seeds and red tags for extension seeds. All the blanks on the tags are precisely filled out as regards their purity, germination percentage, moisture content, etc.

V. Wheat Seed Certification Standards

The wheat seed certification standards were first worked in 1957 after the closing of the First Far East Seed Improvement Conference held in Taiwan in 1956. They were put into trial in 1958. However, several revisions have been made since then and, following the suggestions of the seed specialists from the Mississippi State University who were here in 1959 and 1960, the final wheat seed certification standards now adopted in Taiwan may be presented hereunder for reference.

A. Standards for Field Inspection

1. General standards:

- a. Only one variety of wheat may be grown for seed production on a field.
- b. A 3-meter protective interval should be kept in case other wheat varieties are planted on the same farm.
- c. At the time of field inspection, the inspectors should also inspect the facilities for harvesting, drying and storing the seeds to prevent mechanical

mixture.

d. Unless properly bagged and sealed, certified wheat seeds should not be stored in the same building with other varieties of wheat.

e. Apparent marking signposts should be erected on the farms.

2. Specific standards:

Type of seed farms	Other varieties (Maximum)	Rust disease
Foundation seed farms	None	None
Stock seed farms	0.2%	None
Extension seed farms	0.5%	None

B. Standards for Laboratory Certification

Item	Foundation seed	Stock seed	Extension seed
Moisture content (max.)	12%	12%	12%
Pure seed (min.)	88%	99%	99%
Other varieties	None	None	None
Other crops	None	None	None
Weed seed (max.)	None	None	None
Inert matter (max.)	0.3%	0.5%	1.0%
Germination (min.)	90%	85%	80%

Note: The size of wheat sample is 1 kg.

Results of field and laboratory inspections made in 1959 and 1960 are reported in the following:

Field/laboratory inspection	Foundation seed farms		Stock seed farms		Extension seed farms	
	1959	1960	1959	1960	1959	1960
Field inspection						
a) Total acreage inspected (ha.)	4.10	3.85	51.29	54.90	82.84	872.91
b) Acreage meeting certification standards (ha.)	4.10	3.85	48.49	53.50	74.09	847.81
c) Acreage disqualified (ha.)	None	None	2.80 (5.6%)	1.40 (2.5%)	8.75 (10.6%)	25.10 (2.9%)
Laboratory inspection						
a) Total amount of seeds inspected (kg.)	4,500	4,431	112,442	104,358	122,088	1,098,833
b) Amount of seeds meeting certification standards (kg.)	4,500	4,431	107,582	98,708	106,378	972,296
c) Amount of seeds disqualified (kg.)	None	None	4,860 (43%)	5,650 (5.4%)	15,710 (12.8%)	126,537 (11.5%)

From the above table, it may be seen that, of the total stock and extension seed farms established in 1959 and 1960, a portion of them were disqualified. This is also true with some seeds produced from these farms. Varietal contamination and infection of rusts were the main factors for their disqualification. It may also be pointed out that, with the establishment of the Provincial Seed Testing Laboratory in Taichung in 1959, both field and laboratory inspections in 1960 have been greatly strengthened and almost all the extension seed farms and seeds produced therefrom were inspected, examined and certified.

VI. Processing, Storage and Distribution of Wheat Seeds

In Taiwan, wheat is harvested from late February to March. Wheat plants are tied into bundles and threshed with a foot pedalled thresher. The grains will then be sun-dried; and, when they are sufficiently dried, they are fanned with a winnower to get rid off chaff, earth and other inert matters. To keep the quality of seeds during the storage, the moisture content of grains has been set to be below 12 percent. Therefore, several dryings may be necessary during the storage period in order to meet this requirement. A seed inspection is made after harvest and only those seeds meeting the certification standards will be kept for use.

The certified seeds, after being properly labelled, are stored in wooden bins inside wheat seed granaries. These bins are lined with aluminum sheet inside to keep out moisture and damages from insects and rats. To provide facilities for storing wheat seeds, the Joint Commission on Rural Reconstruction (JCRR) has contributed NT\$3,518,200 from its 1959 budget to construct 24 new wheat seed granaries, each ranging from 106 M² to 160 M² in size. These new granaries are now completed and, together with 15 others previously constructed, a total of 39 wheat seed granaries of various sizes are now available in Taiwan, which will be enough to hold approximately 2,400 metric tons of seeds or seeds for planting 35,000 to 40,000 hectares of wheat each year.

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

A. Foundation seeds produced by the Taichung, Tainan, and Taitung DAISs and the Seed & Seedling Multiplication Station are distributed to the stock seed growers through the prefectural farmers' associations free of charge.

B. Stock seeds produced by the stock seed growers are purchased by township farmers' associations at market price after drying and certification. These seeds

will be stored in tight bins of wheat seed granaries with proper labels. If the township farmers' associations are not able to appropriate enough funds for seed purchase, the Provincial Food Bureau will be asked to share a portion of the funds needed. Stock seeds will be sold or loaned to the extension seed growers at the time of planting by the township farmers' associations. The Government gives a cash subsidy of NT\$300 per hectare for stock seed growers to operate the stock seed farms.

C. Extension seeds are sold to the farmers either in cash or in exchange for common wheat grains both with a 10 percent premium. In case farmers do not want to buy extension seeds until planting time, the township farmers' associations or Provincial Food Bureau will have to buy the multiplied seeds, also at 10 percent premium price. These seeds will then be sold or loaned to ordinary farmers at the planting time.

The present wheat seed multiplication and distribution systems have worked out very successfully. As wheat is planted in Taiwan only one crop a year and the seeds for this year have to be produced from the crop of the previous year, most farmers are not able to keep the quality of seeds in their own storage. Therefore, besides providing them with wheat seed granaries, the Joint Commission on Rural Reconstruction has, in addition, contributed about NT\$150,000 annually during the past two years to implement this seed production program. It is thought that, by providing the farmers with good and pure seeds, the wheat production in this Island can be substantially increased.

SWEET POTATO IMPROVEMENT AND MULTIPLICATION AND DISTRIBUTION OF PLANTING MATERIALS IN TAIWAN

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I. Introduction

During 1958 and 1959, the acreage of sweet potato (*Ipomoea batatas* Lam.) in Taiwan has been gradually reduced. This is in line with the Government's effort to divert some cultivated lands for producing higher protein-containing crops such as soybean, corn and peanut so as to increase the feed production necessary for the Island's expanding hog raising program. However, this decrease in sweet potato acreage does not mean to jeopardize the production of sweet potato in this Island, for, with the increase in unit yield through the uses of better varieties, better cultural practices and better field management, sweet potato production in 1958 and 1959 has actually exceeded that of the previous years. The sweet potato production during the past five years may be compared in the following:

Sweet Potato Production in Taiwan During 1956-60

Year	Acreage (ha.)	Yield per ha. (kg.)	Production (m. t.)
1956	230,236	11,154	2,568,104
1957	228,760	11,774	2,693,417
1958	228,699	12,934	2,957,893
1959	226,487	12,778	2,894,146
1960	235,387*	12,654	2,978,676

* In 1959, after the occurrence of the unprecedented torrential rains on August 7, many rice fields were destroyed and, after being reclaimed, they were turned to grow sweet potato, thus resulting in an increase in the sweet potato acreage in 1960,

In line with the policy of diverting more cultivated land for other more essential crops while augmenting the sweet potato production through the increase of unit yield, the production goals of sweet potato for the next four years as projected by the Chinese Government are as follows:

Goals of Sweet Potato Production in Taiwan for 1961-1964

Year	Acreage (ha.)	Yield per ha. (kg.)	Production (m. t.)
1961	207,000	14,000	2,898,000
1962	204,000	14,500	2,958,000
1963	201,000	15,000	3,015,000
1964	198,000	15,500	3,069,000

Sweet potato is used in Taiwan for food, feed and for making potato starch for industrial uses. In recent years, because of the general improvement of living standard on the one hand and the promotion of hog production on the other, sweet potato used for food has been decreased while that for feed has been significantly increased. A rough estimate of the uses of sweet potato for different purposes as of today is as follows:

For food	29.3 percent
For feed	62.9 percent
For starch	6.8 percent
For seed	1.0 percent
Total:	100 percent

In addition, sweet potato vine is used in Taiwan also for feed besides its use as planting materials. It is estimated that, for a hectare of sweet potato, at least 10 metric tons of vines can be harvested for feed during the growing and harvesting period. With the planting of some 220,000 hectares of sweet potato in the Island each year, about 2,200,000 metric tons of fresh potato vines could be harvested for hog feed.

II. Varietal Improvement

Sweet potato improvement work in Taiwan is done primarily by the Chiayi Agricultural Experiment Station of the Taiwan Agricultural Research Institute in

Chiayi. Some work is done also by the District Agricultural Improvement Stations of Hsinchu, Taichung, Tainan and Taitung. During the past several years, through their efforts, a number of new varieties have been produced, and those released for commercial planting during the past two years may be briefly introduced in the following:

A. Extension of a New Colored Variety

Tainung No. 57 in 1958

This new sweet potato variety designated as Tainung No. 57 was developed by the Chiayi Agricultural Experiment Station from a cross between Tainung No. 27 and Nancy Hall, an American variety, in 1950. It is a colored variety with yellow flesh, very high in Vitamin A content and tasting better than most of the white varieties. One kilogram of fresh Tainung No. 57 sweet potato was calculated to contain as much as 22,220 I. U. of Vitamin A according to the analysis determined by the Department of Biochemistry, College of Medicine, National Taiwan University. The yield of Tainung No. 57 is as good as or sometimes even better than the white varieties as may be seen from the average of three years' regional tests conducted at different places during 1955 to 1957.

1. Tuber Yield of Tainung No.57 vs. Other Cultivated Varieties as Checks in 1955-57 Regional Trials

Unit: kg/ha.

Locality	Variety	1955	1956	1957	Average
Fengshan	Tainung No. 57	35,940	27,300	35,865	33,035
	Tainung No. 3	32,205	24,240	33,720	30,055
Luchu	Tainung No. 57	41,250	27,645	17,340	28,745
	Tainung No. 27	43,470	34,035	17,580	31,695
Hsinying	Tainung No. 57	22,575	26,010	26,835	25,140
	Tainung No. 17	28,485	22,380	24,270	25,045
Hsuehchia	Tainung No. 57	25,800	18,030	13,395	19,075
	Tainung No. 31	29,940	16,020	17,580	21,180
Shanhwa	Tainung No. 57	13,410	24,690	24,930	21,010
	Tainung No. 10	17,400	37,230	26,190	26,940
Chiayi	Tainung No. 57	23,190	20,310	20,970	21,490
	Tainung No. 31	28,890	17,430	13,710	20,010
Putze	Tainung No. 57	31,710	18,630	21,585	23,975
	Tainung No. 9	18,300	10,290	18,765	15,785
Szechu	Tainung No. 57	21,150	22,980	23,100	22,410
	Red Tuber Tail	25,275	16,650	29,925	23,950
Yungkang	Tainung No. 57	—	15,630	17,265	16,448
	Nancy Hall	—	12,930	9,465	11,198
Kuantien	Tainung No. 57	—	19,455	37,710	28,583
	Nancy Hall	—	16,800	25,125	20,963

**2. Nutritional Composition of Tainung No. 57 as Compared
With Polished Rice (100-gram samples)**

Element	Tainung No. 57	Polished rice
Crude protein (%)	0.63	6.8
Crude oil (%)	0.17	0.7
Vitamin A value (I. U.)	2,222	0
Thiamine (mg.)	0.147	0.120
Riboflavin (mg.)	0.024	0.030
Ascorbic acid, reduced form (mg.)	21	0

Note: Tainung No. 57 was determined only recently by the Biochemistry Department, Medical College of National Taiwan University, in September and October, 1960.

Data on polished rice were quoted from the "Food and Nutrition" written in Chinese and published by JCRR in 1956.

The Tainung No. 57 sweet potato was released for commercial planting in 1958, as its yield was much higher than the introduced colored variety Nancy Hall and was comparable to most of the cultivated varieties but with a much higher composition of various nutrient contents. A total of 125 hectares was tried in Yunlin, Chiayi and Kaohsiung in southern Taiwan. The result was very satisfactory, the average yield per hectare being about 30,000 kilograms in most places. In 1959, the acreage of Tainung No. 57 has increased to 324 hectares and the planted areas extended to some localities in Taichung, Changhwa, Nantou and Miaoli in central and northern Taiwan. In 1960, the projected acreage for Tainung No. 57 is 1,157 hectares, which will be planted then almost in every spot throughout the Island. According to regional tests, Tainung No. 57 is adaptable for spring planting in Taipei, Hsinchu, Taichung, Hwalien and Taitung, and for fall planting in almost every part of the Island. In spring planting, it is to be planted some time in March, and, in fall planting, it is to be planted preferably in July and August. As it is an early maturing variety, harvesting can be made about five months after planting. However, Tainung No. 57 is not as tolerant to drought as some white varieties are, and, furthermore, it prefers good soils such as loam or sandy loam.

As Tainung No. 57 is a colored variety containing much higher nutritive contents than most of the white varieties do, it is extended primarily for human consumption. It is calculated that, when fresh Tainung No. 57 is sliced into potato chips and the chip percentage is averaged at 32.6 percent, then 1.43 kilogram of the dry chip, when consumed by human beings, will furnish approximately the same amount of calories that one kilogram of polished rice can give, while there is yet an extra intake of 97,760 I. U. of Vitamin A, which the rice does not have. Therefore, with

the incorporation of this colored variety of sweet potato into the regular human diet, it will help not only reduce the per capita rice consumption, but, at the same time, increase the Vitamin A intake in the regular daily diet.

The average rice consumption per capita per year in this Island is 150.7 kilograms at present. However, the average sweet potato consumption is but 32.20 kilograms of fresh sweet potatoes per capita per year. Therefore, any increase in sweet potato consumption will help save a portion of rice either for export or for local demand of the expanding population.

B. Seed Multiplication of New Varieties

In addition to the extension of Tainung No. 57 in 1958, at least four other new sweet potato varieties selected from the province-wide regional tests have been entered into seed multiplication list in 1959. These four new varieties are Okinawa 100, Hsinchu No. 1, Tainung No. 53 and Tainan No. 14. They may be briefly described in the following:

Okinawa 100. This variety was developed in Okinawa from a cross between two sweet potato varieties called Chifu and Chouchow. It was introduced to Taiwan by the Chiayi Agricultural Experiment Station through the National Agricultural Research Institute after World War II. It is a variety of sweet potato with light red skin but with yellow flesh inside. It is fairly tolerant to wet and adaptable to a wide variety of soils. As can be perceived from the foregoing section, Tainung No. 57 is suitable primarily for fall planting, whereas Okinawa 100 is good for spring planting. In the spring of 1959, it was tried over 31 localities throughout the Island. Out of these 31 localities, Okinawa 100 outyielded the locally grown varieties in 24 places in tuber production and 26 places in chip production. The average chip percentage of Okinawa 100 is well above 30 percent.

Hsinchu No. 1. This variety was produced by the Hsinchu District Agricultural Improvement Station from a cross between Tainung No. 31 and the native Green-Wire variety. It has a red skin but with light yellow flesh color. In localities, it is good for spring planting in Taichung, Hsinchu and Taipei, but, for fall planting, it has been found to outyield the other cultivated varieties in many places in Pingtung, Kaohsiung, Taichung, Hsinchu, Taipei and Hwalien. It is one of the most hopeful varieties of sweet potato for northern districts.

Tainung No. 53. This variety is a natural hybrid selected by the Chiayi Agricultural Experiment Station from its breeding field. Both skin and flesh being white, it is adaptable for spring planting in Chiayi and Taitung and for fall planting

in southern and eastern Taiwan.

Tainan No. 14. This variety was developed by the Tainan District Agricultural Improvement Station several years ago from a cross between an American variety called Yellow Skin and Tainung No. 17. It has a white skin with white flesh. Although it is quite susceptible to stem rot caused by *Fusarium batatatis*, it has a very high chip percentage and yields very satisfactorily in both spring and fall plantings in Hwalien and in fall planting in Pingtung.

C. Sweet Potato Varieties Adaptable for Interplanting With Rice on Paddy Fields in Winter Season

At present in Taiwan, considerable acreage of paddy fields is planted with sweet potatoes during the winter season. They are interplanted to the rice rows about two to three weeks before the second rice crop is harvested in the fall. By so doing, the local farmers will be able to get an extra crop in the winter following a regular crop of rice in the fall. In a recent estimate, it is found that, of some 230,000 hectares of sweet potatoes planted in a year, about 40,000 hectares are intercropped with the second rice crop in the winter. As varieties adaptable for winter interplanting are still needed, an experimental planting with both old and new sweet potato varieties was conducted in the winter of 1959. Preliminary results show that Hsinchu No. 4 and Tainung No. 48 are good for winter interplanting in Hwalien, Tainung Nos. 58, 53 and Hsinchu No. 1 in Hsinchu, Tainung No. 31 and Tainan No. 14 in Taichung, Tainung No. 10 in Changhwa, Hsinchu No. 1 in Yunlin, Hsinchu No. 4 and Tainung No. 53 in Chiayi, and Hsinchu No. 1 and Okinawa 100 for interplanting in Pingtung district. However, all these results are rather preliminary and premature, and further experimentation is necessary in order to ascertain their merits.

D. Common Sweet Potato Varieties Now Grown in Taiwan

The most common sweet potato varieties now grown in Taiwan are Tainung Nos. 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, in general, are relatively early maturing, perform better under adverse conditions, and grow fairly well on poor lands. For these reasons, they still dominate as the leading commercial varieties in northern and central Taiwan. However, their quality is considerably poor, for they contain more water in tuber, produce less dry chips than the improved varieties, and are harder to keep. On the other hand, the improved

varieties, though superior in chip and keeping quality, require good soil for planting and need longer growing period than the native varieties. Therefore, improved varieties such as Tainung Nos. 17, 31 and 45 are planted primarily in the southern part of Taiwan. The improved varieties were developed formerly by the Chiayi Agricultural Experiment Station and their origins are as follows:

Origin of Some Common Tainung Sweet Potato Varieties

Variety	Parentage	Year cross made	Year selected
Tainung No. 3	Chan × American Yellow Skin	1922	1923
Tainung No. 9	Chieh-yu × Nancy Hall	1922	1928
Tainung No. 10	American Yellow Skin × Red Skin	1922	1928
Tainung No. 17	Red Meat × Cake Potato	1924	1930
Tainung No. 31	White Holland × Yuan-ti	1929	1937
Tainung No. 44	Foreign Variety × Tainung No. 14	1936	1944
Tainung No. 45	Ying-chai-yeh × Tainung No. 4	1936	1944

In addition, there is a new variety designated as Tainung No. 58, which was released for commercial planting a few years ago. As far, it has only small acreage in Ilan and Taipei in northern Taiwan. This variety was developed by the Taiwan Agricultural Research Institute from a cross between Tainung No. 47 and Iron-wire native variety. It yields more tubers than the native varieties do, but matures somewhat later than the latter.

III. Multiplication of Sweet Potato Seed Materials

A. Sweet Potato Seed

Multiplication System

As sweet potato is a vegetatively propagated plant, both potato tubers and vines can be used as planting materials. In actual field work, the farmers in Taiwan use commonly the vines for general planting. However, in seed multiplication work, in order to keep the varietal purity on the one hand and to produce the planting materials as fast and plentiful as possible on the other, potato tubers are multiplied on the foundation seed farms, while vines are multiplied and used for distribution from the stock and extension seed farms. The sweet potato seed multiplication system adopted in Taiwan at present may be briefly outlined in the following:

The foundation seed farms. The foundation seed farms form the first level of the sweet potato seed multiplication system. Seed potatoes produced therefrom are used for further multiplication purpose. These seed farms are established at and

operated by seven district agricultural improvement stations, each located at one of the seven food districts where sweet potato is grown. Primarily, the newly extended varieties are multiplied, except in places where only the old improved varieties are grown. Foundation seed farms are seeded with seed potatoes which are supplied in the first year by the breeding stations and later by the district agricultural improvement stations themselves. The planting of foundation seed farms is ordinarily made in August or September and the seed potatoes produced from the farms are distributed in February or March of the following year. Distribution of foundation seed potatoes to the stock seed growers is free of charge.

The stock seed farms. The stock seed farms are established at different prefectures (*hsien*), forming the second level of the sweet potato seed multiplication system. They differ from the foundation seed farms in that the vines produced on the farms are harvested and used for planting the extension seed farms. The stock seed farms are operated by the prefectural farmers' associations or by contract farmers under their supervision. The distribution of vines from stock to extension seed farms is free of charge and is made sometime in May or June. To compensate the prefectural farmers' associations or contract farmers for operating the stock seed farms, a cash subsidy is given by the Provincial Department of Agriculture & Forestry.

The extension seed farms. The extension seed farms are established at different townships, forming the third or final level of the whole sweet potato seed multiplication system. They are operated by contract farmers under the supervision of the township farmers' associations. The extension seed farms differ from the foundation and stock seed farms in that they are planted with the vines instead of seed potatoes, obtained from stock seed farms. However, they are same as the stock seed farms, using vines for distribution to the farmers. The planting of extension seed farms is usually made in May and June and vines are harvested and distributed in August and September. The extension seed growers will sell their vines at a cash price approved by the Provincial Department of Agriculture & Forestry, and, meanwhile, they are entitled to receive certain cash subsidies from the government as compensation.

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

Level of seed farms	Time of planting	Material for planting	Time of distribution	Material for distribution	Operating agency
Foundation seed farms	Aug.-Sept.	Seed potatoes	Feb.-Mar.	Seed potatoes	District agricultural improvement stations
Stock seed farms	Feb.-Mar.	Seed potatoes	May-June	Potato vines	Prefectural farmers' associations or contract farmers
Extension seed farms	May-June	Potato vines	Aug.-Sept.	Potato vines	Township farmers' associations or contract farmers

From the above table, it may be seen that the whole system starting from the time of planting foundation seed farms to the time of distributing vines from extension seed farms to the farmers may be completed within a period of about one year. If seed potatoes were used for planting and distribution at all three levels of seed farms, not only a much larger acreage of seed farms would be necessary, but, at the same time, it would require a much longer time of field work to complete the whole seed multiplication system.

B. Sweet Potato Seed Multiplication Work

During 1959 and 1960

Sweet potato seed multiplication work before 1959 has already been reported to the last Far East Seed Improvement Workshop held in Japan, 1959. During 1959 and 1960, the work has been carried out as usual, except that mostly the new varieties are multiplied and the multiplied seed materials are subject to inspection and certification according to the standards recently set forth in Taiwan. The amount of seed materials multiplied by different seed farms in 1959 and 1960 as compared with that of the two preceding years may be shown in the following table:

Year	Foundation seed farms		Stock seed farms		Extension seed farms	
	Acreage (ha.)	Seed potatoes output (kg.)	Acreage (ha.)	Vines output (kg.)	Acreage (ha.)	Vines output (kg.)
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	3.81	49,799	3.98	2,843,700	49.23	23,773,300
1960	4.05	50,833	2.96	4,269,500	63.88	64,351,700

Sweet potato varieties multiplied in 1959 and 1960: Tainung Nos. 3, 31, 44, 45, 53, 57 and 58, Tainan No. 14, Hsinchu No. 1 and Okinawa 100.

IV. Inspection and Certification

For sweet potato, foundation seed farms are inspected by the Provincial Department of Agriculture & Forestry or its designated agency, the Chiayi Agricultural Experiment Station of the Taiwan Agricultural Research Institute, while the stock and extension seed farms are inspected respectively by the district agricultural improvement stations and the prefectural farmers' associations. Field inspection is made about one month after planting, and then, at the time when potato tubers or vines are ready for distribution, a second inspection is made again. All seed materials will be certified at localities where seed multiplication fields are established, and no laboratory examination is required at the Provincial Seed Testing Laboratory

in Taichung. The system of field inspection and certification of sweet potato as carried out at present in Taiwan may be illustrated with the following table:

Level of seed farms	Sponsoring agency	Field inspection agency	Seed testing agency	Certifying agency
Foundation seed farms	District agricultural improvement stations	Provincial Department of Agriculture & Forestry, Chiayi Agricultural Experiment Station	Provincial Seed Testing Laboratory	Provincial Department of Agriculture & Forestry
Stock seed farms	Prefectural farmers' associations, contract farmers	District agricultural improvement stations	District agricultural improvement stations	District agricultural improvement stations
Extension seed farms	Township farmers' associations or contract farmers	Prefectural farmers' associations	District agricultural improvement stations	District agricultural improvement stations

After field certification, seed potatoes from the foundation seed farms are packed in jute bags attached with white tags, while vines harvested from the stock and extension seed farms are tied in bundles attached respectively with green or red tags. All tags are labelled giving the quality of multiplied seed materials.

V. Sweet Potato Seed Certification Standards

The sweet potato seed certification standards as formulated in 1957 have been revised following the suggestions of the seed specialists from the Mississippi State University who were here in 1959 and 1960. The certification standards now adopted in Taiwan may be presented hereunder for reference.

A. Standards for Field Inspection

1. General standards:

- a. Only one variety of sweet potato may be grown for seed production on a field.
- b. Sweet potato seed farms of various levels should be established at sites where no sweet potato was grown during the previous crop season. The farms should not be located close to other sweet potato farms, nor should they be established at sites with bad drainage.
- c. The compost to be applied on sweet potato seed farms should contain no sweet potato and its residues.

d. Apparent signboards should be erected on the farms.

2. Specific standards:

Level of seed farms	Other varieties (maximum)	Sphaceloma disease stem rot, weevil (maximum)
Foundation seed farms	None	None
Stock seed farms	None	None
Extension seed farms	None	0.2%

B. Certification Standards for Tubers and Vines

1. Tubers (Foundation seed farms):

Item	Standards
Other varieties (max.)	None
Soil dirt	No dirt attached to tubers
Internal	No cavity
Insect damage and disease	No lesions and insect caused holes (including black rot, soft rot and weevil)
Size	200-600 gm.
Tuber skin	No scars
Form	Uniform and normal
Sprouting	None or less than 1 cm. in length

2. Vines (Stock and extension seed farms):

Item	Stock seed farms	Extension seed farms
Other varieties (max.)	None	None
Disease and insect damage	None	None
Length of vines (min.)	30 cm.	30 cm.
No. of nodes in a vine (min.)	6	6
Percentage of vines permitted to be taken from 2nd section of stalks	Less than 30%	Less than 30%
Days to be shipped	Less than two days after harvest	Less than three days after harvest

In 1959 and 1960, field inspection and tuber and cutting certification were made according to the above standards. The results were as follows:

Item	Foundation seed farms		Stock seed farms		Extension seed farms	
	1959	1960	1959	1960	1959	1960
Field inspection						
a. Total acreage established (ha.)	3.81	4.05	3.96	2.96	49.23	63.88
b. Acreage meeting certification standards (ha.)	3.81	4.05	3.96	2.96	49.23	63.88
c. Acreage disqualified (ha.)	None	None	None	None	None	None
Tuber inspection						
a. Total amount of potato tubers produced on foundation seed farms (kg.)	49,799	50,833	—	—	—	—
b. Amount of potato tubers meeting certification standards (kg.)	48,600	44,800	—	—	—	—
c. Amount of potato tubers disqualified as seed (kg.)	1,799	6,033	—	—	—	—
d. Percentage disqualified	3.6%	11.9%	—	—	—	—
Vine inspection						
Number of certified vines distributed	—	—	2,843,700	4,269,500	23,773,300	64,351,700

VI. Processing and Distribution of Seed Materials

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

A. Processing and Distribution of Potato Tubers from Foundation Seed Farms

Potato tubers produced on foundation seed farms are harvested about five to six months after planting. Only those meeting the certification standards are kept for seed. Soil is removed from the surface so that each potato tuber selected is free from wound or insect damage. The selected seed potato tubers are then packed into jute bags, each containing about 60 kg. To each bag, a white tag is attached bearing the name of variety, name and address of shipper (in this case the district agricultural improvement station), number of bags and total weight of potato tubers to be shipped, date of shipment and name and address of consignee (in this case the prefectural farmers' association) including the grading on different standards. The seed potatoes are shipped by trucks to the prefectural farmers' associations either for planting on their own stock seed farms or for distribution to contract

farmers for their planting. The whole process must be completed within a week after harvesting.

B. Processing and Distribution of Vines from Stock Seed Farms

As mentioned before, stock seed farms are planted with foundation seed tubers, and the planting is made in February or March. After three or four months of growth when plants attain their best growth, they are ready for cutting. Two harvests can be made about one month apart. Under proper and good management, each seed tuber will give from 10 to 15 stalks at each harvest or a minimum of 20 vines in two harvests. The cut potato vines are tied into bundles of 1,000 each, and are, after being inspected, certified and tagged. They are shipped to the extension seed growers by ox-carts for planting. The distribution of vines must be completed within two days after the cutting is made.

C. Processing and Distribution of Vines from Extension Seed Farms

The extension seed farms are planted with potato vines obtained from the stock seed growers. The planting is made in May or June. After three or four months of growth, they are, in turn, ready to be cut for vines. Usually 15 top vines can be taken from each plant in two harvests. After being inspected, the healthy and qualified vines are packed into bundles, also 1,000 per bundle, and tagged. They are distributed right in the field to the farmers for general planting.

After distribution, complete record on seed multiplication work will be sent by the operating agencies to the Provincial Department of Agriculture & Forestry and to other agencies concerned. As it is a JCRR financed project, it will also then be reported by the Provincial Department of Agriculture & Forestry to the Joint Commission on Rural Reconstruction to fulfill the terms of the project agreement entered between the two parties.

VII. Government Subsidies for Sweet Potato Seed Multiplication Work

During the past two years and also years before, the following government subsidies have been given by the Provincial Department of Agriculture & Forestry to the operating agencies for sweet potato seed multiplication work.

A. Subsidy to Foundation Seed Farms

As seed tubers produced from the foundation seed farms are given to the stock seed growers free of charge, the district agricultural improvement stations, as the operating agencies, are provided by the Provincial Department of Agriculture & Forestry in their regular annual budget an appropriation of NT\$3,750 to NT\$4,000 per hectare for sweet potato seed multiplication work. The total expenditure for foundation seed farms of all seven district stations in a year is estimated at NT\$30,000.

B. Subsidy to Stock Seed Farms

The vines 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 of sweet potatoes as a result of vine cutting, a cash subsidy of NT\$3,750 to NT\$4,500 per hectare is given by the government. The annual budget for this item is about NT\$18,000.

C. Subsidy to Extension Seed Farms

Vines from the extension seed farms are not given free, but sold to the ordinary farmers at a price about one-third lower than the market price. This measure is taken to encourage the farmers to buy new potato vines from extension seed growers instead of using the vines of old varieties of their own. However, in order to cover the loss incurred from the reduced price and at the same time as an incentive to the extension seed growers on seed multiplication work, the government pays the extension seed growers a cash subsidy on the basis of the number of vines which they have distributed. The current rate of the subsidy is NT\$20 per 10,000 vines or approximately NT\$1,800 per hectare. The total annual budget for this item is about NT\$120,000.

D. Subsidy for Packing and Transporting Seed Materials

The total annual expenditure for this item is about NT\$60,000. Subsidy given for packing and transporting foundation seed tubers 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\$10 per 10,000.

E. Subsidy for Field Inspection and Certification

As all seed materials must be inspected and certified before they are cut and distributed as planting materials to the farmers, an annual appropriation of about NT\$20,000 is given to the inspecting agencies and the Provincial Seed Testing Laboratory for inspection and certification purposes.

F. Subsidy for Holding Training Sessions and Field Contests Among Seed Growers

As most of the seed materials distributed to seed growers and farmers are of new sweet potato varieties, training sessions are usually conducted at the planting time to teach the farmers about the characteristics of the new sweet potatoes and the method of culturing them. At the time of harvest, field contests on seed multiplication work are held among the seed growers and among the operating agencies. The best ones will be rewarded with prizes by the Provincial Department of Agriculture & Forestry. The annual budget for this item is about NT\$30,000.

G. Subsidy for Supervision and Travelling Expenses

As stock and extension seed farms are scattered widely in different prefectures and townships, adequate supervision is necessary. Although the sponsoring and operating agencies have contributed a part of the supervision and travelling expenses from their own budget, the government is also doing its best. The annual appropriation from the government for this purpose is about NT\$50,000.

The whole government budget for sweet potato seed multiplication work in a year at present in Taiwan is about NT\$400,000, of which the JCRR has contributed annually about NT\$300,000 towards the total expenditure.

PEANUT IMPROVEMENT AND SEED PRODUCTION IN TAIWAN

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I. Introduction

Peanut is used in Taiwan for food, oil and feed purposes. In a rough estimate, after reducing the amounts for seed and for the unavoidable loss after harvest, about 60 percent of the total production of peanuts is for various food uses and 40 percent for oil extraction. From oil extraction, peanut oil and peanut cakes are obtained. Peanut oil is used primarily for cooking purpose, while peanut cakes are used for making mixed feed and a small quantity as fertilizer. The amount of peanuts to be produced during the next four years and their uses for various purposes may be estimated and respectively presented in the following two tables:

Peanut Production Projected for 1961-1964 in Taiwan

Year	Acreage (ha.)	Production (m. t.)	Yield per ha. (kg.)
1961	108,000	112,320	1,040
1962	106,000	114,480	1,080
1963	104,000	116,480	1,120
1964	102,000	118,320	1,160

**Estimated Amount of Peanuts Used for
Various Purposes During 1961-1964 in Taiwan**

Year	Production goal (m. t.)	Amount for seed (m. t.)	Amount of loss after harvest (m. t.)	Amount for food uses (m. t.)	Amount for oil extraction (m. t.)
1961	112,320	15,120	1,120	53,230	42,850
1962	114,480	14,840	1,140	54,870	43,630
1963	116,480	14,560	1,160	56,560	44,200
1964	118,320	14,280	1,180	58,300	44,560

The peanut production goal for 1960 is set at 111,000 metric tons of peanuts with the planted acreage projected at 111,000 hectares and yield per hectare at 1,000 kg. However, with the increase in acreage of soybean and corn, it has been difficult for the acreage of peanut to reach the goal in 1960. It is for this reason that the acreage of peanut projected for 1961 to 1964 is on the decrease instead of on the increase side. Peanut production for the last four years including production in 1960 is shown in the following for reference:

Peanut Production in Taiwan During 1957-1960

Year	Acreage (ha.)	Production (m. t.)	Yield per ha. (kg.)
1957	103,584	93,714	905
1958	103,983	96,423	927
1959	99,135	97,042	979
1960	100,497	102,167	1,017

Peanut is grown in Taiwan in both the spring and fall seasons. Spring planting is made in February and March, although it may extend as early as the middle of December to as late as the middle of May, varying with localities. 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 peanuts is planted in the spring and 40 percent in the fall.

The main peanut growing regions are in Yunlin, Chiayi and Tainan in the southern part of the Island. These three prefectures constitute more than one half of the total acreage. In acreage, Hwalien on the east coast is only next to Yunlin. As peanut is grown primarily in dryland areas, it is often rotated and intercropped with such field crops as sugarcane, sweet potato, soybean and corn. Because peanut is considered as a dryland crop and, consequently, very little irrigation water is provided. Otherwise, it is believed that a considerable jump in unit yield will be possible, if some irrigation is made, especially at the early period of growth and at the time of flowering.

II. Varietal Improvement

Peanut improvement work in this Island is led by the Tainan District Agricultural Improvement Station and the Taiwan Agricultural Research Institute with other district agricultural improvement stations cooperating in carrying out regional

tests. During the past ten years, seven new peanut varieties have been released for commercial planting. These include the extension of Tainan Pei-yu-tou Nos. 1, 2 and 5 in 1950, Tainung No. 1 and Tsingtao in 1957 and Tainan Nos. 6 and 7 in 1960. The acreage occupied by these varieties in 1960 has reached some 40,000 hectares or about 40 percent of the total acreage planted in a year. In addition, some new varieties and selections are still at different stages of testing. The progresses made during the past two years may be briefly described in the following:

**A. Increase in Acreage
of Tainung No. 1**

The Tainung No. 1 peanut variety was produced by the Taiwan Agricultural Research Institute from the varieties obtained from mainland China by pure line selection. It was released for commercial planting in 1957. Since then, it has been extended to Hwalien, Ilan, Hsinchu, Miaoli, Taichung, Changhwa, Nantou, Kaohsiung and Pingtung. As it has a rather wide adaptability, Tainung No. 1 has increased very rapidly during the past two years. It is estimated that at least some 4,500 hectares have been planted in 1960. The distribution of Tainung No. 1 in different districts is approximately as follows:

Estimated Acreage of Tainung No. 1 Planted in 1960

Locality	Estimated acreage (ha.)
Hwalien	1,500
Ilan	200
Hsinchu	600
Miaoli	500
Taichung	600
Changhwa	600
Nantou	200
Kaohsiung	100
Pingtung	200
Total:	4,500 ha.

Tainung No. 1 has been proved to yield on average about 10 percent better than the native varieties and 5-8 percent better than Tainan Pei-yu-tou Nos. 1, 2, 5 and Tsingtao, according to the province-wide regional tests conducted during 1954 and 1955. At present, Tainan Pei-yu-tou No. 1 and Tainung No. 1 are the two leading

improved varieties of peanuts with Tainan Pei-yu-tou No. 1 occupying about 35,000 hectares primarily in Yunlin, Chiayi, Tainan and Taitung and Tainung No. 1 about 4,500 hectares in various places as mentioned above. Tainan Pei-yu tou Nos. 2 and 5 and Tsingtao together occupy about 500 hectares, making up the total of about 40,000 hectares occupied by these five improved varieties.

B. Preliminary Extension of Tainan

Nos. 6 and 7 in 1960

Tainan Nos. 6 and 7 were developed by the Tainan District Agricultural Improvement Station in 1951 from the crosses made respectively between Peikang Pei-yu-tou × Tainan Pei-yu-tou No. 1 and between Java Small Seed No. 12 and Tainan Pei-yu-tou No. 1. After preliminary yield tests at the Tainan Station, they were put into regional varietal tests in 1958. As they were found to be especially adaptable for planting in Yunlin, Chiayi and Tainan, they were released for commercial planting and seed multiplication for these two varieties was started in 1959. In 1960, a small acreage was extended in the above three prefectures. Performance of Tainan Nos. 6 and 7 as summarized from the regional varietal tests may be shown in the following table:

**Performance of Tainan Nos. 6 and 7 at Localities
in Tainan, Chiayi and Yunlin in Regional Tests**

Crop	Test variety	Yield per ha. in kg. (average of two years, 1957 & 1958)						
		Tainan	Peimen	Putze	Huwei	Peikang	Average	Index
Spring	Tainan 6	1,518	798	2,219	1,124	1,657	1,463	110
	Tainan 7	1,299	868	2,260	1,085	1,526	1,407	106
	Tainan Pei-yu-tou 1	1,254	793	2,222	953	1,527	1,350	102
	Tainung 1	1,061	697	2,097	920	1,633	1,281	97
	Native variety	1,125	819	2,276	892	1,521	1,326	100
Fall	Tainan 6	1,110	366	881	805	809	794	121
	Tainan 7	1,155	428	837	786	830	807	123
	Tainan Pei-yu-tou 1	1,096	422	683	664	751	723	110
	Tainung 1	1,055	321	636	681	699	678	104
	Native variety	1,053	368	623	627	596	653	100

In 1958 and 1959, Tainan Nos. 6 and 7 were tried also at 81 localities in Tainan, Chiayi and Yunlin districts to compare with Tainan Pei-yu-tou No. 1 and native variety. The results of this large scale trial planting may be shown in the following table:

**Trial Planting of Tainan Nos. 6 and 7 at 81 Localities
in Tainan, Chiayi and Yunlin During 1958 and 1959**

Variety	Yield per ha. in kg. (average of two years)					
	Spring planting		Fall planting		Average of two crops	
	Yield	Index	Yield	Index	Yield	Index
Tainan 6	1,668	112	1,105	118	1,387	114
Tainan 7	1,645	110	1,192	129	1,419	117
Tainan Pei-yu-tou 1	1,607	108	1,025	110	1,316	108
Native variety	1,494	100	932	100	1,213	100

From the above two tables, it may be seen that, no matter whether it is in the trial planting or in the previous regional varietal tests, Tainan Nos. 6 and 7 yield better than Tainan Pei-yu-tou No. 1 or the native variety in Tainan district. In seasonal planting, Tainan No. 6 seems to prefer better for spring planting, while Tainan No. 7 is more adaptable for fall planting, although both of them could be planted in any of the two seasons. Characteristics of the two varieties may be briefly given in the following for reference:

Characteristics of Tainan Nos. 6 and 7

Variety	Parentage	Size of kernels	Shape of kernels	Kernel waist	Kernel beak	Shape of seed	Oil content
Tainan 6	Peikang Pei-yu-tou × Tainan Pei-yu-tou No. 1	Small	Short & plump	Not prominent	Not prominent	Short & roundish	48.33%*
Tainan 7	Java Small Seed No. 12 × Tainan Pei-yu-tou No. 1	Medium	Long & plump	Shallow waist	With beak but not prominent	Long & conical	47.50%

* Oil content of native variety determined to be 47.01 percent.

**C. New Peanut Varieties in
Regional Varietal Test**

In addition to the released varieties mentioned above, there are seven others, which have been put into province-wide regional varietal tests at eleven localities throughout the Island since the spring of 1959. Up to the present time, three crops have been grown and the performance of these new varieties as compared with the old ones may be summarized in the following table:

**Performance of New Peanut Varieties in Province-wide
Regional Tests Conducted During 1959-1960**

Variety	Yield per ha. in kg. (average of 11 localities)							
	Spring crop 1959		Fall crop 1959		Spring crop 1960		Average	
	Yield	Index	Yield	Index	Yield	Index	Yield	Index
Spanish White	2,276	107	1,335	105	1,963	106	1,858	106
Southern Cross	1,985	93	1,194	94	1,730	93	1,636	94
Sp. 146-H-48-3	2,019	95	1,129	89	1,876	101	1,675	96
Imp. Sp. 2-B-48-1	2,137	101	1,390	109	1,909	103	1,812	104
H-51B-123	2,214	104	1,329	105	1,900	102	1,814	104
I-59-1	2,223	105	1,305	103	1,830	99	1,786	102
Tainan No. 8	2,103	99	1,322	104	1,788	96	1,738	99
Tainan No. 6	2,209	104	1,324	104	1,826	98	1,786	102
Tainan No. 7	2,252	106	1,280	101	1,889	102	1,807	103
Tainan Pei-yu-tou No. 1	2,138	101	1,233	97	1,767	95	1,713	98
Tainung No. 1	2,148	101	1,196	94	1,907	103	1,750	100
Native variety	2,125	100	1,270	100	1,855	100	1,750	100

From the above table, it may be seen that, of the seven new varieties tested, Spanish White, Imp. Sp. 2-B-48-1 and H-51B-123 yielded better than all other extended varieties and the native peanuts, with I-59-1 being equal or slightly inferior than Tainan Nos. 6 and 7. They were developed by the Taiwan Agricultural Research Institute, Spanish White and Imp. Sp. 2-B-48-1 being introduced from U. S. A., I-59-1 from an introduction from Kinmen Island and H-51B-123 from a selection originated from cross breeding. In regional adaptability, the best three of the varieties tested at different districts may be shown in the following table:

District	Best three of varieties tested		
	1	2	3
Taipei	H-51B-123	Imp. Sp. 2-B-48-1	Spanish White
Hsinchu	I-59-1	Tainan No. 7	Tainung No. 1
Taichung	Tainan No. 7	H-51B-123	Spanish White
Huwei	Imp. Sp. 2-B-48-1	I-59-1	Spanish White
Putze	Imp. Sp. 2-B-48-1	Spanish White	H-51B-123
Peikang	Tainan No. 7	I-59-1	Tainung No. 1
Shanhwa	Imp. Sp. 2-B-48-1	Tainan No. 6	H-51B-123
Tainan	Tainan No. 8	Spanish White	Tainan No. 7
Kaohsiung	Spanish White	Tainung No. 1	H-51B-123
Taitung	H-51B-123	Imp. Sp. 2-B-48-1	Spanish White
Hwalien	Spanish White	Tainan No. 7	Imp. Sp. 2-B-48-1

All the above seven new varieties were tested again in the fall of 1960, and, the ones being consistently better will be recommended for seed multiplication and extension when the time comes.

D. Other Promising Materials at Different Stages of Testing

In addition to the seven new varieties in province-wide regional varietal test, other materials under different stages consist of the following:

1. New varieties from pure line selection—In 1954, with the financial assistance from the Joint Commission on Rural Reconstruction (JCRR), the Taiwan Agricultural Research Institute and the Tainan District Agricultural Improvement Station conducted jointly a province-wide single plant selections of peanuts from the farmers' fields throughout the Island. A total of 2,616 single plants and 1,975 seed groups of native peanuts were collected. Since then, after repeated selection and elimination during the past years, several promising lines have been obtained and, at present, they are under the advanced stage of testing. These promising lines consist of TP(B)-3, NT(B)-2, CY(B)-55, YL(B)-20 and others.

2. New selections from cross breeding—Cross breeding work on peanuts has been carried out by the Taiwan Agricultural Research Institute and the Tainan District Agricultural Improvement Station along with other improvement work after the World War II. The major purpose is to breed for disease resistant varieties. The Spanish type of peanuts grown at present in Taiwan is not resistant to such diseases as *Sclerotium* wilt, *Cercospora* leaf spot and rosette disease. Crossing of the varieties of the Spanish type with the varieties of the Virginia type developed in other countries has been found to produce ably some lines comparatively more resistant to *Sclerotium* wilt than the present commercial varieties. Some of these disease resistant lines are now under yield test. A separate paper is written on the breeding of peanuts for disease resistance and may be found elsewhere in this report.

3. Disease resistant varieties from irradiated material—In the spring of 1957, two varieties of peanuts, Tainan Pei-yu-tou No. 1 and Tsingtao, were sent to the Brookhaven National Laboratory in U.S.A. for X-ray and thermal neutron treatments. Treated seeds were planted in Taiwan by the Taiwan Agricultural Research Institute for further experimentation. Since then, six irradiated generations have been grown, and, from these materials, some disease resistant lines have been selected. Detailed report is included in the paper written for breeding disease

resistance on peanuts.

The peanut varieties which Taiwan still needs most are the varieties which can stand a higher level of drought than those grown at present. As peanuts grown in Taiwan are planted mostly in dryland areas where irrigation water is usually unavailable, drought resistance is an important character in order to minimize the degree of damage from drought, which has occurred so often times in recent years. Some drought resistant varieties have been obtained from cross hybridization, but they are still under different stages of testing.

III. Peanut Seed Multiplication

A. Peanut Seed Multiplication System

Peanut seed multiplication system was established in Taiwan in 1950. It follows the same pattern as adopted for such grain crops as rice and wheat, consisting of three levels of seed farms, i. e., foundation, stock and extension seed farms with each of these three levels of farms operated by a level of agencies designated by the Provincial Department of Agriculture & Forestry. The operation of peanut seed multiplication system now in Taiwan may be briefly outlined in the following:

1. The foundation seed farms—The foundation seed farms are established at and operated by the District Agricultural Improvement Stations (DAIS) at Taipei, Hsinchu, Taichung, Tainan, Pingtung, Taitung and Hwalien. Seed peanuts for foundation seed farms are supplied by the district stations themselves. If it is a newly released variety, they will be supplied by the Tainan District Agricultural Improvement Station or by the Taiwan Agricultural Research Institute from their breeders' seeds. The varieties multiplied on the foundation seed farms during 1959 and 1960 may be shown in the following table:

District station	Peanut varieties
Lotung Branch Station of Taipei DAIS	Tainung No. 1
Hsinchu DAIS	Tainung No. 1, Tainan Pei-yu-tou No. 2
Taichung DAIS	Tainung No. 1, Tsingtao
Tainan DAIS	Tainan Pei-yu-tou No. 1, Tainan No. 6, Tainan No. 7
Kaohsiung DAIS	Tainung No. 1, Tsingtao
Taitung DAIS	Tainung No. 1
Hwalien DAIS	Tainung No. 1

2. The stock seed farms—The stock seed farms are established at the

prefectural level under the supervision of the prefectural farmers' associations. In most cases, these stock seed farms are operated by contract farmers, who have the experience in the past and are interested in seed multiplication work. Seeds for stock seed farms are supplied by the district agricultural improvement stations with foundation seed peanuts, which are sold to stock seed growers at a price about a half of the market price. Seeds from stock seed farms are sold to the extension seed growers at the ordinary price in the following crop season.

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. Seeds produced from extension seed farms are sold to the farmers for general planting at a price little higher than the market price.

The whole system of peanut seed multiplication may be illustrated by the following table:

Level of seed farms	Operating agency	Supervising agency	Seed distributed to
Foundation seed farms	District agricultural improvement stations	Provincial Department of Agriculture & Forestry	Stock seed growers at prefectural level
Stock seed farms	Contract farmers	Prefectural farmers' associations	Extension seed growers at township level
Extension seed farms	Contract farmers	Township farmers' associations	Ordinary farmers for general planting

B. Peanut Seed Multiplication Work During 1959 and 1960

The peanut seed multiplication work during 1959 and 1960 was carried out according to the system as mentioned above. The amount of seeds multiplied as compared with that of the two previous years may be shown 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.)
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
1959	7.25	7,354	48.08	48,979	237.12	310,863
1960	7.10	7,100	42.04	97,034	210.70	233,736

The acreage of seed farms established in 1959 and 1960 was smaller than that established in 1957 or 1958. This decrease in acreage was made purposely so as to facilitate the supervision and to ensure that good seeds could be produced and

distributed finally to the hands of the farmers. Some seed farms established were actually damaged by the torrential rains occurring on August 7, 1959. In spite of these facts, seeds produced in 1959 and 1960 were enough to increase respectively another 2,000 hectares of new peanut varieties in Taiwan. It is estimated that the acreage occupied by the new varieties has increased to some 40,000 hectares as of 1960, which is about 40 percent of the total peanut acreage planted in a year. The other 60 percent is still dominated by the native varieties.

IV. Inspection and Certification

Peanut seed farms are subject to field inspection. Two field inspections are made: one at the time when plants are in flowering and the other just before the harvesting of seeds. Harvested seeds will be sampled and sent to the Provincial Seed Testing Laboratory for examination and certification. However, because of the lack of enough trained field inspectors, not all of the peanut seeds harvested in 1959 and 1960 have been sampled and sent to the Laboratory for necessary examination. This will be strengthened in 1961 so as to fulfill the requirements. Inspection and certification of peanut are carried out by the following agencies:

Level of seed farms	Sponsoring agency	Field inspecting agency	Sampling agency	Seed testing agency	Certifying agency
Foundation seed farms	District agricultural improvement stations	Provincial Department of Agriculture & Forestry	Provincial Department of Agriculture & Forestry	Provincial Seed Testing Laboratory	Provincial Department of Agriculture & Forestry
Stock seed farms	Prefectural farmers' associations	District agricultural improvement stations	District agricultural improvement stations	Provincial Seed Testing Laboratory	District agricultural improvement stations
Extension seed farms	Township farmers' associations	Prefectural farmers' associations	Prefectural farmers' associations	Provincial Seed Testing Laboratory	District agricultural improvement stations

V. Peanut Seed Certification Standards

Peanut seed certification standards were formulated in the fall of 1956, after the closing of the First Far East Seed Improvement Conference held in the summer of 1956 in Taiwan. Certification of seed was tried for the first time on peanut in the fall crop of 1957 on a part of the multiplied seeds. However, several revisions on the certification standards have been made since then so as to fit the local requirements. The final revision was made only recently, which may be presented hereunder for reference:

A. Standards for Field Inspection

1. General standards:

- a. Only one variety of peanut may be grown for seed production on a farm.
- b. Peanut seed farms of various levels should not be established on lands which were used even partially for threshing peanuts or for piling threshed peanut plants during the previous crop.
- c. At the time of field inspection, the inspectors should also inspect the facilities for harvesting, drying and storing the seeds to prevent mechanical mixture.
- d. Unless properly bagged and sealed, certified seed peanuts should not be stored in the same building with other varieties of peanuts.
- e. Peanut seed farm should be established in a whole lot. If two peanut varieties are to be planted on the same lot of land, they should be separated at least 2 meters apart. This 2-meter space may be planted to other crops, if desired.

2. Specific standards:

Level of seed farms	Other varieties (Maximum)	<i>Sclerotium</i> wilt (Maximum)
Foundation seed farms	None	None
Stock seed farms	0.2%	0.2%
Extension seed farms	0.5%	0.5%

B. Standards for Laboratory Inspection

Item	Foundation seed	Stock seed	Extension seed
Moisture content (max.)	13%	13%	13%
Pure seed (min.)	99%	98%	98%
Other crops or varieties (max.)	None	None	None
Weed seed (max.)	None	None	None
Inert matter (max.)	1%	2%	2%
Germination (min.)	90%	85%	85%

Note: The size of peanut sample is 1 kg. of unshelled seed peanuts.

Results of field and laboratory inspections during the last four crops from the fall of 1958 to the spring of 1960 may be presented in the following:

Field/laboratory inspection	Foundation seed farms				Stock seed farms				Extension seed farms			
	1958 Fall	1959 Spring	1959 Fall	1960 Spring	1958 Fall	1959 Spring	1959 Fall	1960 Spring	1958 Fall	1959 Spring	1959 Fall	1960 Spring
Field inspection												
1) Total acreage inspected (ha.)	5.00	3.60	3.35	3.75	39.25	30.53	21.95	20.09	73.23	80.22	124.70	86.00
2) Acreage meeting certification standards (ha.)	5.00	3.60	3.35	3.75	35.60	30.53	16.85	20.09	71.35	77.80	93.90	81.60
3) Acreage disqualified (ha.)	None	None	None	None	3.65	None	5.10	None	1.88	2.42	30.80	4.40
Laboratory inspection												
1) Total amount of seeds inspected (kg.)	4,965	3,714	2,933	3,815	25,854	32,469	11,450	23,278	30,952	50,298	75,000	63,920
2) Amount meeting certification standards (kg.)	4,965	3,714	2,933	2,315	17,674	29,269	11,100	15,372	26,222	42,898	67,480	60,270
3) Amount of seeds disqualified (kg.)	None	None	None	1,500	8,180	3,200	350	7,906	4,730	7,400	7,520	3,630

It may be seen from the above table that some acreage of stock and extension seed farms and also considerable amount of seeds produced therefrom, especially those established and multiplied in the fall of 1959 and in the spring of 1960, were discarded. The main reasons for disqualification were varietal contamination and occurrence of serious *Sclerotium* wilt in case of seed fields and the loss of germination and presence of impure seeds in laboratory examination. As mentioned before, the occurrence of the torrential rains on August 7, 1959 later followed by a drought in the spring of 1960 had caused considerable difficulties on seed multiplication work; and, as a matter of fact, seeds produced during the above two seasons were not as full as the other years. As peanut in Taiwan is grown primarily as an upland crop and the lands on which peanut is planted are generally in lack of irrigation water, drought has always inflicted considerable loss to peanuts and any improvement on irrigation facilities for peanut fields will materially increase the yield of peanuts in this Island.

VI. Seed Processing, Storage and Distribution

In Taiwan, peanuts are harvested about 120 days after planting. Harvesting is usually made by hand, although, in some cases, a small hoe may be used. Threshing of peanuts from the plants is done right in the field. It is done also by hand, but, sometimes, a peanut harvesting knife is used. Recently trials have been made to thresh peanuts with pedal rice thresher by modifying certain parts in the machinery. Harvested peanuts, after being cleaned off the dirt and other foreign matters, are packed into jute bags and hauled by ox-carts from the fields to concrete grounds for drying.

The moisture content of freshly harvested unshelled 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 until the seeds enclosed inside the shells are dried and free from shell walls. Dried seeds can be easily splitted open by pressing the shells with fingers. The standard for moisture content of peanut seeds is at the maximum of not over 13 percent.

The dried seed peanuts, after being inspected, are bagged, sealed and labelled with a certifying tag indicating the type of seeds, name of variety, all necessary information on the quality and germination of seeds, name of seed growers and time of harvesting. To distinguish the type of seeds, white tags are used for foundation seeds, green tags for stock seeds and red tags for extension seeds. These different colors of tags are used also for differentiating different types of seeds of other crops in the seed multiplication work. After being properly bagged, sealed and tagged, seed peanuts are stored temporarily at the storage house and then distributed to the responsible agencies for further multiplication or extension. Peanut in Taiwan is grown two seasons a year, and seeds produced in the previous crop can be used for seed in the following crop season. As the interval between the two crops is usually very short, storage of seed peanuts is not a serious problem. However, to facilitate the storage and distribution of seeds, especially at places where large acreage of peanuts is grown, the provision of large granaries for peanut seeds is still necessary. In its 1961 fiscal budget, JCRR has agreed to appropriate a total of some NT\$450,000 to construct two peanut seed granaries in the spring of 1961, one to be located at Fenglin Township in Hwalien Prefecture on the east coast and the other at Peikang Township in Yunlin Prefecture on the west coast. If such seed granaries will materially help improve the keeping quality of seed peanuts and facilitate the seed multiplication work, more will be constructed so as to strengthen the peanut seed multiplication program.

Seed peanuts for distribution are not shelled. Foundation seed peanuts are distributed to the stock seed growers by the district agricultural improvement stations through the prefectural farmers' associations, formerly free of charge, but at a price about a half of the market price at present. Stock seeds are distributed by the prefectural farmers' associations to extension seed growers through the township farmers' associations at the market price. The extension seed peanuts collected by the township farmers' associations from the extension seed growers are sold to the farmers for general planting. To facilitate the purchase of multiplied seeds from the stock and extension seed growers, JCRR has appropriated in its 1961 budget a sum of NT\$200,000 as the purchasing fund for the prefectural and township farmers'

associations. The fund will be used for advanced payment of the seed, so that the stock and extension seed growers will not sell their seeds to others who may use them for food and oil extraction purposes.

VII. Government Subsidies for Peanut Seed Multiplication Work

In addition to the purchasing fund appropriated by JCRR, the following subsidies have been given by the Taiwan Provincial Department of Agriculture & Forestry with JCRR financial assistance to the operating agencies for regular peanut seed multiplication work during the past years.

A. Subsidy for Multiplying Stock and Extension Seeds

Foundation seeds produced by the district agricultural improvement stations are paid out from their regular budget appropriated by the government. However, for stock and extension seeds which are multiplied and carried out by contract growers, a cash subsidy of NT\$300 per hectare has been given to contract seed growers during the past two years to compensate for their work. This subsidy is still necessary for at least two reasons: (1) the fields of contract seed growers must be subject to inspection and certification and off-types or diseased plants must be eradicated; and (2) their seeds must be sold to the government agencies at a price approved by the Provincial Department of Agriculture & Forestry and these seeds are to be distributed according to the government plan. The total budget for this item is about NT\$150,000 to NT\$200,000 a year.

B. Subsidy for Packing and Transporting Multiplied Seeds

During the past two years, a total of about NT\$140,000 has been appropriated by the government from the JCRR grants to buy 100,000 jute bags for packing different levels of multiplied seeds, each bag having a holding capacity of about 60 kg. of unshelled seed peanuts. In addition, a cash subsidy of NT\$0.10 to NT\$0.15 for each kilogram of seed is given to the district agricultural improvement stations and prefectural farmers' associations for packing and transporting the multiplied foundation and stock seeds. The total annual expenditure for this item amounts to about NT\$24,000.

C. Subsidy for Handling Seed Distribution

Seed storage and distribution are handled by the prefectural and township

farmers' associations. During the period of seed storage and especially at the time of seed distribution, some losses of seeds are unavoidable. The government gives some subsidy to cover such losses. The present rate is NT\$5 per each 100 kg. of seeds. The total annual budget for this item is about NT\$40,000.

D. Subsidy for Holding Farmers' Field Days

At the time of harvest, farmers in nearby areas are invited to the seed multiplication farms to see the method of seed production and the superiority of the new varieties over the old ones. The best seed growers are given rewards or prizes by the Provincial Department of Agriculture & Forestry. The expenses for holding farmers' field days on peanuts in a year is about NT\$30,000.

E. Subsidy for Expenses for Field and Laboratory Inspection

During the past two years, an annual appropriation of some NT\$20,000 has been made by the government to cover the expenses for field and laboratory inspection. The expenses for this item will be further increased as soon as there are enough trained technicians to do the seed inspection and certification work.

F. Subsidy for Supervision and Travelling Expenses

As the acreage of stock and extension seed farms of peanuts are considerably large and, in most cases, these farms are distributed and widely scattered in a prefecture or township, in order to see that these seed farms are properly established and managed, the operating agencies are given certain financial assistance by the government to strengthen their supervision work. The amount for this item from the government is about NT\$50,000 a year.

G. Other Government Subsidies for Varietal Demonstration, Publication of Extension Circulars, etc.

The total annual budget for peanut seed multiplication work during the past two years is about NT\$500,000. Towards this amount, JCRR has contributed yearly about NT\$400,000. The total JCRR contribution towards the peanut improvement work, including research, extension and seed multiplication, is no less than NT\$800,000 a year.

BREEDING FOR RESISTANCE TO SCLEROTIUM WILT IN PEANUTS

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In Taiwan, the most common diseases in the peanut (*Arachis hypogaea*) are *Sclerotium* wilt, *Cercospora* leafspot and rosette diseases. However, of these three, *Sclerotium* wilt is the most destructive one, particularly in the fall planted crop. It is estimated that the loss of peanuts as due to *Sclerotium* wilt alone is about 9-15 percent of the total production of a year. The most important causal pathogen of *Sclerotium* wilt is *Sclerotium rolfsii*, others being *Sclerotinia arachidis*, *Sclerotinia miyabeana*, *Diplodia* sp., *Fusarium* spp. and *Pseudomonas solanacearum*. They cause the plants to wilt and die almost at any stage from young to maturing plants. Although treatment of seed with Sperguson, an organic fungicide, is effective in minimizing the death of young seedlings, the infection may continue to occur on old plants. *Sclerotium rolfsii* is a soil borne fungus, but, as it attacks also many other plants including wild grasses, consequentially, transmission of the disease can be made freely not only among peanuts but also between peanuts and other plants through the help of soil, wind, insects, seed and farm tools. Therefore, breeding for disease resistance is the only effective and economical means for controlling *Sclerotium* wilt and is an important task for further improvement of the peanut production in this Island.

With the financial and technical assistance from the Joint Commission on Rural Reconstruction (JCRR), work on the breeding for resistance to *Sclerotium* wilt in peanuts was started by the Taiwan Agricultural Research Institute (TARI) in 1954. As of today, several promising resistant lines have been obtained from the crosses between the Spanish and Virginia types and from the materials irradiated with

X-rays and thermal neutrons. The work as carried out by the Institute during the past few years may be briefly reported in the following.

A. Determination of Comparative Susceptibility of Locally Grown Peanut Varieties Towards Sclerotium Wilt Under Natural Conditions

The peanut varieties grown in this Island are primarily of the Spanish or erect type. They are quite susceptible to *Sclerotium* wilt, although they may show different degrees of susceptibility. During the years of 1954 and 1955, when the presently grown peanut varieties were still included in the province-wide regional varietal tests, they were rated for their degree of susceptibility to *Sclerotium* wilt at different localities under natural conditions. Four ratings were adopted as follows:

<u>Rating</u>	<u>Degree of susceptibility</u>
+	Light
++	Medium
+++	Heavy
++++	Very heavy

The peanut regional varietal tests in 1954 and 1955 were conducted at eleven places throughout the Island. Of these eleven places, seven were found to have wilt epidemics at least in one of the four crops in two years. Comparative degrees of susceptibility of different varieties as rated towards *Sclerotium* wilt may be shown in Table 1:

Table 1.
Comparative Susceptibility of Presently Grown Peanut Varieties Towards Sclerotium Wilt Under Natural Conditions

Variety	Taipei			Hsinchu		Tai-chung	Pei-kang	Tainan	Taitung			Hualien
	1954 spring crop	1954 fall crop	1955 spring crop	1954 spring crop	1955 spring crop	1955 spring crop	1954 fall crop	1954 fall crop	1954 spring crop	1954 fall crop	1955 fall crop	1955 fall crop
Fante 17	+	+++	+	+++	+	++	++	+++	+++	++++	++	++
Tsingtao	++	+	++	++	+	+	++	+++	+++	++	+++	++
Lungtan Yu-tou	++	+++	+++	++	+	++	++	+++	+	+++	++	++
Tainung 1	+	+	+	+	++	+	++	+++	+++	++	++	++
Tainan Pei-yu-tou 1	+++	+++	++	+++	++	++	+++	+++	++	+++	+++	+++
Tainan Pei-yu-tou 2	++	+++	++	+++	+++	+++	++	+++	++	+++	+	+++
Tainan Pei-yu-tou 5	++++	+++	+++	++++	+++	++	++	+++	+++	++	+++	+++
Peikang Yu-tou	++++	+++	+++	+++	+	+++	+++	+++	+++	++	+++	++

Table 1. (continued)

Variety	Taipei			Hsinchu		Tai-chung	Pei-kang	Tai-nan	Taitung			Hua-lien
	1954 spring crop	1954 fall crop	1955 spring crop	1954 spring crop	1955 spring crop	1955 spring crop	1954 fall crop	1954 fall crop	1954 spring crop	1954 fall crop	1955 fall crop	1955 fall crop
Taitung Fengli Ta-kung-tou	++++	++++	+	++++	+++	+++	++	+++	+++	++++	++	++
Taitung Fengli Yu-tou	++	++++	++	+++	+	+++	+	+++	+++	++	+++	+++
Native variety (1)	++++	+++	+	+++	+	+++	++	+++	+++	++++	++	++
Native variety (2)	+	+++	++	+++	+	++	+	+++	+++	++	+	++

Of these twelve varieties included in the regional varietal tests in 1954 and 1955, Tainan Pei-yu-tou Nos. 1, 2 and 5 were the first three varieties released for commercial planting in Tainan district in 1950. Tainung No. 1 and Tsingtao were later released for extension at other localities in 1957. At present, Tainan Pei-yu-tou No. 1 and Tainung No. 1 are the leading improved varieties occupying together about 40,000 hectares or nearly 40 percent of the total peanut acreage planted in a year. Fante 17, Lungtan Yu-tou, Peikang Yu-tou, Taitung Fengli Ta-kung-tou and Taitung Fengli Yu-tou are the old improved varieties selected by the farmers from the native varieties and they are still planted at some localities occupying certain acreage in Taiwan. From the above ratings, it may be said that, comparatively, Tainung No. 1 and Tsingtao are less susceptible to *Sclerotium* wilt than the other varieties, while Peikang Yu-tou, Taitung Fengli Yu-tou, Tainan Pei-yu-tou No. 5 and native variety (1) are the heaviest. None of them, however, is considered resistant to *Sclerotium* wilt.

B. Determination of Comparative Susceptibility of Some Introduced Peanut Varieties Towards *Sclerotium* Wilt Under Natural Conditions

During the past few years, considerable number of peanut varieties have been introduced from outside. In 1956 and 1957, fifteen varieties of them were especially selected to observe their susceptibility towards *Sclerotium* wilt. Tainan Pei-yu-tou No. 1 was used for comparison. This experiment was conducted at TARI in Taipei. As *Sclerotium* wilt occurs primarily in the fall crop in northern Taiwan, these test varieties were planted in early August. About mid-October, disease symptom began to show up and, until mid-November, many wilt plants were found. Four classes of rating were adopted as before: light, medium, heavy and very heavy. For each tested variety, 100 plants were taken from each plot and four plots were observed.

Those having less than 20 percent of diseased plants were considered as light, 20–40 percent as medium, 40–60 percent as heavy, and 60 percent above as very heavy. Comparative susceptibility of these fifteen introduced varieties as compared with that of Tainan Pei-yu-tou No. 1 towards *Sclerotium* wilt is shown in Table 2:

Table 2.
Comparative Susceptibility of Some Introduced Peanut Varieties Towards
***Sclerotium* Wilt Under Natural Conditions in Taipei, Taiwan**

Variety	1956 fall crop	1957 fall crop
Florence sp.	+++	+++
Argentine	+++	++
Spanish 205	+++	+++
Spanish 18-38	+++	++
Improved sp. 2-B-48-1	++	++
Spanish 18-38-42	+++	++++
Dixie Spanish	+++	+++
Spain	+++	+++
Spanish White	++	+
Spanish Small	++	++
Sp. 146-H-48-3	+	+
Southern Cross	++	+
Kinorales	+	+
White Nanking	+++	+++
Kinmen var.	+	+
Tainan Pei-yu-tou 1 (local variety)	++	+

From Table 2, it may be seen that, except Sp. 146-H-48-3, Kinorales, Kinmen variety, Spanish White and Southern Cross which were rated as only lightly susceptible, other introduced varieties were quite susceptible to *Sclerotium* wilt. In Table 1, Tainan Pei-yu-tou No. 1 was found to be fairly susceptible to *Sclerotium* wilt, but, in this experiment, it was classified as belonging to the same class as Spanish White and Southern Cross. Spanish White and Improved sp. 2-B-48-1 have been advanced recently to the province-wide regional varietal test and have been found to yield better than Tainan Pei-yu-tou No. 1 in many places during the past three crops.

C. Test for Resistance of Peanut Varieties to *Sclerotium rolfsii* by Artificial Inoculation With Disease Pathogen

The above ratings were made under natural conditions and the rating made in one year may not be in conformity with that in other years. In order to determine the resistance of different peanut varieties to *Sclerotium* wilt, artificial inoculation

was made in 1958 at the Seed & Seedling Multiplication Station in Tungshih, Taichung Prefecture, where a number of peanut experiments was carried out. *Sclerotium rolfsii* was isolated and used for preparing inoculum as it is the most important pathogen causing the *Sclerotium* wilt disease. The inoculum was prepared by the Department of Plant Pathology, TARI, for use. A total of 30 peanut varieties were inoculated, 11 of which being the Spanish type and 19 the Virginia type. Inoculation was made by putting the disease inoculum near the basal portion of the main stalk of young seedlings, when they were about five weeks old. Counting of diseased plants was made every week after the inoculation. The result was as follows:

Table 3.
Artificial Inoculation of *Sclerotium rolfsii*
on Different Peanut Varieties

Plant type	Variety	No. of plants inoculated	No. of diseased plants counted	Percentage of diseased plants
Spanish	Tainung No. 1	92	53	57.6
	Tainan Pei-yu-tou No. 1	93	57	61.3
	Tsingtao	92	62	67.4
	H-51B-123	84	35	41.7
	Southern Cross	90	56	62.2
	Spanish White	89	34	38.2
	Sp. 18-38-42	78	57	73.1
	E. G. Red	91	36	36.6
	Java No. 13	86	52	60.5
	Youka-ichi Shouliu	87	47	54.0
	Kanagawa-tachi peanut	94	51	56.4
	Average:			
Virginia	Virginia Bunch	84	71	84.5
	NC-1	37	32	86.5
	NC-2	52	44	84.6
	C-37	31	28	90.3
	Florispán Runner	88	57	64.9
	Fla. strain 392-12	91	62	68.1
	Fla. strain 396	70	57	81.4
	Early Runner	81	35	43.2
	Dixie Runner	72	47	65.3
	Holland Sta. Runner	89	72	80.9
	Jumbo Runner	62	47	75.8
	Southeast Runner	66	46	69.7
	Chiba No. 74	54	49	90.7
	Kulume No. 3	63	33	52.6
	China variety	59	49	83.1

Table 3. (continued)

Plant type	Variety	No. of plants inoculated	No. of diseased plants counted	Percentage of diseased plants
	Chiaochow-fu peanut	75	53	70.8
	Li-lo-tuo	51	43	84.3
	Li-chi-tzo	64	45	70.3
	Yuan Yang Tou	61	34	55.7
	Average:			79.1

From Table 3, it may be seen that the highest percentage of diseased plants was found on Chiba No. 74 (90.7%) and least on E. G. Red (36.6%). The percentage of diseased plants on the varieties of the Spanish type ranges from 36.6 to 73.1 percent averaging at 55.6 percent and that on the varieties of the Virginia type ranges from 43.2 to 90.7 percent averaging at 79.1 percent. This indicates that the Virginia type of peanuts is not any stronger in resistance to *Sclerotium* wilt than the Spanish type as usually thought, although the former type may be stronger in resisting to other diseases. According to this experiment, Spanish White, E. G. Red and H-51B-123 of the Spanish type and Early Runner, Kulume No. 3 and Yuan Yang Tou of the Virginia type are comparatively less susceptible to *Sclerotium rolfsii* than the other varieties, although none of the varieties tested is considered resistant. Yuan Yang Tou is one of the few peanut varieties of the Virginia type grown in Taiwan, where it has been grown primarily on the Pescadores Islands for no less than 50 years.

D. Breeding for Resistance to *Sclerotium* Wilt Through Cross

Breeding Between the Spanish and Virginia Types of Peanuts

Although both the Spanish and Virginia types of peanuts are not resistant to *Sclerotium* wilt, they do show different degrees of resistance among different varieties. Since 1954, several crosses were made by the TARI not only between varieties of the Spanish type, but also between varieties of both the Spanish and Virginia types. It was hoped that, through the uses of two distinct groups of genetically diversified materials in the breeding program, some resistant varieties may be developed.

In this cross breeding work, two local peanut varieties of the Spanish type, Tainan Pei-yu-tou No. 1 and Tsingtao, were used as the common female parent, with each of them crossed to three varieties of the Spanish type, one variety of the Valencia type and nine varieties of the Virginia type, all of which being introduced formerly from the United States and Japan. After preliminary selection and multiplication in F_2 , plants grown in F_3 and F_4 were subject to artificial

inoculation with *Sclerotium rolfsii*. The result is that some resistant lines were obtained from the crosses between the Spanish and Virginia types but none between other combinations. The result may be summarized in Table 4:

Table 4.
Test for Resistance to *Sclerotium rolfsii* of the Progenies Obtained from the Crosses Between the Spanish, Valencia and Virginia Types of Peanuts

Cross No.	Varieties used as female parent	Varieties used as male parent	Male plant type	No. of lines selected & multiplied in F ₂	No. of lines inoculated in F ₃	No. of lines showing resistance	No. of lines inoculated in F ₄	No. of lines showing resistance in F ₄
A	Tainan Pei-yu-tou No. 1 (Spanish type)	Sp. 18-38-42	Spanish	14	139	14	40	0
B	Tainan Pei-yu-tou No. 1 (Spanish type)	B-115-13	Spanish	12	113	9	40	0
C	Tainan Pei-yu-tou No. 1 (Spanish type)	Dixie Spanish	Spanish	2	34	2	40	0
D	Tainan Pei-yu-tou No. 1 (Spanish type)	Kinorales	Valencia	7	90	7	40	0
E	Tainan Pei-yu-tou No. 1 (Spanish type)	Virginia Bunch 67	Virginia	5	36	5	40	1
F	Tainan Pei-yu-tou No. 1 (Spanish type)	Florispan Runner	Virginia	5	70	5	80	0
G	Tainan Pei-yu-tou No. 1 (Spanish type)	Fla. strain 392-12	Virginia	3	27	3	28	0
H	Tainan Pei-yu-tou No. 1 (Spanish type)	Fla. strain 396	Virginia	3	6	3	10	0
I	Tainan Pei-yu-tou No. 1 (Spanish type)	Tanega shima	Virginia	7	63	7	60	0
J	Tainan Pei-yu-tou No. 1 (Spanish type)	Early Runner	Virginia	11	133	11	130	8
K	Tainan Pei-yu-tou No. 1 (Spanish type)	Dixie Runner	Virginia	1	38	1	30	0
L	Tainan Pei-yu-tou No. 1 (Spanish type)	Southeast Runner	Virginia	4	72	4	70	0
M	Tainan Pei-yu-tou No. 1 (Spanish type)	Jambo Runner	Virginia	2	3	2	10	0
N	Tsingtao (Spanish type)	Sp. 18-38-42	Spanish	4	67	4	40	0
O	Tsingtao (Spanish type)	B-115-13	Spanish	4	46	4	40	0
P	Tsingtao (Spanish type)	Dixie Spanish	Spanish	2	31	2	40	0
Q	Tsingtao (Spanish type)	Kinorales	Valencia	6	96	6	40	0
R	Tsingtao (Spanish type)	Virginia Bunch 67	Virginia	4	51	4	40	11
S	Tsingtao (Spanish type)	Florispan Runner	Virginia	10	137	10	140	23

Table 4 (continued)

Cross No.	Varieties used as female parent	Varieties used as male parent	Male plant type	No. of lines selected & multiplied in F ₂	No. of lines inoculated in F ₃	No. of lines showing resistance	No. of lines inoculated in F ₄	No. of lines showing resistance in F ₄
T	Tsingtao (Spanish type)	Fla. strain 392-12	Virginia	3	26	4	20	0
U	Tsingtao (Spanish type)	Fla. strain 396	Virginia	7	93	3	40	5
V	Tsingtao (Spanish type)	Tanega shima	Virginia	4	16	7	40	0
W	Tsingtao (Spanish type)	Early Runner	Virginia	2	31	2	40	0
X	Tsingtao (Spanish type)	Dixie Runner	Virginia	4	28	4	40	0
Y	Tsingtao (Spanish type)	Southeast Runner	Virginia	1	4	1	10	0
Z	Tsingtao (Spanish type)	Jambo Runner	Virginia	5	25	5	30	0

‡ Disease developed after inoculation in F₃ was not as serious as that in F₄.

From Table 4, it may be seen that the crosses which give disease resistant lines in F₄ are the following:

Cross No.	Cross combination	No. of disease resistant lines selected in F ₄
E	Tainan Pei-yu-tou No. 1 × Virginia Bunch 67	1
J	Tainan Pei-yu-tou No. 1 × Early Runner	8
R	Tsingtao × Virginia Bunch 67	11
S	Tsingtao × Florispan Runner	23
U	Tsingtao × Fla. strain 396	5
Total:		48

All the resistant lines were obtained from the crosses made between the Spanish and Virginia types, and there are 48 of them. These 48 lines were tested for yield in the fall of 1959 (F₅) and, again, in the spring of 1960 (F₆). The parental varieties used in the crosses were included to facilitate comparison. After testing for two crop seasons, it was found that, out of these 48 lines, eleven seem to be most promising from the standpoints of both the yield and disease resistance. The performance of these eleven lines as against the parental varieties may be seen in Table 5:

Table 5.
Performance of Eleven Disease Resistant Lines Selected from the
Crosses Between the Spanish and Virginia Types of Peanuts

Line No.	Parentage	Yield in 6 m ² plot (g.)		No. of diseased plants in the total of 300		Rating
		1959 fall crop	1960 spring crop	1959 fall crop	1960 spring crop	
S- 18-249	Tsingtao × Florispan Runner	2,320	1,640	11	6	R
S- 28-261	Tsingtao × Florispan Runner	2,280	2,150	2	4	HR
S- 78-282	Tsingtao × Florispan Runner	1,140	1,130	6	2	HR
S- 83-286	Tsingtao × Florispan Runner	1,120	1,290	8	6	R
S- 86-292	Tsingtao × Florispan Runner	1,395	850	18	6	MR
S-121-449	Tsingtao × Florispan Runner	1,865	1,100	11	1	R
S-124-452	Tsingtao × Florispan Runner	2,395	1,640	15	10	MR
S- 91-582	Tsingtao × Florispan Runner	2,130	1,180	15	5	MR
J- 21-361	Tainan Pei-yu-tou No. 1 × Early Runner	1,310	1,050	9	6	R
R- 95-434	Tsingtao × Virginia Bunch 67	590	720	6	8	R
R- 84-561	Tsingtao × Virginia Bunch 67	1,330	1,090	5	14	R
Parental varieties						
	Tainan Pei-yu-tou No. 1	1,340	1,160	63	31	HS
	Tsingtao	1,390	1,149	61	38	HS
	Florispan Runner	1,280	1,421	26	29	S
	Early Runner	1,160	1,080	42	51	HS
	Virginia Bunch 67	1,213	1,316	48	47	HS

Note: HR—Highly resistant
R —Resistant
MR—Moderately resistant
S —Susceptible
HS—Highly susceptible

From Table 5, it can also be seen that, out of eleven lines selected, eight of them are derived from the cross between Tsingtao and Florispan Runner, two between Tsingtao and Virginia Bunch 67 and one between Tainan Pei-yu-tou No. 1 and Early Runner. Tsingtao and Florispan Runner are, therefore, two good combiners as far as genetics and breeding are concerned. Although both of them were tested not resistant to *Sclerotium* wilt either under natural condition or after inoculation test, nevertheless, when they were crossed together, they did give the progenies with fair degree of resistance. These eleven selected lines were put into regular yield test again in the fall of 1960 to ascertain their commercial value in the future.

E. Selection of Disease Resistant Varieties from Irradiated Materials

In addition to breeding for resistance through cross breeding of the Spanish

and Virginia types of peanuts, selection was made also of disease resistant varieties from irradiated materials. In the spring of 1957, two varieties of peanuts, Tainan Pei-yu-tou No. 1 and Tsingtao, were sent by JCRR to Brookhaven National Laboratory in the U.S. for radiation treatment. Each variety consisted of about 10,000 seeds and they were treated with X-rays and thermal neutrons as follows:

<u>Treatment</u>	<u>Degree</u>
X-rays	15000 r
	20000 r
Thermal neutrons	120 minutes
	170 minutes
	220 minutes

The treated seeds were sent back to Taiwan in the fall of 1957 and given by the JCRR to the TARI for further experimentation and selection. Since then, six irradiated generations have been grown at the Seed & Seedling Multiplication Station. From R₂ to R₆ generations, artificial inoculation with *Sclerotium rolfsii* was performed to facilitate the selection of disease resistant materials. The disease inoculum was prepared by culturing pure *Sclerotium rolfsii* on a medium made of powdery peanut shells in a glass bottle of about 2,000 cc. in size. About 20 days of culturing the inoculum was taken out and placed on the base of young seedlings to facilitate the development of the disease. Through this repeated inoculation at every irradiated generation, a total of 104 resistant lines were selected finally from the I generation grown in the fall of 1959. These 104 selected lines of peanuts were tested for yield at three localities in the spring of 1960, and, of these 104 lines eight were found to be consistently better in both yield and disease resistance than the original varieties. The performance of these eight resistant lines selected from the irradiated materials may be summarized in Table 6:

Table 6.
Yield of Eight Selected Lines from Irradiated Materials

Selected line	Yield index						Yield per ha. of 1960 spring crop				
	Diseased plots				Non-diseased plots		Tainan	Huwei	Tung-shih	Average	Yield index
	1958 fall crop	1959 spring crop	1959 fall crop	1960 spring crop	1959 fall crop	1960 spring crop					
TP-B-1038	209	180	380	237	144	130	(kg.) 1,263	(kg.) 1,830	(kg.) 1,851	(kg.) 1,646	136
TP-E-2263	128	308	588	182	102	95	1,285	1,545	1,416	1,415	117
TP-E-1963	193	90	133	107	133	107	1,635	1,935	835	1,468	122
TP-D-1391	180	139	133	179	103	120	1,700	1,855	1,429	1,663	137
TP-E-2832	152	114	112	122	97	91	1,185	1,385	975	1,182	98
Tainan Pei-yu-tou No. 1	100	100	100	100	100	100	1,300	1,520	798	1,206	100
TS-A-3036	202	159	120	143	108	94	1,105	1,430	1,495	1,343	117
TS-D-3081	435	118	116	158	103	109	1,035	1,850	1,646	1,510	131
TS-E- 959	179	126	240	126	113	101	1,572	1,765	1,373	1,571	136
Tsingtao	100	100	100	100	100	100	1,155	1,210	1,090	1,152	100

Note: TP—Selected lines derived originally from Tainan Pei-yu-tou No. 1

TS—Selected lines derived originally from Tsingtao

A —Treated with thermal neutrons 120 min.

B —Treated with thermal neutrons 170 min.

C —Treated with thermal neutrons 220 min.

D —Treated with X-rays 15000 γ

E —Treated with X-rays 20000 γ

For rating of the resistance to *Sclerotium* wilt, five classes were arbitrarily adopted as before: highly resistant (HR), resistant (R), moderately resistant (MR), susceptible (S) and highly susceptible (HS). The eight selected lines from irradiated materials were rated in the past as follows:

Table 7.
Rating of Eight Selected Lines of Peanuts vs. *Sclerotium rolfsii*

Selected line	1958 fall crop (R ₃)	1959 spring crop (R ₄)	1959 fall crop (R ₅)	1960 spring crop (R ₆)
TP-B-1038	MR	MR	MR	MR
TP-E-2263	R	R	R	HR
TP-E-1963	R	S	S	HS
TS-A-3036	R	MR	R	R
TS-D-3081	R	MR	R	R
TS-D- 959	HR	S	S	R
TP-E-1931	MR	S	S	HS
TP-D-2832	MR	MR	MR	S
Tainan Pei-yu-tou No. 1	S	HS	HS	HS
Tsingtao	S	HS	HS	HS

Comparatively, all these eight selected lines show a higher degree of resistance to *Sclerotium rolfsii* than the original varieties Tainan Pei-yu-tou No. 1 and Tsingtao. TP-E-2263 was considered to be the best of all, for it was proved high in both yield and disease resistance. TP-E-1931 was weaker in disease resistance, but it was selected for its highest yield of the eight selected lines tested. All of these lines were put into yield test again in the fall of 1960.

F. Conclusion

Breeding for resistance to diseases is always an important problem in any crop improvement work and is a task hard to be undertaken. It takes the plant breeders to look incessantly for resistant materials which may or may not be found. In peanuts, *Sclerotium* wilt (called stem rot in the U.S.), *Cercospora* leafspot and rosette disease are the three most serious diseases universally found in almost every peanut growing region throughout the whole world; and very few varieties grown are resistant to these diseases. Dr. W. C. Gregory of the North Carolina State University is one of the only few people who are able to produce disease resistant varieties of peanuts from irradiated materials such as NC-1, NC-2, C-37, etc. Though the varieties being resistant in the U.S. may not necessarily be resistant here, we are lucky enough, however, to be able to develop some resistant varieties of our own, not only from the irradiated materials but from the cross breeding as well. The availability of these resistant varieties gives us a hope to further increase the unit yield of peanut in this Island.

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SOYBEAN IMPROVEMENT AND SEED PRODUCTION IN TAIWAN

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I. Introduction

Soybean was formerly a minor crop in Taiwan, but has become important in recent years because of the increasing local demand for oil, beancakes and various food uses. It is estimated that the annual soybean requirement for food and oil alone during the next five years will gradually exceed the mark of 180,000 metric tons when the consumption of soybean for food and for oil is calculated respectively on the basis of 6 kilograms and 8.33 kilograms (or 1 kg. of soybean oil) per capita per year. If deficit protein feed requirement for hogs is to be provided with soybean, then probably another 100,000 metric tons of soybeans will be desired. The requirement of soybeans for food and oil during the next five years in Taiwan is estimated as follows:

Estimated Amount of Soybeans Required for Uses in Food and Oil During the Years 1960-1964 in Taiwan

Year	For various food uses (m.t.)	For oil extraction (m.t.)	Total* (m.t.)
1960	67,000	90,000	157,000
1961	70,000	92,000	162,000
1962	74,500	95,000	169,500
1963	78,800	98,000	176,800
1964	82,800	101,000	183,800

* Additional amount of soybeans needed for hog feed not included.

In order to meet the demand as much as possible, efforts have been made by the local agencies, including government offices, farmers' associations, research institutions and the Joint Commission on Rural Reconstruction (JCRR) as well, to promote the domestic soybean production. It may be said that, through the development of new improved varieties of soybean and the exploitation of new areas for soybean planting, both the acreage and production of soybean have been con-

siderably increased during the past few years. However, in spite of all these efforts, because of the limited cultivated lands, a greater portion of the needed soybeans, especially those used for oil extraction and feed purposes, remains to be depending on the imported soybeans. Local soybeans, which have been projected to produce from 51,300 metric tons in 1960 to 105,000 metric tons in 1964, will be expected to be enough to cover all food uses within one or two years, and there may be some surplus for oil extraction in the not too distant future. The soybean production during the past five years and the production goals as projected for the next four years may be shown in the following table:

Soybean Production and Production Goals for 1956-1964 in Taiwan

Item	Year	Acreage (ha.)	Production (m.t.)	Yield per hectare (kg.)
Actual production 1956-60	1956	37,505	26,442	706
	1957	41,029	33,055	808
	1958	47,894	41,682	870
	1959	53,784	44,451	826
	1960	59,665	52,653	882
Production goals 1961-64	1961	62,000	62,000	1,000
	1962	70,000	77,000	1,100
	1963	78,000	93,600	1,200
	1964	84,000	105,000	1,250

As a result of the increase in acreage through the development of better improved varieties, soybean is now planted almost at every corner of the Island, although the principal growing region still lies in the southern part around Pingtung and Kaohsiung, where more than half of the total soybean acreage is established. As regards planting season, soybean in Taiwan may be sown in the spring, summer, fall or in all three seasons. In Pingtung and Kaohsiung areas where three seasons are grown, soybeans are planted primarily as a catch crop between the two crops of rice in the fall. In this case, soybean seeds are sown in rice fields in October either about 10 to 15 days before or just after the harvesting of the second rice crop. In Tainan, Chiayi and Yunlin, soybeans are planted in the spring and summer, whereas in Miaoli, Hsinchu and Taoyuan in northern Taiwan, they are grown as far only as the summer crop. Soybeans are harvested about four months after planting, depending on the varieties grown and the districts in which they are grown.

II. Varietal Improvement

A. Increase in Acreage of Improved Varieties

It has been reported at the last Far East Seed Improvement Workshop held in Japan, 1959, that, although soybean improvement work in Taiwan has a rather late start, several improved soybean varieties of the yellow-seed type have been released for commercial planting since 1956. The first improved variety Sankuo was extended in Miaoli in the summer of 1956, then followed by the Palmetto variety in southern Taiwan in 1957 and by the Shihshih variety in the central part in 1958. As these improved varieties yield significantly higher than the native green and black beans and fit better in the local cropping and rotation system, their acreage increases very rapidly. The estimated acreage occupied by these three varieties in 1960 from the spring to fall crop seasons is about 33,500 hectares or more than three-fifths of the total soybean acreage projected for that year. The increase in acreage of these three improved soybean varieties since 1956 in Taiwan may be shown in the following table:

Acreage Increase of Three Improved Soybean Varieties Since 1956

Variety	Prefecture	1956 (ha.)	1957 (ha.)	1958 (ha.)	1959 (ha.)	1960 (ha.)	Planting season
Sankuo	Ilan	—	—	—	200	200	Spring
	Taipei	—	—	—	—	40	Summer
	Taoyuan	—	—	230	1,200	1,000	Summer
	Hsinchu	—	200	1,300	2,400	2,200	Summer
	Miaoli	200	1,200	2,400	3,000	2,200	Summer
	Yunlin	—	—	400	1,200	1,500	Summer
	Chiayi	—	—	400	1,200	1,500	Summer
	Hwalien	—	1,000	1,500	1,000	1,200	Summer
Total:		200	2,400	6,230	10,200	9,840	
Palmetto	Yunlin	—	—	—	100	300	Spring
	Chiayi	—	—	—	50	200	Spring
	Tainan	—	—	—	300	800	Spring and summer
	Kaohsiung	—	633	5,000	7,000	7,400	Spring, summer and fall
	Pingtung	—	1,000	6,500	9,000	12,600	Spring, summer and fall
	Taitung	—	—	—	400	400	Spring and summer
	Hwalien	—	—	—	—	200	Spring
Total:		—	1,633	11,500	16,850	21,900	

(continued)

Variety	Prefecture	1956 (ha.)	1957 (ha.)	1958 (ha.)	1959 (ha.)	1960 (ha.)	Planting season
Shihshih	Nantou	—	—	—	60	150	Spring and summer
	Taichung	—	—	300	300	300	Spring, summer and fall
	Changhwa	—	—	—	200	200	Spring, summer and fall
	Chiayi and Tainan	—	—	—	200	400	Spring and summer
	Kaohsiung and Pingtung	—	—	—	300	500	Spring, summer and fall
	Taitung	—	—	—	100	200	Fall
Total:		—	—	300	1,160	1,750	
Grand Total:		200	4,033	18,030	28,210	33,490	

The originally projected acreage of the improved varieties in 1960 is 35,000 hectares. However, due to the occurrence of the Shirley Typhoon on August 1, 1960, some fields in Miaoli, Hsinchu and Taoyuan had been destroyed; and, as a result, there is a shortage of about 1,500 hectares. In spite of this fact, the acreage of the improved varieties in 1960 has exceeded that in 1959 by about 4,000 hectares. JCRR has contributed, respectively, a sum of about NT\$700,000 each year in 1959 and 1960 to help carry out the seed multiplication and extension programs of these improved varieties.

B. Extension of Two New Varieties Acadian and Wakashima in Pingtung and Kaohsiung in 1960

Acadian, an American variety, and Wakashima, a Japanese variety, were introduced respectively by the Kaohsiung and Hsinchu District Agricultural Improvement Stations in 1953. After two years of province-wide regional tests in 1955 and 1956, they were found to yield fairly well in Pingtung and Kaohsiung during the fall planting season. Therefore, following then, these two varieties with several others were tried again at a number of places within the Pingtung and Kaohsiung areas in 1957, 1958 and 1959. It is found that, although Acadian and Wakashima may not be adaptable for growing in all three seasons such as the Palmetto variety is, they are not as sensitive as and yield better than Palmetto when they were taken for late fall planting either on paddy fields following the harvesting of the second rice crop or on dryland. For this reason, Acadian and Wakashima were decided to be released for extension in the fall of 1960. The results of trial planting of these two varieties in the Pingtung and Kaohsiung areas may be summarized in the following:

**Trial Planting of the Acadian Variety in Pingtung and Kaohsiung
Areas in Fall Planting**

District	Test locality (Township)	Acadian (kg./ha.)	Check variety (kg./ha.)	Index	Ranking in the whole test
Pingtung	Wantan	1,163	1,010	115	1
	Neipu	2,801	2,213	127	2
	Likang	2,576	1,896	136	1
	Chouchow	2,874	1,776	160	1
	Linlo	2,136	1,774	123	1
	Chutien	1,696	1,260	134	3
	Chiatung	2,616	1,760	149	3
	Chiatung	1,381	1,341	103	1
	Changchi	1,308	1,028	127	2
	Wanluan	1,224	810	151	1
	Nanchow	1,150	1,092	105	1
Kaohsiung	Taliao	1,522	1,049	145	2
	Niaosung	1,248	1,177	106	2
	Linyuan	1,830	1,480	123	3
	Chiaotou	1,422	1,398	102	1
	Chiaotou	1,323	1,310	101	1

**Trial Planting of the Wakashima Variety in Pingtung and Kaohsiung
Areas in Spring and Fall Plantings**

Planting season	District	Test locality (Township)	Wakashima (kg./ha.)	Check variety (kg./ha.)	Index	Ranking in the whole test
Spring	Pingtung	Wantan	2,184	1,562	140	1
		Linlo	1,462	1,054	139	2
		Neipu	2,320	1,680	138	1
		Neipu	980	700	140	1
		Likang	2,540	1,725	147	1
		Chiatung	2,040	816	250	2
	Kaohsiung	Niaosung	2,130	2,130	100	3
Fall	Pingtung	Wantan	1,898	1,626	117	1
		Wantan	1,070	1,010	106	2
		Neipu	3,261	2,213	147	1
		Likang	2,120	1,896	112	3
		Chouchow	1,538	1,776	179	1
		Linlo	1,960	1,744	112	2
		Chutien	2,232	1,260	177	2
		Chiatung	3,200	1,760	182	1
		Chiatung	1,374	1,341	102	1
		Changchi	1,476	1,028	142	1
		Wanluan	1,190	810	145	2
	Kaohsiung	Taliao	1,600	1,049	153	1
		Meinung	1,860	1,660	112	1
		Niaosung	1,265	1,117	107	1
	Linyuan	2,130	1,480	143	1	

Both Acadian and Wakashima will be used primarily for late fall planting, although Wakashima can also be grown in the spring season. A small acreage of these two varieties will be tried in the fall of 1960. However, both of them are not adaptable for summer planting in southern Taiwan, for they are not sure to set seed during that climatic season.

C. Extension of a New Soybean Variety Dortchsoy for Spring Planting in Hsinchu Area in 1961

Soybean is grown in the Hsinchu area only after the extension of the first improved variety Sankuo in Miaoli in 1956. Sankuo is a very high yielding variety and has gained acreage very rapidly from 200 hectares in 1956 to some 9,840 hectares in 1960. It is now planted in Miaoli, Hsinchu, Taoyuan, Taipei and Ilan in northern Taiwan, and in Yunlin, Chiayi and Hwalien in southern and eastern parts of the Island. However, Sankuo is very sensitive to both photo-length and temperature and is consequently confined primarily to summer planting, except perhaps in Ilan and Hwalien where some spring planting is done. Therefore, as far, only one summer crop of soybean is grown in Hsinchu area, and a search for a desirable spring variety is considered a dire need.

In 1959, with the cooperation of the Miaoli Prefectural Farmers' Association, a new lot of soybean varieties, which were recognized as quite promising in their previous tests, was tried for spring planting in Houlung Township in Miaoli by the Hsinchu District Agricultural Improvement Station. Seventeen varieties were tested including Palmetto and Shihshih. Preliminary result showed that a new variety called Dortchsoy was the best. The yield of the first five best ones in the test as compared with that of Palmetto and Shihshih may be shown in the following table:

New Soybean Varieties Tried for Spring Planting in Houlung, Miaoli, in 1959

Variety	Yield per hectare(kg.)	Index	Ranking	Number of days for maturity
Dortchsoy	2,630	114.4	1	110
Kaohsiung-yu No. 1	2,620	113.9	2	110
Chichibu-mushakkin	2,600	113.0	3	110
Kaohsiung Introduction No. 19	2,440	106.0	4	105
Kouchi-daizu	2,340	101.7	5	110
Palmetto		(no harvest of seeds)		
Shihshih	2,300	100.0	6	106

In the spring of 1960, Dortchsoy, Chichibu-mushakkin and Kouchi-daizu were tried again with other seven varieties at ten localities in Miaoli and Hsinchu, whereas Kaohsiung-yu No. 1 and Kaohsiung Introduction No. 19 were dropped from the list because of their small size of beans, although they yielded rather satisfactorily previously. These varieties were planted in the later part of February and harvested in June. The results again showed that, of the ten localities where tests were made, Dortchsoy led at seven localities. The best five soybean varieties shown in the tests of 1960 may be summarized in the following table:

**Varietal Testing Conducted in 1960 in Miaoli and Hsinchu Areas Showing
Five Best Soybean Varieties in Spring Planting**

Locality	Dortchsoy		Shihshih		Kouchi-daizu		Kantou No. 13		Chichibu-mushakkin	
	kg./ha.	Rating	kg./ha.	Rating	kg./ha.	Rating	kg./ha.	Rating	kg./ha.	Rating
Chupei	1,420	1	820	7	1,250	2	1,200	3	850	6
Hsiangshan	1,390	1	870	7	1,160	2	1,080	3	960	5
Peipu	1,610	1	1,331	2	1,237	5	1,163	4	1,014	6
Paoshan	950	2	1,120	1	780	5	850	3	810	4
Nanchuan	1,650	1	1,650	1	1,400	4	1,600	2	1,500	3
Houlung	2,800	1	2,200	2	1,800	6	1,800	6	2,000	4
Miaoli	1,520	1	1,100	5	1,200	3	1,150	4	1,000	6
Touwu 1	1,390	1	640	7	1,120	2	900	3	850	4
Touwu 2	560	4	610	3	390	8	410	7	470	5
Tahu	2,110	1	1,750	3	1,750	2	1,330	9	1,475	6
Average	1,540	1	1,209	2	1,208	3	1,148	4	1,093	5

Because Dortchsoy is adaptable for spring planting in Miaoli and Hsinchu and has consistently given higher yield than other tested varieties, it was decided that a small acreage of about 50 to 100 hectares be tried in the spring of 1961 in that area.

Dortchsoy is an American variety introduced to Taiwan some years ago. It is a medium-sized plant, much taller than Shihshih but not as leafier as Sankuo. In Hsinchu and Miaoli, Dortchsoy could set seed also in summer planting, but its yield is not as good as Sankuo. Because Dortchsoy is adaptable for spring planting, it is now tried in many other places to see its regional adaptability.

D. Other New Soybean Varieties Under Experimentation

In addition to the varieties mentioned above, there are many others which are

under different stages of testing. The most hopeful ones include the following:

1. Varieties developed from cross breeding by the College of Agriculture of the National Taiwan University and the Provincial College of Agriculture at Tai-chung. These include NTU114, E27, E31, E44, E49 and F19.

2. Disease resistant varieties selected from seeds irradiated with X-rays and thermal neutrons. At present, thirty-one selected strains have been put into comparative yield test at six localities in Miaoli and Hsinchu in the summer of 1960. Any one yielding as good as the presently cultivated varieties but with a higher degree of disease resistance under natural conditions will be selected for further experimentation and commercial planting.

3. Foreign varieties showing promising performance in observation tests. In the spring and summer of 1960, a total of about 50 foreign soybean varieties, which were introduced to Taiwan formerly from different parts of the world, were put into observation tests at all the seven district agricultural improvement stations. Those showing best performance are Bilofield from the Philippines, Kim from U. S. A., Aso-masaru and Aso-musume from Japan and La Heng from Thailand.

E. Recent Introduction of New Soybean Varieties from U. S. A.

Recently, over 2,950 soybean varieties were introduced from the United States to Taiwan. This was made possible through the request of Mr. Yu-wei Cheng of the Taiwan Agricultural Research Institute when he visited the Soybean Regional Laboratory in Illinois and the Plant Industry Division of the United States Department of Agriculture in Beltsville, Maryland. Mr. Cheng was sent to the United States for a year of training in the field of upland food crop improvement in 1959 by JCRR and ICA/China under the 1959 TA Program. The varieties brought back by him represent almost a world collection and include all ten groups of soybeans planted from north to south in the continental United States. These introduced varieties are now under seed production and will be systematically tested at different parts of the Island for their regional adaptability in this part of the world and their reaction toward rust and other soybean diseases prevalent here. The possession of these genetically diversified materials of soybeans is a wealth for Taiwan as far as the soybean research and improvement works are concerned.

III. Soybean Seed Multiplication

A. Soybean Seed Multiplication System

Soybean seed multiplication system in Taiwan was established only after the extension of the Sankuo variety in 1956. It follows the same pattern as adopted for rice or wheat, dividing the seed multiplication farms into three levels: foundation, stock and extension seed farms. The first foundation seed farm was established at the Hsinchu District Agricultural Improvement Station in 1956 with the stock and extension seed farms in Miaoli Prefecture in the same year. Only one variety, Sankuo, was multiplied. Now, with the improved varieties being planted and extended in almost every part of the Island, it has become a regular province-wide seed multiplication system. The operation of soybean seed multiplication system in Taiwan may be briefly outlined in the following:

1. The foundation seed farms. The foundation seed farms are established at and operated by the district agricultural improvement stations or their branch stations in Taipei, Ilan, Hsinchu, Taichung, Tainan, Pingtung, Taitung and Hwalien. Seeds for foundation seed farms are multiplied and carefully selected by the district stations themselves and any off-types present in the fields must be dutifully and faithfully eradicated to ensure varietal purity. As the improved soybean varieties grown in different districts are not always the same, varieties to be multiplied in different district agricultural improvement stations would differ accordingly. Soybean varieties multiplied at foundation seed farms during 1959 and 1960 at different district stations may be shown in the following table:

District Station	Varieties multiplied	For stock seed farms at:
Taipei DAIS	Sankuo	Ilan and Taipei Prefectures
Hsinchu DAIS	Sankuo, Dortchsoy	Miaoli, Hsinchu and Taoyuan Prefectures
Taichung DAIS	Shihshih	Taichung, Changhwa and Nantou Prefectures
Tainan DAIS	Sankuo, Palmetto, Shihshih	Yunlin, Chiayi and Tainan Prefectures
Kaohsiung DAIS	Palmetto, Acadian, Wakashima	Kaohsiung and Pingtung Prefectures
Taitung DAIS	Palmetto, Shihshih	Taitung Prefecture
Hwalien DAIS	Palmetto, Sankuo	Hwalien Prefecture

2. The stock seed farms. The stock seed farms of soybean are established at different prefectures and operated by contract farmers under the supervision of prefectural farmers' associations or, in some cases, by prefectural governments. Seeds for stock seed farms are supplied by the district agricultural improvement stations free of charge from the foundation seed farms. The stock seed growers,

on the other hand, must sell their seeds to prefectural farmers' associations after harvest, and, to this effect, they receive certain government subsidies from the latter party to operate the farms.

3. The extension seed farms. The extension seed farms are established at different townships forming the third or final level of the soybean seed multiplication system. These seed farms are operated by contract farmers under the supervision of township farmers' associations. 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. The harvested seeds from the extension seed farms will be bought by the township farmers' associations, and when planting season comes, they will be sold or loaned to the farmers for general planting.

The operation of the whole soybean seed multiplication system may be summarized in the following table:

Level of seed farms	Operating agency	Supervising agency	Seeds supplied by	Seeds distributed to
Foundation seed farms	District agricultural improvement stations	Provincial Department of Agriculture & Forestry	District agricultural improvement stations themselves	Stock seed farms in prefectures
Stock seed farms	Contract farmers	Prefectural farmers' associations or prefectural governments	District agricultural improvement stations	Extension seed farms at township level
Extension seed farms	Contract farmers	Township farmers' associations	Prefectural farmers' associations	Ordinary farmers

B. Soybean Seed Multiplication Work During 1959 and 1960

As the acreage of the improved soybeans increases, the amount of seeds multiplied at different levels of seed farms has been proportionally increased, although the farmers may have kept some seeds of their own for planting. All seeds multiplied are subject to field and laboratory inspection, especially those kept for a period in storage before distribution. The amount of seeds multiplied in 1959 and 1960 as compared with that of the two preceding years may be shown 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.)
1957	0.35	220	6.00	5,200	158.74	166,740
1958	0.50	510	13.00	18,510	281.00	356,000
1959	1.60	1,708	28.40	31,467	666.70	791,940
1960	1.75	1,916	31.40	32,480	580.80	619,000

Varieties multiplied: Sankuo, Palmetto, Shihshih, Acadian, Wakashima and Dortchsoy.

IV. Inspection and Certification

For soybean seed multiplication farms, one field inspection is made before the maturity of seeds. After seeds are harvested, they will be sampled and sent to the Provincial Seed Testing Laboratory in Taichung for laboratory examination and certification. If harvested seeds are stored over a period of several months, they will be tested again for germination before seed distribution is made. The system of field and laboratory inspection of soybean as carried out at present in Taiwan may be tabulated as follows:

Level of farms	Sponsoring agency	Field inspecting agency	Sampling agency	Laboratory testing agency	Certifying agency
Foundation seed farms	District agricultural improvement stations	Provincial Department of Agriculture & Forestry	Provincial Department of Agriculture & Forestry	Provincial Seed Testing Laboratory	Provincial Department of Agriculture & Forestry
Stock seed farms	Prefectural farmers' associations or prefectural governments	District agricultural improvement stations	District agricultural improvement stations	Provincial Seed Testing Laboratory	District agricultural improvement stations
Extension seed farms	Township farmers' associations	Prefectural farmers' associations or prefectural governments	Prefectural farmers' associations or prefectural governments	Provincial Seed Testing Laboratory	District agricultural improvement stations

V. Soybean Seed Certification Standards

Soybean seed certification standards have been revised several times since they were formulated in 1957. The revised standards finally recommended may be presented hereunder for reference:

A. Standards for Field Inspection

1. General standards:

- a. Only one variety of soybean may be grown for seed production on a farm.
- b. The crop should not be grown on lands where soybeans were grown during the previous crop season.
- c. Soybean seed farms of various levels should not be established on lands which were used even partially for threshing soybeans or for piling threshed soybean plants during the previous crop.
- d. At the time of field inspection, the inspectors should also inspect the facilities for harvesting, drying and storing seeds to prevent mechanical mixture.
- e. Unless properly bagged and sealed, certified soybean seeds of a certain

variety should not be stored in the same building with other varieties of soybeans.

f. At least a 2.5-meter (or longer) distance should be kept between the seed farms and lands planted to other varieties of soybean. In case the other varieties of soybean are sown by broadcasting, then the separation distance should be widened to 6 meters.

g. Apparent marking signposts should be erected on the farms.

2. Specific standards:

Level of seed farms	Other varieties (maximum)	Virus and rust diseases
Foundation seed farms	None	None
Stock seed farms	0.2%	Slight
Extension seed farms	0.5%	Slight

B. Standards for Laboratory Analysis

Item	Foundation seed farms	Stock seed farms	Extension seed farms
Moisture content (max.)	12%	12%	12%
Pure seed (min.)	99%	98%	98%
Other crops (max.)	None	None	None
Other varieties (max.)	None	10 grams per kg.	20 grams per kg.
Weed seed (max.)	None	None	None
Inert matter (max.)	1%	2%	2%
Germination (min.)	85%	80%	80%

Note: The size of soybean seed sample is 1 kg.

All seed farms established in 1960 have been inspected, whereas only the seeds multiplied in the spring and summer seasons have been examined as the fall crop is still in the fields when this paper is written. The results of field and laboratory inspection may be summarized in the following table:

Field/laboratory inspection	Foundation seed farms	Stock seed farms	Extension seed farms
Field inspection			
1. Total acreage inspected (ha.)	1.75	31.40	509.95
2. Acreage meeting certification standards (ha.)	1.75	30.90	469.80
3. Acreage disqualified (ha.)	None	0.50	40.15
4. Percentage disqualified	None	1.6%	7.8%
Laboratory inspection			
1. Total amount of seeds inspected (kg.)	1,916	25,798	191,044
2. Amount of seeds meeting certification standards (kg.)	1,836	21,438	163,804
3. Amount of seeds disqualified (kg.)	80	4,360	27,740
4. Percentage disqualified	4.2%	17.0%	14.6%

From the above table, it may be seen that a considerable amount of seeds multiplied has been disqualified. This disqualification is due primarily to poor germination. It may be said that soybean seed, because of its proteinous nature, deteriorates very quickly unless it is sufficiently dried and properly stored. To provide facilities for drying and storage of multiplied seed, JCRR has, during the past few years, given financial assistance to construct over 1,000 concrete drying grounds for soybean, each being about 20 ping or 66 m² in size, at various townships; and to purchase over 1,500 air-tight aluminum cans, each enough to hold 100-120 kg. of seed, for storage purpose. In addition, eight large soybean seed granaries have been constructed at the prefectural farmers' associations in Miaoli, Hsinchu, Taoyuan, Hwalien, Yunlin, Chiayi, Kaohsiung and Pingtung to facilitate the storage of soybean seed. The total JCRR appropriation for the above three items is well over NT\$3,000,000.

VI. Processing, Storage and Distribution of Soybean Seeds

In seed processing, soybean plants, after being harvested from the fields, are usually tied into bundles and loaded on ox-carts from the fields to concrete drying grounds for sun-drying and threshing. When soybean pods are sufficiently dried, threshing will be made commonly with the help of a simple farm thresher called flail, which has a short wooden stick called swingle swinging freely at the end of a long wooden handle and beating seeds out from the pods. Empty pods and stalks are cleaned from seeds after threshing and threshed seeds are sun-dried for several days until the moisture content comes down below 12 percent. These seeds will then be further cleaned with Clipper Model M-2 Cleaner, so that all foreign matters and broken pieces can be cleaned out from the seeds. Seeds after being inspected will be stored in aluminum cans or in seed granaries, labelled with all necessary information including the name of variety, type of seeds, name of seed growers and name of the operating agency. If seeds are kept in storage for more than a period of three months, several sun-dryings are necessary, so that the moisture content of seeds will be kept under 12 percent. Germination test will be made again to determine the quality of seeds after storage when seed distribution is made at the time of planting.

Distribution of foundation seeds to stock seed growers is made by the district agricultural improvement stations through the prefectural farmers' associations free of charge. Stock seeds from stock seed growers are sold to and kept by the prefectural farmers' associations for further distribution to extension seed growers through the township farmers' associations when the planting season starts. Ex-

tension seeds from extension seed growers are bought and sold to ordinary farmers for general planting by the township farmers' associations. The prices of stock and extension seeds, after being suggested by the prefectural or township farmers' associations, must be approved by the Provincial Department of Agriculture & Forestry.

VII. Government Subsidies to Soybean Seed Multiplication

To facilitate the extension of new soybean varieties and the replacement of the old ones, the following subsidies have been given by the government for soybean seed multiplication work:

A. Appropriation of Annual Budget for Multiplication of Foundation Seeds

Foundation seeds of soybeans are multiplied by the district agricultural improvement stations and given free to stock seed growers. Expenses for operating foundation seed farms are appropriated annually by the government from its regular budget, which, during the past two years, is figured at about NT\$3,000 per hectare.

B. Subsidy to Stock Seed Growers for Multiplying Stock Seeds

Subsidy given to stock seed growers has been decreased from NT\$2,500 to NT\$1,000 per hectare during the past two years. This subsidy is still provided so that they could render extra labor for the insect and disease control work and their seed farms be subject to the governmental field and laboratory inspection. However, it is hoped that, after a few years, no government subsidy will be necessary for this item and the expenses for field work will be included in the sale of seeds.

C. Subsidy to Extension Seed Growers for Multiplying Extension Seeds

Subsidy to extension seed growers is granted on the basis of NT\$300 per hectare at present. It is also hoped that this subsidy will eventually be terminated and the expenses for operating extension seed farms will be included in the sale of seeds.

D. Subsidy for Expenses for Insect and Disease Control Work

In order to ensure that seed multiplication farms are free from insect and

disease damages, stock and extension seed growers are given a cash subsidy of NT\$100 per hectare towards their expenses for purchasing insecticides and fungicides for insect and disease control work. These insecticides and fungicides are formulated locally and may be obtained through the prefectural and township farmers' associations.

E. Subsidy for Processing, Storing and Distribution of Multiplied Seeds

This subsidy is given to the prefectural and township farmers' associations who are entrusted with the duties of processing, storing and distributing the seeds after collecting from seed growers. The subsidy for this item was calculated on the basis of NT\$0.10 per kg. during the previous years, but it has been reduced to NT\$0.05 per kg. in 1960.

F. Subsidy for Expenses for Field and Laboratory Inspection Work

With the establishment of the Provincial Seed Testing Laboratory in Taichung, the field and laboratory inspection work has been greatly strengthened. To facilitate their work, an annual appropriation of some NT\$50,000 has been made from JCRR for that purpose in addition to the budget provided by the Provincial Department of Agriculture & Forestry itself.

G. Subsidy for Supervision and Travelling Expenses

The district agricultural improvement stations as well as the operating and supervising agencies at prefectural and township levels are given by the government certain subsidy to help their work on supervising seed multiplication farms, although a part of the supervision and travelling expenses are provided from their own budgets for extension work.

H. Other Subsidies from the Government

Subsidies from the government are also given for setting up varietal demonstration plots, holding training classes and farmers' visits, publication of extension circulars, etc.

To help the government strengthen the soybean seed multiplication and certi-

fication programs, JCRR has contributed each year about NT\$400,000 for that purpose. The total amount of fund which JCRR has appropriated for the soybean improvement work, including crop improvement, seed multiplication, extension, etc. is over NT\$1,000,000 each year. 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 AND SEED PRODUCTION IN TAIWAN

S. C. Chang,¹ W. C. Li² and Y. S. Tsiang³

Only in recent years has corn become an important crop in Taiwan due to the expansion of its growing acreage as a result of the increasing demand for feed as well as food. The successful development of hybrid corn has further aroused the interest of farmers in growing this crop. One of the double-cross hybrid varieties, Tainan No. 5, gave an average per hectare yield of 5,688 kilograms of shelled corn (or 104 bushels/acre of ear corn) in the trials conducted at 26 localities in Taiwan in the autumn of 1958. This constitutes a 78% high in yield over the local farmers' variety which was used as check. It showed also maturing three to four weeks earlier than local varieties. At a provincial corn improvement conference held on July 4, 1959 it was decided that Tainan No. 5 be extended to farmers in the autumn of 1960.

Prior to extension of this new hybrid variety, a big-scale demonstration program was carried out in the autumn of 1959. Tainan No. 5 was planted on a total of 28 hectares in 35 different places in the province by 42 farmers; and the average yield of shelled corn was 5,200 kilograms per hectare, or 50 to 100 percent higher than the yields of local varieties grown in the same fields. At the same time, 300 small bags of Tainan No. 5 seed, with contents of each bag sufficient for planting on 0.05 hectare of land, were distributed free of charge to 300 farmers for trial.

Various kinds of information media such as pamphlets and radio broadcasts were employed to explain to farmers the superior qualities of this hybrid corn variety and corn cultural methods in order to pave the way for extension.

Production of double-cross seed was carried out in the spring of 1960 on 38.67 hectares, which produced a total of 51,168 kilograms of high quality seed. The seeds were extended to farmers for planting on a total of 2,030 hectares in the following autumn. Owing to the good groundwork that had been done through

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demonstration and education in the preceding year, farmers had already gained a thorough knowledge of hybrid corn. This may account for the fact that the very first extension of Tainan No. 5 covered more than 2,000 hectares, even though the selling price of hybrid seed was twice that of seed of local varieties.

In view of the need for increasing the production of corn in Taiwan, the Tainan District Agricultural Improvement Station (Tainan-DAIS) has established, with financial assistance from the Joint Commission on Rural Reconstruction (JCRR), a Corn Research Center at corn-producing Putze Township, Chiayi *hsien*. This Center will devote itself to varietal improvement, study on cultural methods, and production and extension of corn seed.

I. Varietal Improvement

The work on corn improvement in Taiwan began in the autumn of 1953 by means of controlled pollination. Three hundred and one ears of open-pollinated varieties were collected from the Tainan-Chiayi area and had been selfed three times a year for three years. Through rigid selection, a total of 36 inbred lines have been developed. Seeds of other native varieties were collected from the mountain regions of Ilan and Hwalien in 1955 and also from those of Wusheh and Hsinchu in 1958; these ushered in the second and third inbreeding projects respectively.

In order to take advantage of genetic diversity, the Tainan-DAIS introduced 70 inbred lines from the United States and tested their general and specific combining abilities. Several high combiners were selected and crossed with locally developed inbred lines, resulting in the development of seven double crosses. In the regional trials conducted at 26 localities in the province in the autumn of 1958, one of the double-crosses, (Oh43 × Oh45) × (D × C), which has been called Tainan No. 5, showed to be the best of all. It yielded, on the average, 5,688 kilograms of shelled corn per hectare, being 78 percent higher than the yield of the native check variety; and matured in about 100-105 days, which is three to four weeks earlier than the native variety. Besides, this hybrid variety showed high resistance to drought and wide adaptation to various environmental conditions in Taiwan.

In 1959, there were developed five other double-crosses. These, together with three previously tested double crosses, were put to regional trials at eleven different localities in Taiwan in the autumn of that year. Tainan No. 5 again had the highest yield, with an average of 5,373 kilograms of shelled corn per hectare, which was 75 percent higher than the yield of the native check variety.

In the autumn of 1959, seven inbred lines were developed from the materials collected in the third inbreeding project started in 1958. They were found to have the qualities of resistance to drought and early maturity to a very high degree. In the spring of 1960, 47 three-way crosses were made by crossing these seven locally developed inbred lines with single crosses which include only American inbred lines. A yield trial has been made of these three-way crosses in the autumn of the same year, but the results are not yet available at the time of writing.

In addition, seed samples of open-pollinated varieties were collected from 325 sources all over the province in the autumn of 1959. They have since been inbred for three generations.

The following are some corn breeding programs undertaken for special purposes:

A. Breeding of Drought-resistance

Most of the corn crop of Taiwan grows throughout November to January when there is little rain. The planting areas are mostly dryland with no irrigation facilities. Even in places where there is some rainfall in the planting season, its amount varies a great deal from place to place and any drought will have an adverse effect on the yield. Therefore, the best way to stabilize production is to develop drought-resistant varieties, and special emphasis has been placed on this point ever since the inauguration of the corn improvement program. That was why all inbred lines and their crosses were grown and tested in fields without irrigation. The Tainan No. 5 hybrid variety, which is highly drought-resistant, is a typical product of this program. All inbred lines in other corn breeding programs such as those mentioned below also would have to show drought-resistance before they are given combining ability test.

B. Development of Dwarf Hybrids

In the fields of sweet potato and sugarcane, where row spacing is wide, corn has been commonly grown as an inter-crop. Where corn plants get tall, they often create a problem of competing for sunlight. The only way to solve this problem is to grow dwarf corn which would not screen the sunlight from the other crops.

On the western seacoast of Taiwan where seasonal winds are very strong during the corn growing period, dwarf corn may be grown more profitably as a winter catch crop than Fan-tze-tou (a kind of garden pea), which has been commonly grown in that area.

The present project was initiated at Tainan-DAIS in 1956 shortly after three dwarf varieties were received from Cornell University of the U. S. A. Fifteen inbred lines were developed and tested in 1958 for their combining ability; but owing to the fact that their genetic diversity was not great enough, no ideal hybrids could be developed from them. In 1959, twelve dwarf inbred lines were obtained from the University of Wisconsin and Cornell University, and some of them have been found to be good combiners as indicated in the single-cross yield trial. It is expected that by the spring of 1962, some hybrid dwarf corn varieties would be available for extension.

At the same time, attempt has been made to convert Tainan No. 5 hybrid into a dwarf variety by transferring the Brachytic-2 dwarf character to the four parental inbred lines involved in the hybrid. All the inbred lines have been backcrossed three times by now.

C. Breeding for Downy

Mildew Resistance

Downy mildew is a common disease to corn and sugarcane, and it had caused serious damage to both crops in Taiwan in 1955-56. As corn is commonly grown as an inter-crop in sugarcane fields in the Tainan-Chiayi area, it is necessary to breed corn varieties which are highly resistant to downy mildew so as to prevent the disease from attacking corn itself and also from menacing the development of the sugar industry. For this purpose, a total of 105 inbred lines either locally developed or introduced from the United States were grown in the Hsinchu downy mildew disease nursery of the Taiwan Sugar Corporation in the spring of 1957, but still no downy mildew-resistant lines were found except two lines, Oh28 and Oh41, which showed slight resistance. In 1958, 155 S_3 inbred lines that had been newly developed were again tested in the disease nursery, but still no downy mildew resistant inbred lines were obtained. In the fall of 1960, another test was made of a total of 285 S_3 inbred lines and the results showed clear evidence of both disease resistance and disease susceptibility. The work is still continuing at the time of writing.

Two downy mildew-resistant inbred lines have also been introduced from The Philippines and are being tested under Taiwan conditions.

D. Development of Male-sterile

Inbred Lines

In order to do away with the trouble of detasseling during seed production,

attempt has been made to develop male-sterile inbred lines. A cytoplasmic male-sterile inbred line, Oh51A^T obtained from Cornell University has been used in making crosses with other inbred lines and in testing "restore" gene for pollen fertility.

In the autumn of 1959, Oh51A^T was crossed with inbred lines Oh43 and Oh45 which have no "restorers". At the same time, crosses were made among inbred lines, NY16, D and H, which have "restorers". In the spring of 1960, double crosses were made between the above-mentioned single-crosses and seven of the double crosses are being tested for the restoring capacity of pollen fertility as well as for yield comparison.

E. Development of Sweet Corn Inbred Lines

Six inbred lines of sweet corn were introduced from Connecticut, U.S.A., in 1957, and were planted in the same year. But owing to the occurrence of a serious leaf blight disease, they could not be multiplied, nor could they be put to combining tests.

In 1958, ten open-pollinated and hybrid corn varieties were introduced from the United States, but only two of them, Hawaiian Sugar (O.P.) and USDA-34 (O.P.), were found to be adaptable to the environment in Taiwan. Inbreeding of selected plants of Hawaiian Sugar and USDA-34 was made accordingly, and seven inbred lines resistant to leaf blight disease have since been successfully developed. Single-crosses of these lines were made and are being grown for yield comparison.

In 1959, there were eleven inbred lines introduced from Purdue University of the U.S.A. The yield trial of single crosses made between these lines showed that some cross combinations such as 81-1×471-V6, 813×471-V6, P14×P39, P39×1193, 813×81-1, and 813×S61 gave better performances. Further test is being undertaken.

II. Seed Production

A. Procedure for Seed Production

Production of hybrid corn seed for extension in Taiwan was started in 1960. In order to facilitate the production work, the PDAF has established in July 1959 the "Procedure for Multiplication and Extension of Improved Corn Varieties", which

is outlined as follows:

1. Multiplication of inbred lines.—The Tainan-DAIS will multiply parental inbred lines in accordance with the annual seed requirement.
2. Production of single-cross seed.—The Tainan-DAIS will produce single-cross seed from the seed of the inbred lines produced by the station. In case of necessity, however, the Tainan-DAIS may entrust the production work to other PDAF stations. Funds required in this connection will be provided by the Tainan-DAIS. Seed produced will be collected by the Tainan-DAIS and then sold to stations and institutes concerned for the production of double-cross seed.
3. Production of double-cross (or certified) seed.—The various district agricultural improvement stations, the Seed & Seedling Multiplication Station and other PDAF-approved stations or institutes will produce, for extension use, double-cross seed from the single-cross seed supplied by the Tainan-DAIS.

B. Seed Production in

1960

Production of double-cross corn seed was made in the spring of 1960 according to the foregoing procedure, with some modifications, by five stations and institutes entrusted by the Tainan-DAIS in the following manners:

1. Single-cross seed required for the production of double-cross seed were supplied to the stations/institutes by the Tainan-DAIS free of charge.
2. For the production of double-cross seed, the Tainan-DAIS gave the producing agencies subsidies at the rate of NT\$2,000 per ha./crop and another NT\$2,000 as an advanced payment for purchasing the seed produced from each hectare.
3. All the double-cross seed produced by the five stations/institutes were sold to the Tainan-DAIS at the market price of field corn.
4. Production method of double-cross seed was specified by the Tainan-DAIS and strictly observed by the entrusted stations/institutes. The Tainan-DAIS supervised and assisted in the implementation.
5. The seed harvested from the male single-cross parents were disposed of by the stations/institutes themselves as feed only and not as seed.

The total planting acreage of double-cross seed plots by the five stations/institutes was 38.67 hectares and total quantity of 58,805 kilograms of double-cross seed

was harvested. Deducting the lost, damaged and disqualified seed, the amount of seed actually available for extension totalled 51,168 kilograms.

Since artificial drying facilities were not installed, all of the harvested ears were sun-dried on drying grounds, shelled by motor-driven corn shellers and then the seed were separated by a seed grader into three grades, large, medium and small. On the basis of their size, the per hectare requirement of seed was estimated at 30 kilograms of large ones, 26 kilograms of medium-sized ones and 22 kilograms of small ones. Seed of respective grades were packed in cloth bags of three different sizes for planting on 0.1-, 0.2- and 0.5-hectare use. Directions for corn planting and seed inspection certificates issued by the PDAF were enclosed and attached to the seed bags respectively.

In the course of seed production, Tainan-DAIS personnel frequently visited the stations/institutes to supervise the work. Generally speaking, the whole production was satisfactory. However, since the entrusted agencies were without previous experience with this work, the amount of good seed produced was lower than the quantity expected. Furthermore, as the harvest time happened to be a rainy season and artificial drying facilities had not yet been installed, some seed were damaged and the average germination percentage slightly lowered. This was a serious problem encountered in the course of hybrid corn seed production in 1960. Now that the artificial dryer has been installed in the Corn Research Center at Putze, it is expected that no such problem will arise in future.

C. Seed Certification

All the hybrid seed produced in 1960 had been inspected and certified by the PDAF in strict accordance with the Rules and Regulations Governing Seed Certification in Taiwan which was promulgated by the PDAF in February of 1960. The following are the standards of seed certification of hybrid corn:

1. Standards for field inspection

a. General standards:

- (1) The field inspection of inbred lines, single and double crosses of corn should be held at least three times. No pre-notice will be given before conducting the field inspection.
- (2) Isolation: No isolation is needed for inbred lines. Isolation for any single or double cross is 300 m. (Note: Inspection of isolation

should be made during the first field inspection.)

b. Specific standards:

(1) Inbred lines: When more than 0.1% of off-types are found in the field or when more than 2% of doubtful plants are found at the time when 5% or more of the seed parent stalks have shed pollen, the field is disqualified for certification.

(2) Single cross:

(a) When more than 0.1% of off-types are found in the field or when more than 2% of doubtful plants are found at the time when 5% or more of the seed parent stalks have shed pollen, the field is disqualified for certification.

(b) Tassels of female parent must be taken off before shedding pollen. Two inspections will be made when all ear parents have 5% or more apparently receptive silks. A single cross will not be accepted for certification, if more than 1% of the seed parent plants are found to have shed pollen during any one of the two inspections, or if more than 2.5% of the total parent plants are found to have shed pollen during the two inspections made on different dates.

(3) Double cross:

(a) Tassels of female parent must be taken off before shedding pollen. Two inspections will be made when all ear parents have 5% or more apparently receptive silks. A single cross will not be accepted for certification, if more than 1% of the seed parent plants are found to have shed pollen during any one of the two inspections, or if more than 2.5% of the total parent plants are found to have shed pollen during the two inspections made on different dates.

(b) A double cross will not be accepted for certification if more than 0.2% of off-type plants are found.

2. Standards for laboratory analysis

a. Inbred lines and single cross:

Item	Inbred lines	Single cross
Off-type ears (max.)	0.1%	0.2%
Ears with off-colored kernels (max.)	0.2%	0.2%

Note: 1) Re-certification of the disqualified items may be applied for when proper improvements are made.

2) No dropped kernels will be regarded as certified seeds.

b. Double cross:

Item	Standards
Moisture content (max.)	13%
Pure seed (min.)	97%
Other varieties (max.)	0.2%
Inert matters (max.)	20%
Weed seed (max.)	None
Germination (min.)	85%

Note: 1) The size of ear samples of an inbred line or a single cross is 20 kg. per lot providing the lot does not exceed 1,000 kg. For a double cross, the size of seed sample is 1 kg. per lot.

2) The first field inspection of inbred lines will be conducted before tasseling. The second field inspection will be conducted at the time of pollen shedding to check the sacking and off-types.

3) The first field inspection of single and double crosses will be conducted before tasseling. The second and third field inspection will be made at the time of pollen shedding.

D. Seed Distribution

Corn seed required by government agencies or other organizations were provided directly by Tainan-DAIS, while those for farmers' use were sold through farmers' associations. Each farmer was entitled to purchase hybrid seed for planting to a maximum of 0.5 hectare.

The farmers' associations, in distributing these seeds, may deduct 7% of the sale proceeds as commission (2% for *hsien* farmers' associations, and 5% for township farmers' associations). The commission will be used as transportation and administrative expenses, and travel fees for extension workers of the farmers' associations. Since most of the farmers' associations in Taiwan are very well

organized, and also because they have agricultural extension service as one of their important activities, it is only logical to distribute hybrid corn seed through them. Extension workers of farmers' associations will not only assist in the seed sale program, but also advise farmers in the planting of corn.

The quantities of corn seed distributed in the autumn of 1960 are shown in the following table:

Distribution of Hybrid Corn Seed in the Autumn of 1960
(As of Early November)

District	Planting area (ha.)	Amount of seed (kg.)
Ilan <i>hsien</i>	20.60	458.00
Taoyuan <i>hsien</i>	10.00	220.00
Hsinchu <i>hsien</i>	40.00	880.00
Miaoli <i>hsien</i>	55.20	1,214.40
Taichung <i>hsien</i>	40.00	880.0
Taichung City	10.00	260.00
Nantou <i>hsien</i>	50.00	1,100.00
Changhwa <i>hsien</i>	143.20	3,150.40
Yunlin <i>hsien</i>	500.00	10,000.00
Chiayi <i>hsien</i>	326.50	7,838.00
Tainan <i>hsien</i>	160.50	3,650.00
Tainan City	5.20	156.00
Kaohsiung <i>hsien</i>	37.00	740.00
Pingtung <i>hsien</i>	38.30	755.20
Taitung <i>hsien</i>	200.00	4,400.00
Hwalien <i>hsien</i>	63.50	1,398.60
Sub-total:	1,700.00	37,100.60
Government agencies	227.05	5,445.20
Others	62.95	1,495.734
Free distribution and reserve for experimental use	39.95	752.10
Sub-total:	329.95	7,693.034
Total:	2,029.95	44,793.634

E. Seed Price

In order to establish a self-sustaining hybrid corn seed production and extension program which will be independent of governmental subsidies, the PDAF has adopted a policy of selling hybrid corn seed at a price higher than seed of local varieties. Adequate funds derived from the proceeds of seed sale may be accumulated and set aside for the production and extension of hybrid corn seed in the future. Some

farmers as well as extension workers who do not realize the significance of this change in policy may feel uneasy since governmental subsidies have been provided as an incentive measure for years; but, according to a sample survey among corn farmers, most of them, being aware of the fact that the hybrid corn variety yields far more than local varieties, are willing to pay the higher price for its seed. The selling price of double-cross hybrid corn seed for 1960 has been set by the PDAF at NT\$15.00 (equivalent to US\$0.37) per kilogram according to the following computation:

Item	Amount
Cost of single-cross seed	NT\$0.84
Subsidy to growers	1.68
Purchase of seed from growers	5.50
Transportation	0.40
Packing	0.46
Processing	0.37
Loss and discarding during shelling and grading	0.45
Miscellaneous cost	0.40
Extension expenses	0.85
Commission to farmers' association	1.05
Multiplication fund	3.00
Total:	NT\$15.00

III. Prospect of Hybrid Corn Extension and Problems

Hybrid corn has aroused deep interest among farmers during its first year of extension, mainly because of its excellent qualities. It may be safely predicted that the future of this new crop is very bright.

In spite of the fact that the acreage of arable land in Taiwan is limited and the competition among various crops for land is keen, the planting area for hybrid corn can still be greatly expanded as it can be grown in any of the following ways:

- A. Intercropping with other dryland crops
- B. Planting as a catch crop between two crops of rice
- C. Planting on hilly land
- D. Planting on tidal land

It is already a common practice of Taiwan farmers to interplant corn with other dryland crops, such as peanut, sweet potato, soybean, sugarcane, etc. Being early maturing as well as high yielding, hybrid corn fits easily into the intensive crop rotation systems and it will steadily replace a part of the extensive area of sweet potato. From the standpoint of feed nutrition and land use, corn is of greater value than sweet potato; and, therefore, expansion of the corn acreage would be a proper measure of agricultural development in Taiwan.

The production goals of corn for the next four years as projected by the Government of the Republic of China are as follows:

Goals for Corn Production in Taiwan for 1961-1964

Year	Acreage (ha.)	Yield per hectare (kg.)	Production (m. t.)
1961	18,000	2,100	37,800
1962	22,000	2,200	48,400
1963	24,000	2,300	55,200
1964	30,000	2,400	72,000

The hybrid corn variety, Tainan No. 5, gives a higher yield and matures earlier if planted not later than September. In the breeding program, attention is being paid to the development of hybrids which will be more suitable for late planting, say in October or November. Varieties for planting on hilly land should be highly drought-resistant and those for tidal land planting should be of the dwarf type.

Since downy mildew is one of the most serious diseases that limit the production of corn, greater efforts will be exerted on the breeding for resistance to this disease.

With respect to production and extension of hybrid corn seed, close attention will be paid to the following three major points:

A. Organization of Seed

Growers

The current practice of producing hybrid corn seed by governmental stations, or institutes is only an expedient measure for the present. For large-scale extension in the future, it will be necessary to establish a sound system organized on the basis of a commercial enterprise with governmental agencies responsible only for the multiplication of inbred lines and single-cross seed, and the production and sale of double-cross seed entrusted to the farmers themselves. In this connection, as farmers' associations are well organized in Taiwan, it will be feasible to set up

seed departments in a certain number of farmers' associations by organizing those association members who produce hybrid corn seed to handle the seed work. A small portion of proceeds derived from the sale of seed will be sent to governmental stations or institutes concerned by the farmers' associations as funds for future development and improvement of corn.

B. Seed Storage and Germination Rate

Since Taiwan is located in the subtropical and tropical zones, where temperature and relative humidity are high, storing seed under improper conditions would greatly affect seed germination. In 1960, the germination rate of some of the hybrid corn seed dropped rapidly when they were shipped to the farmers' associations and kept there for two or three months. Special attention will therefore be given to the seed storage problem. Before adequate storage facilities are available in the farmers' associations or other seed distributing agencies, it is deemed appropriate to distribute seed to various areas only when the local planting time is approaching so as to avoid long period of poor storage before the seed are used.

C. Price and Marketing

Since price, determined by the condition of supply and demand, is a decisive factor in the extension of crop acreage, these problems will need careful study. At the present time, corn is used mainly as poultry feed and supplemental foodstuff. Incentive measures will be taken to encourage farmers to replace sweet potato chips with corn as hog feed. This will greatly influence the increase of corn production and will be beneficial to both hog raisers and corn growers. With a promising market, it will be possible to keep the corn price at a level favorable to farmers.

SORGHUM IMPROVEMENT AND SEED PRODUCTION IN TAIWAN

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I. Introduction

Sorghum is a minor crop in Taiwan. Every year, about 2,200 hectares are planted in the Penghu Island (Pescadores), and 1,500 hectares in Taiwan proper. In addition, there are about 370 hectares of sorghum in Kinmen, which, municipally, belongs to Fukien Province of China. Sorghum is planted primarily in dryland areas where no irrigation water is available. Sorghum grain is used for poultry feed; but, in recent years, it has become an important raw material for preparing sorghum wine to be sold to Hongkong and other countries in Southeast Asia. The acreage and production of sorghum in Taiwan including Penghu during the past few years may be shown in the following table:

Sorghum Production in Taiwan During 1955-1959

Year	Acreage (ha.)	Production (m.t.)	Yield per ha. (kg.)
1955	3,082	1,070	347
1956	3,785	1,599	422
1957	3,916	3,132	800
1958	3,569	2,932	822
1959	3,685	3,282	891

Planting of sorghum is made largely in March and April during the spring time, and harvesting in June or early July. Therefore, only one crop is grown in a year. However, in seed multiplication, both spring and fall plantings may be made. Recently, through the improvement of varieties and cultural practices, the unit yield has been considerably increased. As may be seen from the above table, the average yield of sorghum grains in 1955 was only 347 kilograms per hectare; but, in 1959, it had been increased to some 891 kilograms per hectare.

II. Varietal Improvement

Sorghum improvement work in Taiwan is led by the Taichung District Agricultural Improvement Station (DAIS) with the cooperation of other DAIS in Hsinchu, Tainan, Taitung and Hwalien. Although the work started rather lately, new varieties have been extended for commercial planting and some new introductions including hybrid sorghums are under testing at the present time. Some accomplishments made in varietal improvement of sorghum may be briefly described in the following:

A. Extension of the Westland and Other New Sorghum Varieties in 1956

Westland is a variety introduced at the same time with other eleven varieties of sorghum from the United States in 1953 through Mr. R. H. Davis, former Commissioner of the Joint Commission on Rural Reconstruction (JCRR) in Taiwan. For three years tested in the Taichung district during 1953-55, Westland, Farr White Martin and Colby were found to be the best. These three varieties are of the dwarf type with compact head. They are more adaptable for planting in dryland areas than the native tall sorghum. Consequently, they were recommended for extension in Taiwan proper in 1956. About 800 hectares were tried that year in Taichung, Pingtung, Taitung and Hwalien. The grain yield of these three varieties together with the next two best ones and their agronomic characteristics based on the three years' average at the Taichung DAIS may be presented in the following for reference:

Performance of Five Introduced Sorghum Varieties in Yield Tests During 1953-55

Variety	Height of stalks (cm.)	Days to maturity	Type of head	Color of grains	Grain yield per hectare (kg.)
Westland	86.9	97	Compact	Brownish	3,690
Farr White Martin	90.3	103	Compact	White with black spots	3,460
Colby	92.5	101	Compact	Brownish	3,557
Leoti Red	83.9	109	Somewhat spreading	Brownish	3,359
Early Sumac	207.3	103	Compact	Brownish	2,859

Note: Spring planting.

Westland, Farr White Martin and Colby were released for extension in 1956. But, after two years of general planting, it was found that Westland was a better variety than Farr White Martin and Colby and, to simplify the extension work, only Westland was planted after 1958. The acreage occupied by these new varieties since their extension in 1956 may be shown in the following table:

Acreage Occupied by New Sorghum Varieties Since 1956

Year	Variety	Acreage (ha.)
1956	Westland, Farr White Martin, Colby	1,050
1957	Westland, Farr White Martin, Colby	1,243
1958	Westland	1,250
1959	Westland	1,400
1960	Westland	1,400

B. New Sorghum Varieties in the Regional Test

In addition to Westland released for extension in 1956, another five newly-introduced varieties of sorghum were put into regional varietal tests in 1958 and 1959 in Hsinchu, Miaoli, Taichung and Changhwa. These include DD Hegari, DD Shallu, Caprock, Redbine and 7078 with Westland as check. According to the results so far obtained, Redbine and DD Hegari yield significantly better than Westland in Hsinchu and Miaoli, and Redbine and 7078 in Taichung and Changhwa. However, when Redbine, DD Hegari and 7078 are compared, DD Hegari is more tolerant to bird damage and matures several days earlier, in spite of the fact that the yield of DD Hegari is somewhat lower than Redbine or 7078. A small acreage of seed of DD Hegari was multiplied therefore in 1960 for possible extension in the coming year. The results of the regional varietal tests conducted during the spring of 1959 and of 1960 may be summarized in the following:

Results of Regional Varietal Tests of Five New Sorghum Varieties Conducted During the Spring of 1959 and 1960 (Westland used as check)

Variety	Days to maturity	Year	Hsinchu		Miaoli		Taichung		Changhwa	
			Yield (kg./ha.)	Index	Yield (kg./ha.)	Index	Yield (kg./ha.)	Index	Yield (kg./ha.)	Index
Redbine	101-105	1959	4,250	113	5,494	117	4,734	121	4,531	96
		1960	4,580	101	4,366	102	5,997	108	4,500	102
DD Hegari	81-93	1959	4,063	108	5,278	112	2,538	64	4,065	86
		1960	4,375	96	4,172	97	5,740	104	4,000	91
7078	103-109	1959	3,750	100	4,716	100	4,593	117	4,750	101
		1960	2,950	65	2,903	68	5,810	105	5,000	114
Caprock	102-111	1959	4,063	108	5,109	108	4,359	111	3,953	84
		1960	3,400	75	3,169	75	5,940	107	4,450	101
DD Shallu	110-117	1959	2,188	58	4,266	90	3,750	95	3,166	67
		1960	2,500	55	2,445	58	4,390	79	3,500	80
Westland	99-103	1959	3,750	100	4,716	100	3,914	100	4,703	100
		1960	4,525	100	4,240	100	5,532	100	4,400	100

C. Hybrid Sorghum Varieties

Under Testing

Besides the new varieties under regional varietal tests, another group of 10 hybrid sorghum varieties and their male and female parents was introduced from the United States in 1958 by Mr. L. F. Chen of the Taiwan Provincial Department of Agriculture & Forestry. They were tested in 1959 at the Taichung DAIS. The preliminary results show that at least six hybrid varieties give higher yield than Westland and the first three of them, 69E, 78E and 67E, almost tripled the yield of the latter. The results may be shown in the following table:

Performance of Some Hybrid Sorghum Varieties Under Test Conducted During the Spring of 1959 in Taichung

Variety	Days to maturity	Height of stalks (cm.)	Yield per hectare (kg.)	Index
69E Hybrid	96	162.1	5,841.1	346
78E Hybrid	97	207.2	5,608.8	332
67E Hybrid	99	179.8	5,340.9	316
76E Hybrid	97	168.0	4,417.5	262
88E Hybrid	86	181.0	3,548.3	216
219E Hybrid	88	122.8	2,089.1	123
Westland (ck)	85	74.0	1,687.2	100
98E Hybrid	85	101.1	1,651.6	97
239E Hybrid	85	90.7	1,618.8	96
212E Hybrid	85	78.9	1,017.5	60
218E Hybrid	115	246.6	627.0	37

The parentage of the above hybrid varieties are as follows:

- 67E Hybrid—72E × (SA 6645-27-4-3 × DDE Hegari)
- 69E Hybrid—72E × (SA 6645-11-1-1 × DDE Hegari)
- 76E Hybrid—72E × (SA 6645-6-3-2 × DDE Hegari)
- 78E Hybrid—72E × Early Hegari
- 88E Hybrid—72E × Combine Bonita
- 98E Hybrid—72E × (SA 6699-3 × DDE Hegari)
- 212E Hybrid—72E × (2523-1 × Yellow Endosperm)
- 218E Hybrid—72E × DD38 Milo
- 219E Hybrid—72E × Caprock
- 239E Hybrid—72E × Plainsman

III. Sorghum Seed Multiplication

A. Sorghum Seed Multiplication System

Sorghum seed multiplication system was established after the extension of

Westland, Farr White Martin and Colby in the spring of 1956. In the first three years, only the stock and extension seed farms were established. However, since 1959, it follows the same system as adopted for rice and wheat, dividing into three levels of seed farms: foundation, stock and extension seed farms. At present, these farms are operated in the following manner:

1. Foundation seed farms—Operated only in one place in Taichung by the Taichung DAIS. Seeds used for planting are obtained from tassels which have been bagged before blooming in order to prevent stray pollination among different varieties.

2. Stock seed farms—Operated by the Taiwan Provincial Tobacco Research Institute in Taichung Prefecture, where very little sorghum is grown in nearby areas during the sorghum planting season. Seeds for the stock seed farms are supplied by the Taichung DAIS with the foundation seeds, and seeds produced from the stock seed farms are used for establishing extension seed farms.

3. Extension seed farms—Operated at present only in one place at the Seed & Seedling Multiplication Station, which is located up the mountain area in Tungshih Township of Taichung Prefecture, where no other sorghum variety is grown except Westland. The stock and extension seed farms are so established as to keep the multiplied variety in isolation with other native varieties in order to maintain the varietal purity.

B. Amount of Seeds Multiplied During 1956-1960

The amount of seeds multiplied during the years of 1957-1960 after the establishment of the sorghum seed multiplication system 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.)
1957	—	—	0.20	160	24.00	24,000
1958	—	—	0.40	320	24.00	24,000
1959	0.01	24	0.30	300	23.00	23,000
1960 (est.)	0.02	48	0.25	250	16.50	33,000

Note: Sorghum varieties multiplied in 1957: Westland, Farr White Martin and Colby; those during 1958-1960: Westland only.

The average rate of seeding per hectare is 20 kg. The extension seeds multiplied each year will be enough for planting 1,200 to 2,000 hectares.

IV. Inspection and Certification

Sorghum seed farms are subject to field inspection and one field inspection is made at the time of maturity. In 1959, after seed certification standards were formulated, seeds harvested from seed farms were sampled and sent to the Provincial Seed Testing Laboratory for examination and certification. However, as the certification system was just established and also because of the lack of enough trained field inspectors, not all of the seeds produced from different levels of seed farms in 1959 and in the spring of 1960 were sampled and certified. The seed certification standards of sorghum and the laboratory work as conducted since the spring of 1959 may be briefly presented in the following:

A. Sorghum Seed Certification Standards

1. Specific standards for field inspection:

Level of seed farms	Other varieties (maximum)	Diseases at tassels (maximum)
Foundation seed farms	None	None
Stock seed farms	None	0.02%
Extension seed farms	0.5%	0.05%

2. Standards for laboratory analysis:

Item	Foundation seed	Stock seed	Extension seed
Moisture content (max.)	13%	13%	13%
Pure seed (min.)	99%	98%	97%
Other varieties (max.)	None	None	0.01%
Other crops (max.)	None	None	None
Weed seed (max.)	None	0.1%	0.1%
Inert matters (max.)	1%	1.9%	2.89%
Germination (min.)	90%	85%	80%

Note: The size of sorghum sample is 0.5 kg.

For general standards for field inspection, please refer to a publication sent by the Chinese Delegation entitled "Rules and Regulations Governing Seed Certification in Taiwan".

**B. Seed Certification Work in 1959
and in the Spring of 1960**

Seed certification work as carried out in 1959 and in the spring of 1960 on sorghum may be reported in the following:

Crop season	Level of seed farms	Total acreage inspected (ha.)	Acreage meeting standards (ha.)	Total amount of seed produced (kg.)	Amount meeting standards (kg.)
1959 spring	Stock seed farms	0.30	0.30 (100%)	300	300 (100%)
1959 fall	Extension seed farms	23.00	23.00 (100%)	23,000	23,000 (100%)
1960 spring	Stock seed farms	0.25	0.25 (100%)	250	250 (100%)

From the table above, it may be seen that all seed farms and seeds inspected have met the certification standards.

V. Processing, Storage and Distribution of Sorghum Seeds

Sorghum in Taiwan is harvested about 100 to 110 days after planting. Desirable heads are cut off from the stalks by knife and, after being taken out from the fields, they are dried on cement grounds. When the grains are sufficiently dried, they will be threshed from the tassels and further dried to a point when the water content of the seed is below 13 percent. Threshed seeds will then be fanned with a winnower to get rid of the chaff and other inert matters and finally cleaned with a Clipper cleaner. The cleaned seeds will be stored in air-tight aluminum cans before the distribution is made, but, during the storage period, several additional dryings may be necessary in order to keep the moisture content under 13 percent.

Distribution of sorghum seeds from different levels of seed farms is now carried out in the following manner:

A. Foundation seeds produced by the Taichung DAIS are given to the Taiwan Provincial Tobacco Research Institute free of charge for establishing the stock seed farms.

B. Stock seeds produced by the Tobacco Research Institute are given to the Seed & Seedling Multiplication Station to establish the extension seed farms also free of charge.

C. Extension seeds multiplied by the Seed & Seedling Multiplication Station will be bought by the Taiwan Provincial Tobacco & Wine Monopoly Bureau

and then loaned to the farmers without interest for general planting through the prefectural and township farmers' associations. At the time of harvest, the grain sorghums produced by the farmers may be kept for poultry feed or may be sold to the Monopoly Bureau at a price parity of 16 Taiwan ounces of sorghum to 13 ounces of brown rice. Farmers are discouraged to keep their own grains for seed, as sorghum can easily become contaminated among different varieties through open pollination when grown in the farmers' fields.

For sorghum seed multiplication work, besides the annual budget appropriated by the Taiwan Provincial Department of Agriculture & Forestry, both the JCRR and the Taiwan Provincial Tobacco & Wine Monopoly Bureau have contributed every year certain amounts of funds towards the work. The total contribution made by JCRR for sorghum improvement and seed multiplication work amounts to about NT\$100,000 annually.

SUGARCANE PRODUCTION AND IMPROVEMENT IN TAIWAN

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I. Introduction

Sugarcane is believed to have been grown in Taiwan for many and many a decade. In a book written by Mr. Da Yuan Wang in 1349 during the Han Dynasty entitled "Historical Notes of Island Natives in Taiwan", the manufacture of wine from sugarcane juice was mentioned together with the manufacture of salts from sea water. This indicates that, as early as in the 14th century, sugarcane had already been planted in Taiwan. In 1624, when the Dutch conquered this Island, sugar had become an important commodity for export. The sugar industry on this Island continued to develop during the Koxinga Era and it was recorded that, in 1880, a total of 100,000 metric tons of brown sugar had been exported to Japan, Philippines and other countries in Southeast Asia. With further development of the sugar industry during the Japanese occupation, sugarcane has established itself as an important field crop and its acreage has increased in one year (1938-1939 crop) to as high as 160,000 hectares with a total sugar production of some 1,418,730 metric tons. In recent years, although both the acreage and production of sugarcane have been reduced, Taiwan still is one of the main cane growing countries in the world and sugar alone has earned for the government more than fifty percent of the total foreign exchanges received every year from commodity export.

This paper is intended to give very briefly the general background of sugarcane production in Taiwan and a few outstanding accomplishments made in the varietal,

cultural and seed improvement during the past five or ten years. For detailed information on Taiwan sugar industry and sugarcane research, voluminous papers have been published and can be obtained from the Taiwan Sugar Corporation and its Taiwan Sugar Experiment Station.

II. Cane Production in Taiwan

A. Acreage and Production

Sugarcane acreage used to compete with that of rice; but, during the past ten years, because of the rapid increase in the Island's population, food has become more important and the acreage of rice and other food crops has been greatly expanded. As a result, the acreage of sugarcane has been decreased, being not more than 100,000 hectares as compared with some 160,000 hectares in 1938-1939 just before the World War II. However, in spite of the decrease in acreage, Taiwan still can produce enough sugar for export and earns a lion share of foreign exchanges for the government. This has been possible only through the increase in unit yield of sugarcane and sugar, which, in turn, depends largely upon the improvement of cane varieties, cultural practices, seed production, insect and disease control, irrigation facilities and practices and many other factors in connection with sugarcane production operations. The following gives the cane and sugar production during the past ten years, 1949-1950 to 1958-1959, as compared with that of the first year, 1945-1946, after the War.

Cane and Sugar Production During 1949-1959 in Taiwan

Crop year	Acreage harvested (ha.)	Total cane production (m.t.)	Total sugar production (m.t.)	Cane yield per hectare (m.t.)	Sugar yield per hectare (m.t.)
1945-46*	32,624	886,390	86,074	27.17	2.63
1949-50	100,413	5,183,162	612,332	51.62	6.09
1950-51	57,723	2,820,190	350,761	48.86	6.07
1951-52	74,324	4,211,695	520,453	56.67	6.99
1952-53	98,405	7,691,118	882,141	78.16	8.96
1953-54	85,493	6,045,308	701,155	70.71	8.20
1954-55	69,829	5,703,572	733,160	81.68	10.49
1955-56	81,103	5,833,072	767,327	71.92	9.45
1956-57	88,133	6,706,960	832,749	76.10	9.44
1957-58	92,383	7,111,172	893,794	76.98	9.67
1958-59	91,130	7,718,618	939,778	84.70	10.30

* First post-war year.

The above production figures do not include the production for brown sugar, which acreage being about 3,000-4,000 hectares a year with the output of about 20,000 metric tons of brown sugar on the basis of an average of about 5-6 metric tons per hectare.

From the above table, it may be seen that both cane and sugar yields per hectare in 1958-1959 have increased by about 65 percent than those in 1949-1950 after a period of ten years. Therefore, despite the decrease of sugarcane acreage to less than 100,000 hectares in recent years, Taiwan still can produce about 800,000-900,000 metric tons of sugar a year for domestic and export uses.

B. Crop Seasons of Sugarcane

There are two main sugarcane planting seasons in Taiwan. One is during early June to late November. As a great majority of canes is planted in August and September, it is therefore called also as the fall planted cane. Canes planted in the fall season require about eighteen months of growth before they are crushed for sugar. At present, the fall planted canes occupy about 51 percent of the total planted cane acreage.

The other season in which the canes are planted is during the spring season. Planting is made primarily in the months of February and March, although it may start as early as December and end in May. Spring planted canes are harvested about twelve months after planting. As the growing period of the spring planted canes is shorter than that of the fall planted canes, the yield of the former is only about 65 percent of the latter. The spring planted canes occupy about 9-10 percent of the total cane acreage.

In recent years, with the extension of the ratoon culturing practice, a greater portion of the canes harvested during the crushing season is left for ratoon. The acreage of the ratoon cane nowadays occupies about 40 percent of the total cane acreage.

Be it the spring planted, fall planted or ratoon canes, canes in Taiwan are harvested and crushed during the season when the weather is dry and cold and when the sugar content in the stalks is at its peak. The crushing season may start as early as November and last until next May depending upon the amount of canes needed to go into the factory.

C. Sugarcane Growing Regions

Over 80 percent of the sugarcanes in Taiwan are grown in the southern part of the Island, with Tainan Prefecture alone occupying about one-fourth of the total

acreage. Therefore, the main sugarcane growing regions in Taiwan are, in the order of planted areas, Tainan, Yunlin, Chiayi, Pingtung and Kaohsiung, with some acreage of sugarcane in Changhwa Prefecture in central Taiwan. With the closing down of sugar mills in Miaoli and Hsinchu some years ago, the sugarcane acreage in northern Taiwan has been greatly reduced. At present, although some sugarcanes are still grown there, they are used primarily for preparing brown sugar by using the native crude manufacturing method. The following is the distribution of sugarcane acreage at different localities in 1958-1959 crop, both acreages for white and brown sugars being included.

Taiwan Sugarcane Growing Districts and Their Acreage in 1958-1959

Agricultural district	Prefecture/City	Sugarcane acreage (ha.)	% among total acreage
Taipei and Hsinchu	Taipei Prefecture	19	1.03
	Ilan Prefecture	341	
	Taoyuan Prefecture	20	
	Hsinchu Prefecture	305	
	Miaoli Prefecture	337	
	Total:	1,022	
Taichung	Taichung Prefecture	3,429	12.73
	Taichung City	804	
	Nantou Prefecture	2,051	
	Changhwa Prefecture	6,348	
	Total:	12,632	
Tainan	Yunlin Prefecture	16,808	58.93
	Chiayi Prefecture	15,269	
	Tainan Prefecture	25,277	
	Tainan City	1,118	
	Total:	58,472	
Kaohsiung	Kaohsiung Prefecture	9,878	21.79
	Kaohsiung City	498	
	Pingtung Prefecture	11,247	
	Total:	21,623	
Eastern Taiwan	Taitung Prefecture	2,146	5.52
	Hwalien Prefecture	3,324	
	Total:	5,470	
Grand Total:		99,219	100.00

Although the sugarcane acreage during the next few years may be further reduced under the pressure of the expansion of the acreage of rice and other food crops, localities in Tainan and Kaohsiung agricultural districts will continue to be

the most important places where sugarcane will be grown. As a matter of fact, of the 27 sugar mills now operated by the Taiwan Sugar Corporation, 21 are located in these two districts. Any improvement in sugarcane culture here will greatly strengthen the sugar industry of the Island.

D. Land for Sugarcane Culture

With rice occupying the best land of the Island, sugarcane has to be planted on the poorer land. According to the statistics compiled by the Taiwan Sugar Corporation, of some 96,241 hectares of sugarcane planted in 1958-1959 crop, over 72 percent of them is planted in the three-year rotation fields and lowland dryland fields. The distribution is somewhat as follows:

Type of Land for Sugarcane Culture in 1958-1959 in Taiwan

Type of land	Cane acreage in 1958-1959 (ha.)	Percentage (%)
Double-cropping fields	10,739	11.16
Single-cropping fields	8,618	8.95
3-year rotation fields	35,798	37.20
Lowland dryland fields	33,607	34.92
Hilly dryland fields	7,480	7.77
Total:	96,242	100.00

Three-year rotation fields are found primarily in the Tainan agricultural district, where irrigation water is applied following a three-year rotation system. According to this system, water is applied on a piece of land on a three-year rotation basis. In a year when sufficient irrigation water is given, rice crop will be grown. Then, in the following year, when only a minimum amount of water is given, sugarcane will be grown. Lastly, in the year when no irrigation water is given, dryland crops will be grown. This measure is adopted purely because irrigation water available in the Tainan district is enough only to irrigate some 50,000 hectares a year, and, since there are 150,000 hectares of cultivated lands, rice, sugarcane and upland crops have to take a three-year rotation shift in order to use the water to its best advantages.

On dryland fields, where no irrigation water is available, sugarcane has to be grown depending on the water from rainfalls. For this reason, cane yield in dryland area is usually lower than that on irrigated fields.

The acreage of sugarcane on double- or single-cropping fields has been steadily decreased in recent years. As the sugarcane is a long term crop, farmers are

reluctant to sacrifice two crops of rice on the double-cropping fields or one crop each of rice and upland crops on the single-cropping fields, unless the price of sugar is exceedingly attractive and they are paid to do it. In recent years, with the development of various kinds of intercropping methods, some canes have been planted into paddy fields thus gaining acreage on the double- or single-cropping fields.

E. Amount of Sugar Exported from Taiwan

About 87 percent of white sugar and 70 percent of brown sugar produced in Taiwan are for export. The local consumption of white sugar is about 100,000 metric tons a year, and of brown sugar about 2,000 to 10,000 metric tons a year. The amounts of sugars consumed in and exported from Taiwan during the past five years are as follows:

Amounts of Sugars Consumed in and Exported from Taiwan During 1955-1958

Year	White sugar					Brown sugar				
	Total sale (m.t.)	For local consumption		For export		Total sale (m.t.)	For local consumption		For export	
		Quantity (m.t.)	%	Quantity (m.t.)	%		Quantity (m.t.)	%	Quantity (m.t.)	%
1955	679,116	90,365	13.3	588,750	86.7	14,832	2,386	16.1	12,446	83.9
1956	822,874	90,027	10.9	732,846	89.1	19,484	4,547	23.3	14,938	76.7
1957	980,301	122,994	12.5	857,306	87.5	28,343	9,995	35.3	18,347	64.7
1958	913,547	119,075	13.0	794,472	87.0	20,492	5,837	28.5	14,655	71.5

In 1958, the earning obtained from exporting cane sugars was 51 percent of the total of all the commodities exported with rice, pineapple, tea and banana constituting only 17.41%, 4.53%, 4.12% and 3.80%, respectively. Each year, about US\$70,000,000 to US\$80,000,000 worth of foreign exchange is earned from the sale of white sugar and US\$750,000 to US\$1,000,000 from the export of brown sugar.

Both white and brown sugars are sold largely to Japan, about 200,000 metric tons of white sugar and 8,000 to 14,000 metric tons of brown sugar a year. Other countries or regions purchasing Taiwan sugars during the past are South Korea, Hongkong, Singapore and countries in Southeast Asia, Near East, Middle East, North Africa and America.

III. Sugarcane Varietal Improvement in Taiwan

A. Sugarcane Varieties Planted During Pre-war Period

The first recorded variety of sugarcane grown in Taiwan is Tekcha or bamboo

cane, a variety belonging to a different species of *Saccharum* called *S. sinense* originated previously in mainland China. It was believed to have been introduced from Fukien and Kwantung Provinces during the Koxinga Era. This variety has dominated in Taiwan for almost three hundred years, covering about 97 percent of the total acreage during the years of 1902 to 1906. Following then, it was replaced successively by Rose Bamboo, a variety belonging to *S. officinarum* and introduced from Hawaii, thin and thick stalk canes introduced from Java, and finally the variety F108 developed locally by the Taiwan Sugar Experiment Station. The varietal changes of sugarcane in Taiwan may be noted in the following table:

Varietal Changes of Sugarcane in Taiwan

Varietal change	Representative variety	Peak years	% of extension	Average cane yield per ha. (m.t.)	Average sugar yield per ha. (m.t.)
Period of bamboo cane	Tekcha	1902-06	97.0	28.22	2.13
Period of Rose Bamboo	Rose Bamboo	1910-17	94.7	29.25	2.88
Period of thin Java canes	POJ161	1922-26	84.1	42.56	4.34
Period of thick Java canes	POJ2725	1930-35	78.4	66.57	8.84
	POJ2883	1941-42	37.9	66.22	7.40
Period of F108 and F134	F108	1947-50	52.5	66.60	7.60
	F134	1953-54	23.7	71.42	9.70
Period of NCo310	NCo310	Since 1956	94.3	76.30	10.30

F108 was extended during the Japanese time, but in the years following the War II, the Taiwan sugarcane was still dominated by F108, POJ2725 and POJ2883, the acreage occupied by these three varieties alone being above 85 percent of the total planted area. However, the per hectare yield of canes was low during those years. This was because that, just after the War, cane fields were poorly managed, very little compost and fertilizers were used, canes were driven to grow on comparatively poor lands so as to increase staple food production, and lastly but not the least, the old cane varieties were found beginning to deteriorate. Therefore, in varietal improvement work of the first few years after the War, considerable effort had been made to introduce foreign cane varieties, hoping that, by any good luck, one could be selected and be made use of immediately. It may be said here that the successful introduction of NCo310 in the later years has completely changed the varietal picture of sugarcane in Taiwan in the post-war period.

B. The Extension of F134 in 1950 After World War II

F134 is the first sugarcane variety released for extension in 1950 after World War II. It was developed by the Taiwan Sugar Experiment Station from a cross between the Indian cane Co290 and Java cane POJ 2878. According to 63 regional

varietal tests conducted for four years during 1948-1951, F134 outyielded the then cultivated varieties POJ2725, POJ2883 and F108 in sugar by an average of 34 percent. In 1953-1954 crop, F134 had extended to an acreage about 23.7 percent of the total, and, at least for a short period, this variety had contributed considerably to the stabilizing of the sugar industry in Taiwan. Unfortunately, though very good in sugar yield, F134 is very weak against the wind, and, at the same time, a better cane variety, NCo310, was released for extension. Therefore, within a very short span of time, F134 was replaced by NCo310. At present, F134 occupies only less than 2-3 percent of the total cane acreage.

C. The Successful Introduction of NCo 310 During Post-war Period

NCo 310 was introduced from Natal, South Africa, in 1947. After five years of observation and regional varietal tests, this variety was found especially adaptable under Taiwan climatic and edaphic conditions. Its average yield of sugar per hectare was 50 percent higher than that of POJ2883 and almost double that of F108 when planted on poor soil. The outstanding characteristics of NCo310 are as follows:

1. Profuse tillering and high yielding ability;
2. High sugar content, higher than any sugarcane varieties planted previously;
3. Deep root system, tolerance to drought and adaptability for planting on poor soil;
4. Thin to medium stalk canes, fairly elastic and better resistant to winds than the thick canes;
5. Narrow leaves, not easily breakable by winds when planted along coastal areas;
6. Very strong ratooning ability; and
7. Appreciable resistance to most sugarcane diseases formerly rampant in Taiwan, such as downy mildew, red rot, leaf scotch and mosaic.

NCo310 was released for commercial planting in 1952, and, within a few years, its acreage increased very rapidly and, as of today, it occupies more than 94 percent of total cane acreage planted every year in Taiwan. With the extension of NCo310, the old varieties such as POJ2725, POJ2883, F108 and F134 have almost been completely wiped out at present. The acreage increase of NCo310 since its extension may be shown in the following table:

Acreage Increase of NCo310 Since Its Extension in 1952

Crop year	Acreage of NCo310 (ha.)	% of total	Average per ha. sugar yield of crop year (m.t.)
1949-50	0	0	6.09
1950-51	0	0	6.07
1951-52	79	0.10	6.99
1952-53	1,412	1.30	8.96
1953-54	39,869	42.80	8.20
1954-55	52,084	68.25	10.49
1955-56	71,534	81.62	9.45
1956-57	86,150	91.54	9.44
1957-58	92,043	94.08	9.67
1958-59	90,804	94.35	10.30

From the above table, it may be seen that the average per hectare sugar yield of the whole province has been steadily increased since the extension of NCo310 in 1951-1952 crop. Although not all of this increase is attributed totally to NCo310 alone, nevertheless, the change of the cultivated variety to NCo310 is the prime important factor, especially when the canes have to be planted on a comparatively poor soil in recent years. NCo310 gives at least the following advantages over the old varieties:

1. Increase in both the quality and yield—With very little diseased stalks harvested from NCo310, the quality of juice has been improved. The yield of sugar per hectare has increased to 10.30 metric tons in 1958-1959 as compared with that of 6.07 metric tons in 1950-1951 crop.

2. Decrease in spreading some major sugarcane diseases—Since the extension of NCo310, such diseases as downy mildew, red rot, mosaic and leaf scorch have been greatly minimized.

3. Decrease in acreage needed for seed purpose—At the time when thick cane varieties were planted, one hectare of canes could supply only the seed material for five hectares. But, with the high tillering ability of NCo310, at least 15 hectares can be planted with the seed material from one hectare of canes. This saves every year about 10,000 to 15,000 hectares of canes for seeding purpose. They could all be crushed as raw material for sugar.

4. Establishment of the ratoon planting system—When thick canes were planted, only one plant crop was grown and no ratooning was practised. Canes had to be planted every year, which involved not only the wasting of seed but also extra labor

in field operations. When NCo310 is planted, ratoon is possible and ratooning has become an established system in sugarcane culture at present in Taiwan.

D. Other Introduced Cane Varieties Released for Extension in Taiwan in Recent Years

In addition to NCo310 mentioned above, two other introduced varieties have been released for extension during the past few years. These two varieties are H37-1933 and NCo334 which may be briefly described in the following:

1. **H37-1933** This variety was developed by the Hawaiian Sugar Experiment Station, but was introduced to Taiwan in 1950 from the Philippines. After several years of testing, it was found to be especially adaptable for interplanting on paddy fields in the first crop of rice. A total of about 1,200 hectares have been planted in 1958-1959 in Taichung and Pingtung districts.

2. **NCo334** This variety was introduced to Taiwan in 1953 with several other newer NCo varieties from South Africa. After preliminary observation and regional varietal tests, NCo334 was found to outyield NCo310 in a number of places and was selected for extension in 1959. A small area is now planted in Taichung, Tainan and Pingtung districts. The performance of NCo334 in the regional varietal tests may be shown in the following table:

Performance of NCo334 in Regional Varietal Tests During 1957-1958 and 1958-1959

Locality	Crop year	Yield of cane per ha. (m.t.)		Sugar content (%)		Yield of sugar per ha. (m.t.)		Index	Soil type
		NCo334	NCo310	NCo334	NCo310	NCo334	NCo310		
Taichung	1957-58	158.8	131.1	13.86	14.67	22.6	18.6	123	Loam
	1958-59	210.5	139.1	12.63	14.06	26.6	19.6	136	Loam
Chihu	1957-58	158.1	129.9	13.53	14.70	21.4	19.1	112	Sandy soil
	1958-59	169.7	114.1	11.75	12.61	19.9	14.4	139	Sandy soil
Sankandien	1957-58	137.2	114.2	13.75	14.87	18.9	16.9	111	Sandy loam
	1958-59	173.4	132.6	11.96	13.38	20.7	17.7	117	Loam
Wanli	1957-58	149.1	129.2	13.51	15.18	20.1	19.6	103	Loam
	1958-59	163.2	127.9	14.16	14.15	23.1	18.4	126	Loam
Hsiaokang	1957-58	125.6	106.7	12.76	13.27	16.0	14.2	113	Light clay
	1958-59	143.6	98.7	12.25	12.37	17.6	12.2	144	Light clay
Chiwei	1957-58	138.2	116.8	13.22	13.46	18.3	15.7	116	Sandy loam
	1958-59	157.2	111.0	12.48	13.12	19.6	14.6	135	Sandy loam

E. New Cane Varieties Released for Extension by Taiwan Sugar Experiment Station After the War

Although many cane varieties introduced from outside have been put into extension, the Taiwan Sugar Experiment Station and its breeding stations in Pingtung

and Wantan have worked hard in producing cane varieties of their own. Every year, several hundred thousands of new seedlings were raised and propagated from the crosses made under local conditions. A total of 15 new varieties have been released for extension since 1956.

1956:	F135 and F136
1957:	F137 to F140
1958:	F141 to F144
1959:	F145 to F148
1960:	F149

F136, F138, F139, F140, F141, F142 and F147 are canes for good soil, where they yield better than NCo310. Some acreage is now planted to these varieties in Taichung and Pingtung.

F137 is a thin cane especially good for poor soil. When it is planted on sandy soil, gravelly land or saline soil in the coastal areas, it may give the yield 10 percent higher than NCo310. A small acreage is now planted along the coastal areas in Lungyen, Peikang and Hsiaolung, and on gravelly land south of Pingtung.

F144 is a variety especially adaptable for intercropping with paddy rice during the fall season. It gives a yield 15 percent higher than NCo310 when used for the same purpose.

Probably, the best variety developed so far is F146. It gives good yield and is resistant to most of the rampant diseases found in Taiwan. It is suitable for intercropping with many other field crops so as to increase the cash returns of the farmers. Furthermore, it is adaptable to a wide range of soil types, and, on good soils, it outyields NCo310 by about 10 percent. Its ratooning ability is almost as good as NCo310, although, on average, its ratoon yield is only about 90 percent of the latter. An extension of some 3,000 hectares of F146 has been planned for 1961-1962 crop.

F148 and F149 are early maturing varieties and can be harvested for crushing purpose in October or November. With these varieties, it may be possible to extend the crushing season of the mills from October to May, so as to cut down the overall milling expenses. F148 is good for both spring and fall planting; but, F149 is adaptable for fall planting only. A small acreage of these two varieties will be extended in 1961-1962 crop.

The main characteristics of the above 15 new varieties of sugarcane developed in Taiwan may be summarized in the following table:

Characteristics of 15 New Sugarcane Varieties Developed in Taiwan

Variety	Parentage	Stalk size	Adaptability or preference	Resistance against diseases				Other characters
				Downy mildew	Red rot	Mosaic	Leaf scorch	
F 135	POJ2725 × PSA 32	Large	Good loam soil	MS	R	VR	MR	Weak toward wind
F 136	F 86 × 30-1130	Medium large	Good soil	VR	MS	VR	VR	Late maturing
F 137	F 108 × Co290	Medium	Sandy poor soil, saline soil	VR	VR	VR	MR	Tolerant to drought, etc.
F 138	PT41-161 × Co356	Thick	Good soil	R	R	R	R	Weak toward wind
F 139	34-257 × POJ2878	Medium large	Good soil	MR	MR	VR	MR	Tolerant to drought
F 140	PT43-52 × CP34-79	Medium	Good and wet soil	M	MS	R	R	Short stalks, weak toward wind
F 141	PT46-150 × PT43-52	Medium	Good soil	S	R	VR	R	High yield, good internal structure
F 142	NCo310 × EK327	Medium	Good soil	VR	R	VR	R	Early maturing, high sugar content, good ratooning
F 143	F 135 × 37-1423	Medium	Fairly good soil	VR	R	VR	MR	Tolerant to wind
F 144	NCo310 × 47-1079N	Medium	Good soil, interplanting with rice in the fall	R	R	MR	R	Early maturing, tolerant to wind
F 145	POJ2878 × ? (open pollinated)	Medium large	Good soil	R	MR	R	MS	Medium to late maturing
F 146	NCo310 × PT43-52	Medium	Fairly good soil	VR	M	VR	MR	Good for intercropping, wide adaptability
F 147	H32-8560 × PT43-52	Medium large	Good soil	R	R	S	R	Not tolerant to drought
F 148	F 138 × PT48-21	Thin medium	Fairly good soil	VR	M	M	R	Very early maturing, high sugar content
F 149	PT43-52 × CP34-79	Medium	Good and wet soil	VR	M	MR	VR	Very early maturing, high sugar content, but not tolerant to drought

Note: VR—Very resistant, R—Resistant, MR—Moderately resistant, M—Medium, MS—Moderately susceptible, S—Susceptible, VS—Very susceptible.

F. Promising New Selections in Regional Varietal Tests

Besides those already released for extension, there are about 80 new selections or seedlings under different kinds of regional varietal tests. The regional tests now carried out by the Taiwan Sugar Experiment Station in cooperation with other five district sugarcane improvement stations established by the Taiwan Sugar Corporation in different districts consist of the following:

1. Regional varietal tests for spring and fall plantings
2. Regional varietal tests for ratoon planting

3. Regional varietal tests for intercropping with rice in the first and second rice crops

In 1960, a total of 113 sets of regional varietal tests of various kinds was carried out by the Taiwan Sugar Experiment Station at 22 localities in sugarcane growing districts throughout the Island. Those considered quite promising in these tests include new selections and introductions as follows:

New selections: 41-536; 53-57, 53-73, 53-2091, 53-2268; and 54-39, 54-68, 54-168.

Introductions: B37172 from Barbados; H39-3633, H40-1184 from Hawaii; NCo376 from South Africa.

In recent years, breeding for disease is considered especially important. For examples, F135, F140 and F141 were finally dropped from the extension list because of their susceptibility to downy mildew or red rot. To strengthen the disease testing work on varieties, disease nurseries for leaf scotch and downy mildew have been established respectively in Tainan and Hsinchu. All new varieties, whether it be the local selection or a foreign introduction, must be tested for two years in disease nurseries, and, only when they prove to be definitely resistant to the diseases, they are permitted to be put into regional varietal tests. For red rot and mosaic diseases, the same requirement is applied, except that the varieties are tested with artificial inoculum right in the field or in the laboratory at the Taiwan Sugar Experiment Station.

IV. Sugarcane Cultural Improvement

Before World War II, sugarcane was planted primarily in the fall season; only one plant crop was grown; the average of the crop was eighteen months old; field operations were done practically by man and animal labor with the aid of simple farm tools; and no pre-treatment of seed of any kind was practised. However, during the past ten years after the War, upon the recommendations of the Taiwan Sugar Experiment Station and the district sugarcane improvement stations, considerable changes and improvements have been made in the sugarcane cultural practices. Some outstanding ones may be briefly mentioned in the following:

A. Extension of Ratooning Cultural Practice

Ratoon culture of sugarcane was nothing new in other sugarcane-growing countries, but, in Taiwan, it was almost an epoch-making and as drastic a change as the shifting from thick cane varieties to NCo310. As a matter of fact, the adoption of the ratoon sugarcane culture was made possible only following the

extension of NCo310 after 1951. The first ratoon crop was tried in 1952 (1952-1953 crop) after the harvesting of the 1951-1952 crop, but the acreage was very small. However, in the 1953-1954 crop year, there were about 9,400 hectares of ratoon canes, occupying nearly 10 percent of the total cane acreage planted in that crop year. At present, ratoon culture has become a common practice on sugarcane in Taiwan and the acreage has increased to 40 percent of the total in 1958-1959. The expansion of ratoon sugarcane during the past few years may be noted in the following table:

Expansion of Ratoon Cane Acreage in Taiwan

Crop year	Acreage (ha.)	Percentage of total (%)
1953-54	9,402	10.1
1954-55	19,490	25.5
1955-56	28,028	31.9
1956-57	29,279	31.1
1957-58	36,784	37.5
1958-59	39,082	40.6

Ratoon canes are grown for a period of about a year, from the harvesting of the plant crop to the time of the next harvesting season. As a shorter growing period is needed, the yield of ratoon canes is about 75 to 80 percent of the plant canes. When it is calculated on per month basis, the yield of ratoon canes is actually higher than that of plant canes.

The advantages of the ratooning practice besides the shortening of cane crop period are: increase in cane acreage, better utilization of land, saving of seed material, reduction in labor for unnecessary field operation and lastly the reduced cost for sugar production. As the ratoon canes now occupy about 40 percent of the total cane acreage, the age of cane crop in Taiwan has reduced from the former eighteen months to about fifteen months at present.

B. Farm Mechanization on Taiwan Sugarcane Plantations

Of some 40,000 hectares of sugarcane plantations owned by the Taiwan Sugar Corporation, sugarcane farming has been done practically with the aid of modern farm machinery. Big tractors of different makes with their attachments have been used for preparing soil, planting seed materials, applying chemical fertilizers, loading harvested canes and many other field operations. It is estimated that, with the use of tractors, about 65 percent of the man and animal labor could be replaced.

However, as of today, farm mechanization is still confined practically on plantation farms. Small farmers, who furnish almost another two-thirds of canes for sugar, are reluctant to use big farm machinery, for they have only small farms to work on. They prefer to use such simple tools as hoe, spade, cutting knife, ox-carts, etc. It will be difficult, therefore, to modernize and mechanize the field operations on all sugarcane fields in Taiwan, unless small farms are converted into big ones.

C. Intercropping of Sugarcane With Rice on Paddy Fields

Intercropping of sugarcane with rice on paddy fields is made with the purpose of increasing the sugarcane acreage on paddy land. On heavy clay soil of weather-depending fields in the Hsinying and Chiaotou districts, where only one fall rice crop is grown, intercropping is made to increase the productivity of the land and to give the farmers a better cash return. Several methods of intercropping have been developed by the Taiwan Sugar Experiment Station and district sugarcane improvement stations. One method of intercropping is to interplant sugarcane with rice in the first rice crop in the spring season. In this case, cane seed is planted into every fifth row of rice in March to April about two or three months before the rice is harvested. Sugarcane planted in this way will be harvested in next February or March about 12 months after planting. This type of intercropping is practised at present at some localities in Taichung and Pingtung. H37-1933, a variety introduced from Hawaii, is used primarily for this purpose.

Another method of intercropping is to interplant sugarcane to rice fields in the second rice crop during the fall season. Cane seed is planted into rice rows from August to October about two or three months before the harvesting of the rice crop. Canes planted in this way will be harvested in January or February about 15 months after planting. This type of intercropping in the second rice crop is now practised on weather-depending fields in Hsinying and Chiaotou areas, where heavy clay soil is present.

In the 1958-1959 crop, there were some 6,250 hectares of intercropped canes, occupying about 7.5 percent of the total cane acreage. In 1959-1960, the acreage has increased to some 9,216 hectares, being about 9.6 percent of the total acreage. In order to get enough material for crushing purpose, the Taiwan Sugar Corporation and its sugar mills in different districts have made every effort to increase cane acreage on paddy fields by introducing new techniques in intercropping so as to increase the interest of the farmers.

D. Pre-treatment of Seed Before Planting

Treatment of seeds before planting has almost become a standard practice on plantation farms, although not all of the farmers have done the same. Several treatments are suggested, each one with its specific purpose and function. Treatment of seeds with hot water for two hours at 50°C. has been used for controlling ratoon stunting disease to which NCo310 has been found fairly susceptible. Soaking of seeds in Granosan or Agrosan GN5 solution has been used for preventing the seeds from the infection of sugarcane pineapple disease. In late fall planting or in early spring planting during the cold weather, soaking of seeds in lime water for 24 hours have been found to be effective in improving the germination of buds and accelerating the growth of young seedlings. To prevent the transmission and spreading of stunting disease from seed of NCo310, special tanks are built nowadays on plantation farms to treat the seed with hot water before planting. Seeds of new varieties must be treated also with hot water in order to be free from stunting disease before distribution is made. All these measures were not practised during the pre-war years.

E. Uses of Different Chemicals for Controlling

Insects and Weeds in Cane Fields

Many chemicals have been used for controlling insects and weeds on plantation farms. BHC and recently Aldrin are applied to control underground insects such as black beetle, white grub, white ants, wireworm, crickets and mole crickets. Warfarin baits are placed in the fields to kill wild rats which have caused considerable damage to canes during the harvesting time. The uses of chemicals and Warfarin to kill insects and rats have also been practised by the farmers. About three years ago, the Joint Commission on Rural Reconstruction (JCRR) initiated a project launching a campaign to kill field rats throughout the province. From September 1957 to March 1958, i.e. within a period of six months, a total of about 20,000,000 rats were killed through the use of some 112,658 kilograms of Warfarin. This campaign is still continued with financial assistance from JCRR.

On plantation farms, weedicides such as Karmex (1.0 to 1.5 kilogram per hectare) or a mixture of Simazin (2.0 to 2.5 kilograms per hectare) and 2,4-D (2 kilograms per hectare) have been used for controlling noxious weeds in cane fields. Only two sprays are necessary, one at the time when seeds germinate and the other about one month following the first spray.

F. Improvement in the Uses of Chemical Fertilizers and Irrigation Water

In recent years, considerable quantities of chemical fertilizers have been used for cane culture. In order to recommend the proper amounts of fertilizers to be used on different types of soils and in different districts, a rather intensive study was made by the Soils and Fertilizers Department of the Taiwan Sugar Experiment Station. At present, simple charts have been worked out so that the farmers can follow the recommendations on chemical fertilizers to their best advantages.

For water requirement of sugarcane plants during the time of growth, a rather complete study was made also by the Taiwan Sugar Experiment Station during the past few years. Now, optimum level of soil water for plant growth has been worked out, and plantation farms are able to adjust the irrigation schedule by using the soil tensiometers and gypsum blocks designed and made locally by the Taiwan Sugar Experiment Station.

V. System of Multiplication and Distribution of Planting Materials of New Sugarcane Varieties

A. Seed Multiplication System

1. Recommendation of new sugarcane varieties for multiplication, demonstration and extension—Any new variety of sugarcane, after being tested for two years in the regional varietal and disease tests and proved to be better in yield and disease resistance than the current standard variety, will be recommended by the Taiwan Sugar Experiment Station to the Sugarcane Extension Conference of the Taiwan Sugar Corporation for extension. However, after being approved by the Conference, the new variety will be tried first for a year on the Corporation-owned farms at different localities in order to demonstrate to the farmers the superiority of the new cane over the old ones. At the same time, seed of the new variety will be multiplied to facilitate the future extension. After a year of trial planting and demonstration, if the new variety is proved to be definitely superior in yield and disease resistance, it will be officially released for extension at the locality or localities where it is found to be most fit.

2. Initial multiplication of seed material of new varieties—Seed material of new sugarcane varieties will be multiplied first at the district sugarcane improvement stations in five main sugar growing districts in Taichung, Huwei, Hsinying,

Machia and Pingtung. Breeders' seed will be supplied by the Taiwan Sugar Experiment Station. Usually, as soon as one variety of sugarcane proves to be promising in regional varietal tests, the district sugarcane improvement station will begin to multiply the seed, so that, when it is decided to be extended, there will be enough seed material for distribution. Seed multiplication plots must be inspected by plant pathologists of the Stations before the canes are cut, and seed material must be treated with granosan and hot water before it is distributed.

3. Multiplication of seed material on the Corporation's plantation farms—After seed material of new varieties is multiplied at the district sugarcane improvement stations, it will then be distributed to the Corporation's own plantation farms for planting. Usually, a special seed multiplication plot is established so as to facilitate inspection and supervision.

4. Establishment of seed multiplication plots on the farmers' farms—The seed material multiplied on the plantation farms will be used primarily for their own planting. However, to facilitate the extension of new varieties, seed multiplication plots are also established on the farmers' farms. They will be operated by contract farmers under the supervision of the extension divisions of sugar mills. Seed material for contract farmers will be supplied by the plantation farms.

B. Acreage of Sugarcane Used for Seed Material During Past Years in Taiwan

Except the new varieties which will follow the foregoing seed multiplication system, the seed of the commonly cultivated varieties will be multiplied by the farmers themselves for planting. As planting of sugarcane in Taiwan is made primarily in August and September while harvesting is made in the spring time, cane stalks collected during the harvesting cannot be used for seed for planting during the fall planting season. Therefore, canes from certain acreage have to be cut for seed. Previously at the time when thick canes were planted, one hectare of fall planted canes could only furnish five hectares of seed for planting. However, after the extension of NCo310, with its high tillering ability, one hectare of canes can supply seed for at least 15 hectares. Consequentially, the acreage of canes necessarily being cut for seed during the recent years has been greatly reduced. The following gives the acreage of canes used for seed during the past ten years.

Acreage of Canes Used for Seed during the Past Ten Years in Taiwan

Crop year	Acreage of canes used for seed (ha.)	Percentage in total cane acreage (%)
1949-50	19,920	16.8
1950-51	19,389	24.6
1951-52	19,924	20.8
1952-53	9,176	8.4
1953-54	6,631	7.1
1954-55	5,246	6.8
1955-56	5,810	6.6
1956-57	5,114	5.2
1957-58	5,062	5.3
1958-59	4,687	4.9

From the above table, it may be seen that the acreage of canes needed for seed has been decreased from 19,920 hectares in 1949-1950 to 4,687 hectares in 1958-1959, thus saving about 15,000 hectares of canes for sugar extraction. Recently, Mr. T.P. Pao, Superintendent of the Huwei Sugarcane Improvement Station, and his associates have recommended a new planting method for multiplication of cane seeds. They used top cuttings of canes harvested during the spring time and planted them right after by using some 600,000 seeds per hectare instead of the regular 27,800 seeds per hectare. From this closely spaced planting, it is possible to obtain 1,300,000 to 1,500,000 cane seeds per hectare, enough to supply seeds for planting 65 to 75 hectares of canes on the basis of using 20,000 seeds per hectare. Their experimentation may be shown in the following:

Recommended Method of Planting Seed Nursery as Against the Conventional Practices (Advocated by Mr. Pao and his associates in 1960)

Seed nursery	Number of seeds used per hectare	Number of seeds multiplied per hectare	Ratio
Conventional fall planting	27,778	303,616	1:15
Conventional spring planting	27,778	209,628	1:10
Recommended close planting (Spring planting) (1)	660,000	1,318,293	1:65
(2)	660,000	1,514,395	1:75

Note: (1) Top cuttings used as seed from flowered stalks.
(2) Top cuttings used as seed from non-flowered stalks.

C. Field Inspection of Seed Multiplication Plots

As mentioned before, seeds used for planting seed multiplication plots must be treated for two hours with hot water at 50°C. At the time during the growing

period, regular inspection for diseases is made, in addition to the roguing off of the off-types. The following inspections are made by different responsible agencies:

1. Regular inspection by field worker—Regular inspection is made by the person who is assigned to take charge of the management of seed multiplication plots. He should go to the fields regularly to take notes on the diseases whenever they occur. He should make due report to the sugar mill concerned. The field inspectors of sugar mills (primarily the plant pathologists) will make spot checks at 2-month intervals based on the reports of field workers.

2. Field inspection by pathologists of sugar mills—The pathologists of the sugar mills will make annual inspection of the seed multiplication plots either established on the plantation farms or operated by contract farmers on farmers' farms. This inspection usually takes place in May every year. The pathologists will form into teams and go into the fields and inspect every row of canes for diseases. If the diseased plants reach certain specified standard, the canes in seed multiplication plots will not be cut for seed material. They will be either harvested for sugar or burned if the disease is serious.

3. Field re-inspection by pathologists of district stations—After field inspection made by plant pathologists of sugar mills, the pathologists of the district sugarcane improvement stations will re-inspect the fields and check with the reports as submitted by the field workers and pathologists of sugar mills. This re-inspection will take place each year in June and July. Only those which meet the standards will be permitted to be cut for seed.

According to the standards as established at present, any field with diseased plants of a certain major disease reaching a level of over 5 percent, it will be discarded as the seed plot. If only the ratoon stunting or chlorotic streak disease is found and no other diseases such as downy mildew or red rot are present, canes may be cut for seed if deemed especially necessary, but they must be thoroughly treated with hot water for two hours at 50°C., in order to prevent the transmission of the stunting and chlorotic diseases from seed materials.

VI. Problems Confronting Taiwan Sugar Industry

It has been mentioned before that, in earlier years in Taiwan, the cane acreage had once extended to some 160,000 hectares with a total production reaching 140,000 metric tons. However, in recent years, because of the following reasons, the cane acreage has been limited to less than 100,000 hectares with the annual production of about 800,000 to 900,000 metric tons:

A. Under the pressure of the international export quota given by the International Sugar Council and the threat of the international sugar price, Taiwan dares not to increase the cane acreage and to produce more sugar than it is able to.

B. With the constant increase of the Island's population, the need for increased rice production is more important than anything else and it has been the prime policy of the government to give rice the first priority. And, as a result, sugarcane has been driven to marginal and sub-marginal lands, while better lands are planted mainly to rice.

C. Furthermore, with the improvement in varieties and cultural practices of several upland field crops such as peanut, soybean and corn, farmers are more interested in growing these crops than sugarcane. Consequentially, many farm lands used to be grown to sugarcane have been turned to plant other field crops.

D. Other more incentive crops such as cotton, jute, tobacco have also increased in acreage in recent years.

The above problems will continue to exist in the years to come. In addition, the Taiwan sugar industry will further be faced with the following difficulties:

A. Several irrigation projects are being undertaken at present in Taiwan, and, when they are completed, over 46,000 hectares of lands, which used to be occupied by sugarcane and other upland field crops, could be supplied with irrigation water. A great majority of these newly irrigated lands will be turned to grow rice, thus curtailing further the acreage of canes.

B. About 87 percent of sugar produced in Taiwan are for export and the main purchasing countries are Japan, Iran and other countries in the Southeast Asia, Middle East and Near East. At present, many of these countries have developed or are in the process of developing their own sugar industry. Therefore, in not very distant future, there will be a strong competition for sugar market among the sugar-producing countries, and Taiwan may thus face additional difficulty in exporting its sugar.

Therefore, with all the above problems confronting the Taiwan sugar industry, the sugarcane workers here have to work harder both with their brain and hands. However, it is hoped that, through the improvement of varieties, seeds and cultural methods, the unit yield and production of canes in Taiwan can be further increased, so as to cut down the production cost and help solve the problems of the Taiwan sugar industry.

TEA IMPROVEMENT PROGRAM IN TAIWAN

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To the First Far East Seed Improvement Conference held at Taipei, Taiwan, in 1956, the Chinese Delegation had submitted a report on the tea improvement work in Taiwan presenting mainly the procedures and proceedings of the work. Since 1956, much progresses have been achieved in the course of varietal improvement of tea. This report is prepared mainly for presenting some of the important achievements in tea improvement program of Taiwan to the Third Far East Seed Improvement Workshop with the hope that participants from other countries would generously offer their valuable advices or recommendations so that the program now being carried on in Taiwan may be enlightened and benefited. For countries less advanced in this field, the experiences gained in Taiwan may help them develop their tea improvement program more efficiently and effectively for the good of the mankind.

I. Present Status of Tea Production in Taiwan

There are about 47,000 hectares (ha.) of tea plantations in Taiwan, producing some 18,000 metric tons (m. t.) of made tea annually. Within this acreage, 45,000 ha. are planted to the small leaf varieties and 1,400 ha. to the Assam tea introduced from India before World War II.

The Assam tea is principally used to make black tea for its special characters, whereas the small leaf tea varieties are being used to manufacture into fermented, unfermented and partially fermented tea. The black and green tea are typical examples of the former two groups while the Pouchong and Oolong represent the partially fermented group. According to 1959 record, 3,207,546 kg. of black tea, 3,456,169 kg. of green tea, 1,869,097 kg. of Pouchong tea, 202,401 kg. of Oolong tea and 5,000,881 kg. of secondary tea were exported to some 41 countries or regions to meet the demand of tea drinkers.

The following table indicates the acreage, yield and total production of tea in Taiwan from 1950-1959.

Year	Planted acreage (ha.)	Plucked acreage (ha.)	Per ha. yield of crude tea (kg.)	Production of crude tea (kg.)
1950	42,026.38	34,598.47	230	9,645,385
1951	42,704.04	35,705.42	246	10,502,292
1952	44,119.55	37,998.40	263	11,582,176
1953	44,654.89	39,072.53	267	11,903,361
1954	46,185.96	41,426.62	282	13,006,613
1955	47,000.03	42,808.11	312	14,680,010
1956	47,637.83	43,328.51	282	13,419,749
1957	48,005.50	44,460.58	313	15,002,186
1958	47,976.40	44,897.30	316	15,195,513
1959	48,442.40	45,336.00	341	16,507,132

From the above table, it is apparent that the unit yield of tea in Taiwan was fairly low which was mainly resulted from the poor management of tea plantations and partly due to over-plucking and also to inferior varieties.

Since 1957, the Chinese-American Joint Commission on Rural Reconstruction, in cooperation with the Pingchen Tea Experiment Station, has conducted a demonstration project by applying improved cultural practices on 276.6 ha. of tea plantations in 37 townships within five prefectures. The average yield of the demonstration plots exceeded 3,000 kg. of fresh leaves per ha. (or 750 kg./ha. of crude tea). Should these practices be widely adopted by Taiwan tea growers, coupled with the renewal of old varieties with new and high yielding varieties, the yield of Taiwan tea could be raised to a much higher level compatible to that of the principal tea-producing countries.

II. Varietal Improvement Work

As mentioned in the preceding paragraph, there are both small leaf varieties and Assam varieties grown in Taiwan. The small leaf tea varieties are being grown in the northern prefectures while the Assam tea in the central part of Taiwan.

There are two experiment stations engaged in all phases of tea improvement program in Taiwan, the Pingchen Tea Experiment Station situated in the north and the Yuchih Tea Experiment Station in central Taiwan. Because of their locations, the Pingchen Station is primarily engaged in improving the small leaf tea varieties and the Yuchih Station is devoted to improving the Assam tea varieties in Taiwan.

The varietal improvement work of these two stations may be briefly stated as follows:

A. Pingchen Tea Experiment Station

1. Multiplication and extension of Tainung No. 8 and Tainung No. 28: In 1953, the Pingchen Tea Experiment Station has released two promising tea varieties, i. e. Tainung Nos. 8 and 29, both being crosses between local and introduced tea varieties. From 1956 to 1960, the Station has propagated through layering and cutting method some 193,964 seedlings which were extended to 67 tea growers in 27 townships for planting.

2. Breeding of new varieties and demonstration: The Pingchen Station has started the hybridization work between Assam and local tea varieties. Since 1950, the Station has selected 46 promising strains out of some 338 strains from the F_1 generation. Through years of selections and experimentation, seven new varieties, i. e. Tainung Nos. 478, 501, 609, 627, 705, 716 and 1019, are selected. These seven new varieties have yielded more than 3,500 kg. of fresh leaves per ha., being two times as much as their respective parental lines. Moreover, these varieties have a combination of the promising characteristics of both the small leaf and Assam varieties in the manufacture of black tea. Starting from 1961, regional demonstration work will be carried out in Ilan, Taipei, Miaoli and Hwalien Prefectures.

3. Hybridization and selection of new varieties: From the F_1 generation of some 2,000 crosses, the Pingchen Station has made the following progresses:

- a. Advanced test:—There are 96 strains selected in 1953 which were propagated and planted in 1956. Twenty-three strains are found with high yielding capacity. The strains Nos. 402, 422 and 427 are found exceedingly promising and yielding more than 4,000 kg. of fresh leaves per ha.
- b. Plant-row test:—In 1951, 190 strains were selected. From 1956–1959, yield tests were made; 33 strains were found yielding significantly higher than the standard variety.

In 1952, 229 strains were selected. Among these selections, 48 strains gave higher yield than the Assam variety Kyang, 6 strains were found specially suitable for manufacturing the Pouchong and Oolong tea, both belonging to the partially fermented tea group.

In 1953, 110 strains were selected. According to the yield test, 9 strains were found of high yielding capacity.

4. Basic research on tea breeding:

- a. The utilization of F_1 hybrids in tea breeding:—The Station has tested 238 strains in F_1 hybrids and found that some of the hybrids yield better than the parental lines due to heterosis. The percentage of the desirable effect caused by heterosis in tea is 6.32.
- b. The relationship between the characteristics of leaf buds and the yielding capacity:—According to the results obtained by the Pingchen Station, the number of leaf buds plucked, the internodes between leaves and the weight of 100 buds are positively correlated with the yield, while the thickness of leaves is not related to the yield.

As far as the quality of tea is concerned, the longer the pubescence of leaves is, the better the quality of made black tea will be. In the manufacturing of Oolong tea, more densely distributed pubescence offers better quality in made tea.

All these findings are very helpful to the selection of promising strains and are likely to shorten the period of tea breeding.

- c. Serration of leaves:—The kinds of serrates on leaf edges have long been used as a means of differentiating the tea species. Recently the Pingchen Station has discovered a new tea variety and the leaves of which are without serration. The study of this new variety and its inheritance is currently under-way.

B. Yuchih Tea Experiment Station

1. Selection of promising strains: The Yuchih Station has selected from its Assam experimental farms three batches of a total of 84 promising lines. These lines were first multiplied by vegetative means and then tested by plant-row method. Among the 84 selections,

- a. The first lot of 29 lines was planted in 1953. Plucking and manufacturing of tea started from 1956.
- b. The second lot of 23 lines was planted in 1956. Plucking and manu-

facturing started from 1960.

- c. The third lot of 32 lines was planted in 1959. Plucking and manufacturing will be started some time in 1962.

2. Hybridization and selection of new varieties: Since 1946, the Yuchih Station has developed 1,721 hybrids from the F₁ generation. Plant-row test is now under-way. Among these hybrids, FKK No. 1, No. 5118, No. 184, No. 404, No. 303 and No. 527 are found quite promising and of high yielding capacity.

III. Multiplication and Extension of Improved New Varieties

Since tea is a perennial crop, its breeding requires a longer time than the ordinary farm crops. To date, there are only two new varieties now being extended to tea growers for planting. There are two special characteristics in tea multiplication and extension; firstly, the multiplication rate is comparatively slow due to its vegetative propagation method; secondly, the planting of new varieties is usually accepted only by growers who are to open up a new tea plantation or intend to renew their old plantation which has become unproductive. On account of these reasons, the planting of new varieties in large acreage becomes quite difficult.

The new varieties, after being released by the Taiwan Provincial Government, are multiplied by the experiment station either by layering or by cutting. The seedlings are distributed, upon request, to the prefectural governments for extension. Through the prefectural governments, tea seedlings of the new varieties are given, free of charge, to the tea growers for planting. From 1956-1960, a total of 193,964 seedlings have been propagated and distributed to 67 growers in 27 townships.

COFFEE PRODUCTION IN TAIWAN

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I. General Aspects of Coffee Production in Taiwan

Coffee was first introduced to Taiwan from Manila in 1884 followed by the introduction of another strain of Java Coffee from Bonin Islands eight years later; but it had never been developed into an important industry in the field of agriculture. In 1929, several coffee plantations were established on this Island. Its acreage gradually expanded and reached a climax of around 1,000 ha. in 1942. Most of the coffee orchards are located on the mountainous slopes in central western Taiwan and also along the east coast in Hualien and Taitung Prefectures. During World War II, the coffee acreage was drastically affected, so it dwindled down to only about 100 ha. from 1945 to 1950. Since 1954, the Joint Commission on Rural Reconstruction (JCRR) has started a rehabilitating program on coffee. In order to get the advice from experienced coffee specialist, Mr. Baron Goto, Director of the Extension Service, University of Hawaii, was invited to make a short stay in Taiwan to advise on various phases of coffee development in Taiwan. After Mr. Goto's trip, it was decided that one of the old coffee orchards situated at Yunlin Prefecture be rehabilitated first so that the local personnel could familiarize themselves with the new and improved cultural practices recently developed in more advanced countries. And it was also the policy of the concerned authority to send technical personnel to other countries for training on the modern techniques of coffee culture and to conduct the determination of the quality of green coffee bean produced in Taiwan in order to ascertain its potentiality on the world market.

The commercial coffee varieties now being grown in Taiwan belong to three groups, i.e., Arabica, Liberica and Robusta. Of these three groups, Arabica is the most popular one which occupies 257 ha. out of the total acreage, with Liberica and Robusta planted on 7.9 ha. and 1.7 ha., respectively. To date, the total coffee acreage in Taiwan is 266.6 ha. which are distributed in 9 prefectures as shown in the following table:

Coffee Acreage in Taiwan (1960)

Prefecture	Acreage (ha.)			Total
	Arabica	Liberica	Robusta	
Yunlin	126.0	0.4	0.2	126.6
Nantou	33.0	—	—	33.0
Chiayi	23.0	1.0	0.2	24.2
Pingtung	55.0	1.0	0.8	56.8
Kaohsiung	6.0	1.0	—	7.0
Tainan	2.0	—	—	2.0
Miaoli	1.0	—	—	1.0
Taitung	7.0	3.5	0.5	11.0
Hualien	4.0	1.0	—	5.0
Total:	257.0	7.9	1.7	266.6

II. Coffee Improvement Program in Taiwan

The improvement work on coffee started only five years ago when JCRR launched a program for the development of coffee production in Taiwan. Both varietal and cultural improvement works have been under-way which are briefly described as follows:

A. Varietal Improvement Work

The varietal improvement work is concentrated on the introduction of promising varieties or strains, claimed to be resistant to coffee rust and of high yielding capacity. Through introduction of promising varieties or strains followed by observation and trial planting, desirable germplasm may be adopted in the shortest length of time. From 1957 to 1958, 19 strains of Arabica coffee were introduced to Taiwan from Hawaii, the Philippine Islands and India. Most of these varieties have good quality and high yield and some of them are of rust and drought resistant varieties. The following table gives the name, characteristics and origin of such introductions:

Variety or strain	Outstanding characteristics	Origin
HAES 6434 (<i>Coffea arabica Bourbon</i>)	Good yield	Hawaii
HAES 6439 (<i>Coffea arabica Murta</i>)	Good quality	Hawaii
HAES 6549 (<i>Coffea arabica K-7</i>)	Tolerant to coffee rust	Hawaii
HAES 6550 (<i>Coffea arabica Keats</i>)	Highly resistant to rust	Hawaii
HAES 6551 (<i>Coffea arabica S. L.-17</i>)	Drought resistant and rust tolerant	Hawaii
HAES 6552 (<i>Coffea arabica S. L.-28</i>)	Highly resistant to drought and tolerant to rust	Hawaii
HAES 6556 (<i>Coffea arabica BA-8</i>)	Good yield	Hawaii
HAES 6557 (<i>Coffea arabica BA-10</i>)	Good yield	Hawaii
HAES 6559 (<i>Coffea arabicabica Kaffa</i>)	Good yield	Hawaii
HAES 6590 (<i>Coffea arabica Bombon vermelho</i>)	Good quality	Hawaii
HAES 6591 (<i>Coffea arabica Catura</i>)	Tolerant to wind and good quality	Hawaii
HAES 6634 (<i>Coffea arabica var. cumbaya</i>)	Adaptable to high elevation	Hawaii
P. I. S288 (<i>Coffea arabica</i>)	Rust resistant	Philippines
205112 (<i>Coffea arabica Kents</i>)	Rust resistant	Philippines
205939 (<i>Coffea arabica KP-228</i>)	Rust resistant	Philippines
S288	Rust resistant	India
S333	Rust resistant	India
S446	Rust resistant	India
S795	Rust resistant	India

All the introduced varieties (strains) were trial planted at Chiayi, Yunlin, Pingtung and Taitung for observation. The preliminary results indicate that HAES 6550 introduced from Hawaii is found giving better yield than other introduced strains and also highly resistant to rust and tolerant to drought. If further result confirms its performance, this variety may be multiplied for extension purpose.

For other strains, S-333 introduced from India has never been infested by coffee rust; S-288, S-446, HAES 6549 and HAES 6434 were found to show some degree of resistance to coffee rust.

The trial is still under-way.

B. Cultural Improvement Work

The cultural improvement work was focused on the studies of shade tree problem, rate of fertilization, control of coffee rust and the proper method of orchard management. These may be described hereunder:

Study on Shade Trees in Coffee Orchards. The problem of shade trees in the coffee orchards has long been a controversial contention among the coffee-producing countries. Most of the old coffee-producing countries consider shade trees in coffee orchards a necessity, while certain countries more advanced in coffee culture deem

it completely unnecessary to plant shade trees in the orchards. Like in Hawaii, where the highest unit yield of coffee in the world is maintained, no shade trees have ever been planted in the coffee orchards. On the old coffee plantations in Taiwan, *Leucena gluca* and sometimes Tung oil tree (*Aleurites fordii*) were planted as shade trees. In order to determine the effect of shade trees on coffee, a series of studies has been made since 1957. The preliminary results indicate that shading effected the yield of coffee in Chiayi, whereas, in Yunlin, the outcome was different.

Study on the Optimum Rate of Fertilization in Coffee Orchards. Although there are various recommendations on the rate of fertilization in coffee orchards, so far no standard rate of fertilizing coffee in Taiwan is available whatsoever. The application of fertilizers is important for its supplying of available nutrients to maintain normal growth. Moreover, it strengthens the vigor of the trees and renders the latter more resistant to coffee rust. Due to its dual effect, the proper application of fertilizers becomes a most important practice in modern coffee culture. With the aim to work out an optimum rate of fertilization, study has been started since 1958. According to the data compiled from two years' test, the rate of 2:1:4 (1.5 kg. per tree) seems to give better result than 3:1:4 or 1:1:4. The test is still under-way.

Control of Coffee Rust. Coffee rust (*Hemileia vastatrix*), the most serious disease which wiped out many a coffee orchard in coffee-producing countries, continues to be the most destructive disease to coffee trees. Before rust resistant strains are widely extended, spraying of controlling chemicals remains to be the only effective means in preventing rust. Through repeated tests and applications, it seems that, by spraying the orchards with Bordeaux mixture (formula 8-8 or 9-9) three times from the beginning of rainy season (June) to the end (September), very desirable result could be obtained in the prevention of coffee rust. This practice has been recommended to the coffee growers for practical use.

Application of Modern Cultural Practices. In the course of rehabilitating the coffee orchards in Yunlin Prefecture, all modern cultural practices, i.e. the multiple vertical pruning system, the method of rejuvenating old coffee trees, adequate fertilization, removal of unwanted suckers, etc., generally adopted in Hawaii have been applied in the orchards. All these practices have proven to be very successful in improving the vigor of coffee trees and in increasing the yield. These practices have also been recommended to the coffee growers for practical use.

Establishment of Demonstration Orchard. In order to extend the improved cultural practices to coffee growers, three demonstration coffee orchards were esta-

blished in July 1959 at Tung-ho, Chung-po and Kan-tou-tso. Coffee seedlings were supplied by the Chiayi Agricultural Experiment Station. Supervision was given by specialist of the Chiayi Station. All the three plots have begun to set fruit in 1960 and the average yield is 420 kg. of cherries per ha.

Multiplication of Coffee Seedlings for Distribution. The multiplication of coffee seedlings has been conducted by the Chiayi Agricultural Experiment Station and the Economic Farm of Yunlin Prefecture. In both places, sexual propagation method is being used. Since the Arabica coffee has better quality and enjoys a higher price on the world market, it is therefore chosen as the propagating material. So far, no Liberica or Robusta coffee has ever been propagated for general extension. Coffee seedlings are generally distributed to farmers at a price of NT\$ 0.5-NT\$ 1.0 per each seedling. At present, there are about 350,000 seedlings being grown in the two places enough to expand coffee acreage by 160 ha. (2,200 seedlings/ha.).

III. Prospect of Coffee Development in Taiwan

Although Taiwan is situated at the farther end of the coffee-producing belt, the growth of coffee on this Island is quite normal and the yield desirable as compared with other coffee-producing countries. The green coffee beans produced in Taiwan were sent to the States for quality determination. According to the report, Taiwan coffee is of about the same quality as the Central American products and could be sold without much difficulty in the Pacific regions. However, the world production of coffee in recent years does not offer Taiwan good chances for export. From 1960-1961, the world production of green beans is estimated at 68,900,000 bags (each bag being equivalent to 132.276 lb.); and although this amount is 15% less than the production of the previous year, it is still more than enough for the people to consume. Nevertheless, to cope with the domestic demand, the expansion of coffee planting to not more than 1,000 ha. is still a safe goal in the coffee production in Taiwan.

VEGETABLE IMPROVEMENT IN TAIWAN DURING 1959-60 THROUGH THE DEVELOPMENT OF BETTER PLANTING MATERIALS

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I. Introduction

The general picture of growing vegetable crops and the production and distribution of vegetable seeds in Taiwan have been elaborately reported and discussed in the First Far East Seed Improvement Conference held in June 1956 in Taipei, Taiwan, China, and in the Second Far East Seed Improvement Workshop held in May 1959 in Tokyo, Japan. Detailed reports on the above two Conferences were printed and distributed to different country delegations concerned for reference. Therefore, it seems not necessary to present the general information on vegetable production in Taiwan this time. What the Chinese Delegation is to report at this time are the programs on vegetable improvement through the development of better planting materials carried out in Taiwan since the two seed improvement conferences held in 1956 and 1959. Some programs have already been completed, and some are still underway. The report may be divided into the following sections, namely: (1) Varietal improvement; (2) Experiment on the multiplication of vegetable seeds at high altitudes; (3) Standard for field inspection and laboratory testing of vegetable seeds; (4) Proposed operational procedures for quality control of vegetable seeds; and (5) List of vegetable varieties exchanged between Taiwan and foreign countries during 1956-1960.

II. Varietal Improvement

A. Commercial Production of New Watermelon Variety

Watermelon (*Citrullus vulgaris*) is native of tropical Africa and is grown extensively in central and southern Taiwan. It is one of the most popular fruits for the city and rural populace in Taiwan. However, due to the degeneration of

varietal characteristics as a result of growing several varieties in the same areas for many generations, the watermelons produced have serious drawbacks with respect to the varietal trueness and the uniformity of the fruit quality. The Chinese horticultural workers have been urged to improve the situation, as watermelon is undoubtedly to remain as one of the important fruits highly demanded by people in Taiwan, an island with tropical and sub-tropical climate. Among the various selections and introductions, one variety named "Sugar Baby", a U.S. breeding variety, was recognized as the best among the introduced ones. There was no luck in selection nor in hybridization. The highlights of this new variety may be pointed out as follows:

1. Sweetness—with an average sweetness of over 12.5 Brix.
2. Hard rind—the hard texture of the rind is desirable for long distance shipping.
3. Uniform quality—fruits of this variety are of uniform quality.
4. Flesh texture—crisp texture of flesh renders excellent eating quality.
5. Fruit size—round-shaped fruit of 20 lbs. in weight is desirable for marketing.

The commercial production of new watermelon variety was made possible after being preceded with adaptation test, demonstration, extension and multiplication of pure seeds. It took more than five years for "Sugar Baby" to reach the stage of commercial production after it was introduced into Taiwan from the U.S. in 1954. The introduction was made by Mr. C.S. Wang of the Taipei District Agricultural Improvement Station. However, the adaptation test, demonstration, extension and multiplication of pure seeds of this variety were conducted entirely by the Fengshan Tropical Horticultural Experiment Station with JCRR technical and financial assistances in the past six years.

The first extension of commercial growing was made in the spring of 1959. Quality seeds, at a rate of 0.25 kg. per hectare, were distributed free to the selected watermelon growers for sowing. Sowing was made during mid-March till mid-April 1959 and the fruits were harvested in June and July 1959. The well-managed fields had a yield of 20,000 kg. per hectare. The total area extended under the projected extension program was 30 hectares. When "Sugar Baby" was shipped to Hongkong, it enjoyed a favorable market price which was far beyond the prices received by fruits shipped from other areas.

Multiplication of this variety is under the supervision of the Fengshan Tropical Horticultural Experiment Station of the Taiwan Agricultural Research Institute.

A larger scale extension of this new watermelon variety is currently under the consideration of the government authority. The acreage planted to this variety in the fall of 1959 was estimated at over 100 hectares. It is expected that 200-300 hectares of "Sugar Baby" may be planted in 1960.

Seedsmen are encouraged by the concerned agricultural stations to multiply this new watermelon variety. However, the progress is found rather slow due to the fact that the seed industry in Taiwan is still young and it will take more time before it can reach the enterprising stage of development.

B. Production of Mustard Seed of the Processing Variety "Cha-tsai"

In mustard group (*Brassica juncea*), there are numerous varieties grown on China mainland. But in Taiwan, only a few leafy type are commercially cultivated. Recently, a variety commonly known as "Cha-tsai" (var. *tumida cha-tsai*) was brought into Taiwan and grown successfully as a winter crop in the paddy fields of northern Taiwan. The seeds needed are multiplied at an altitude of 1,000 meters above sea level. The malformation of the stem (actually the swelled stem) is a peculiar feature of this variety. The swelled part remains crisp in texture even after it is processed.

The production of seeds of this mustard variety is at present limited at one farm on the east coast of Taiwan. The demand for Cha-tsai seeds is increasing from year to year, as the processing enterprise and export trade of Cha-tsai is constantly expanding. In 1959, some 100 hectares of land were planted to this variety; and, it is expected that more acreage will be devoted to this new variety of mustard in Taiwan.

The seed production on the said farm is under the constant supervision of the concerned agricultural stations. Heavy roguing was practised so as to maintain the varietal trueness.

III. Experiment on the Multiplication of Vegetable Seeds at High Altitudes

In conformity with the government policy of developing mountain resources, agricultural workers are studying hard the employment of mountain climate for agricultural production. Among the various subjects, to produce vegetable seeds at high altitudes received the first priority for consideration. It became necessary to

conduct experimentation first before any production program can be mapped out. When the experimentation proves successful, vegetable seeds of high economic value not producible on the lowland may be produced on lands of high altitudes, thus providing better land utilization of the mountain areas. According to the experiment conducted during 1959 spring—June 1960 by the Taiwan Agricultural Research Institute in cooperation with the Provincial College of Agriculture, the following results have been obtained. Cabbage, Kohlrabi and four varieties of Pai-tsai produced seeds at several spots of various altitudes, varying from 1,400 meters to 2,300 meters. It is evident that the production of certain kinds of vegetable seeds, usually the ones imported from either Japan or other temperate zone countries, at high altitudes in Taiwan is quite feasible. However, for the development of commercial scale seed production, further experimentation will still be needed for at least another two or three years.

Data derived from the experiments so far conducted may be summarized as follows:

Kind	Optimum sowing season	Seed harvesting time	Altitude (meter)
Cabbage	July—August	May of next year	1,800
Carrot	—ditto—	—ditto—	1,800
Kohlrabi	—ditto—	—ditto—	1,800
Pai-tsai (Heading and Non-heading var.)	September	March of next year	1,400

In view of the feasibility of producing certain kinds of vegetable seeds of high economic value in some mountain areas of Taiwan, further improvement of cultural practices and pest control measures will be energetically promoted with all possible means so that a commercial production of vegetable seeds could be developed within not too distant future.

The advantages of raising temperate zone vegetable seeds in tropical mountain areas so far realized are (1) perfect isolation ensuring the pureness of the seeds, and (2) the low temperature enabling the temperate zone crops to have a normal crop development in tropical zone. However, illumination and high precipitation are the two disadvantages incurred in seed production in mountain areas. Careful study of adequate control measures will be certainly needed.

IV. Standard for Field Inspection and Laboratory Testing of Vegetable Seeds

It has long been felt that the seed improvement work cannot be fully achieved unless there are complete sets of standards with which all crop seeds to be produced

may be precisely measured with scientific and biological methods so as to meet the desired requirements for improved crop production. Following the views and experiences exchanged during the First and the Second Far East Seed Improvement Workshops and being convinced of the importance of employing such standards for improving seed quality, vegetable workers of various agricultural stations have worked out jointly a set of seed standard for field inspection and laboratory testing of vegetable seeds. This set of standard has become an integrated part of the "Seed Minimum Certification Standards" inaugurated by the Taiwan Provincial Department of Agriculture & Forestry in February 1960. Along with the standards, regulations and rules governing seed certification in Taiwan, China, have also been officially promulgated.

Since there are numerous kinds of vegetable seeds produced in Taiwan, it would be difficult to establish separate sets of standards for each kind of vegetable crop. Therefore, vegetable seeds of major economical importance are classified into nine groups as follows:

1. Cabbage group: cabbage, Kohlrabi, cauliflower and broccoli
2. Pai-tsai group: Chinese cabbage and many kinds of Pai-tsai
3. Mustard group: Mustard and Cha-tsai
4. Radish group: all edible radishes
5. Lettuce group: stem lettuce
6. Onion group: Welsh onion
7. Melon group: cucumber, watermelon and pickling melon
8. Bean group: pea, string bean and lima bean
9. Solanum group: tomato, eggplant, sweet pepper and potato

The standard for field inspection covers mainly the following phases:

1. The requirements of seed farms of all the three levels, namely, foundation, stock and extension seed farms, covering limit on the number of varieties grown on each farm, minimum crop rotation period, minimum facilities for harvesting and storing the seeds, and isolation of the farms from other fields.

2. The requirements of seeds, covering maximum allowance for other crop or variety, minimum specific disease infestation permissible for each level of seed farm, etc.

The standard for laboratory testing includes the following items specified for each level of seed farm:

1. Maximum allowance for moisture content
2. Minimum amount of pure seeds
3. Maximum allowance for other crop or variety contaminated
4. Maximum allowance for weed seeds
5. Maximum allowance for inert matter
6. Minimum percentage of germination

The maximum allowance for moisture content of one group of vegetable seeds varies with that of another; and the same is true with other items of the standard set forth at present time. It would require a separate standard for each kind of vegetable within one group in later date when modifications are made possible on the present standard during the course of its implementation. It would be necessary to have such modifications made on the present standard as it is just newly-stipulated and may possibly be incomplete or inadequate for actual implementation.

V. Proposed Operational Procedures for Quality Control of Vegetable Seed

A. Scope of Vegetable Seed Certification

In Taiwan, since the majority of vegetable seeds is produced by individual growers on a self-supplying basis, it is rather difficult to place all the vegetable seed produced under government certification at the beginning. Therefore, as a start, the following vegetable varieties of higher marketing and economic value have been selected in 1960 for seed certification:

1. Radish var.: Mei-nung, Mai-hua and Dah-pai-chee
2. Cabbage var.: Native heat resistant variety
3. Kohlrabi var.: Kinmen early
4. Mustard var.: Cha-tsai and leaf mustard
5. Tomato var.: Manalee
6. Cauliflower var.: Fengshan
7. Watermelon var.: Sugar Baby

B. Purpose

Beginning fall 1960, in order to exercise effective quality control of vegetable seeds produced in Taiwan, seeds of the above varieties produced from the foundation, stock and extension seed farms are subject to field inspection and laboratory testing for their varietal trueness, vitality and purity.

C. Operational Procedures

1. Upon receipt of the planting materials from the upper level farm, each seed farm is required by the Provincial Department of Agriculture & Forestry to submit its seed production plan before or immediately after planting. The plan shall indicate clearly the source of planting materials, varietal name, size and location of the seed farm, its expected production, planned distribution of the seeds to be produced, and the name and address of the seed farm operator.

2. Upon submission of the production plan to the Provincial Department of Agriculture & Forestry by the individual seed farm, the Department and its subordinate stations concerned will, at proper time, dispatch technical personnel to make spot checks on the varietal trueness of the crop. Immediately after the completion of the field inspection, the farm operator will be notified of the results by the inspector on the spot; and, at the same time, a copy of the inspection record will be forwarded to the Provincial Seed Testing Laboratory for reference to facilitate its testing of the seeds in later course. At the time of seed harvest, samples will be collected from the seed farm by personnel sent by the Provincial Seed Testing Laboratory for testing. When the result turns out to be satisfactory and meeting the standard, a certificate will be issued to the seed farm by the Laboratory on behalf of the Provincial Department of Agriculture & Forestry, thus entitling the operator of the farm to sell his seeds with government certification.

Appendix to:

VEGETABLE IMPROVEMENT IN TAIWAN DURING 1959-60
THROUGH THE DEVELOPMENT OF BETTER PLANTING MATERIALS

List 1. Vegetable Varieties Sent to Foreign Countries During 1956-60

Date	Kind	Variety	Recipient country
Aug. 12, 1956	Strawberry	Wild strawberry	U. S. A.
Aug. 18, 1956	Pai-tsai	Fengshan Pai-tsai	U. S. A.
Mar. 4, 1957	Ginger	Wild ginger	U. S. A.
Apr. 3, 1957	Cauliflower	1) Fengshan Hsia Shang 2) Fengshan Extra Early	Philippines
	Eggplant	Pingtung Black Long	
	Pai-tsai	Fengshan Pai-tsai	
	Pea	Taichung No. 9	
	Tomato	Taichung No. 3	
May 17, 1957	Taiwan spinach		U. S. A.
	Chinese cabbage		
	Pai-tsai	Fengshan Pai-tsai	
	Cucumber	1) Japanese variety 3) Chinese variety	
	Edible Amaranth		
	Cabbage	Kinmen cabbage	
July 16, 1957	Broad bean	1) Hsinchu Yu No. 2 2) Hsinchu Yu No. 6	U. S. A.
	Pai-tsai	Fengshan pai-tsai	
	Eggplant	Pingtung Black Long	
	Cauliflower	1) Fengshan Hsia Shang 2) Fengshan Extra Early	
	Green Pea	Taichung No. 9	
	Tomato	Taichung No. 3	
Mar. 4, 1958	Snap bean	I-li	Vietnam
	Pumpkin	Improved long type	
Mar. 8, 1958	Watermelon	1) Ta-Ho Yellow 2) Ta-Ho Iron Rind	Malaya
June 26, 1958	Watermelon	Ta-Ho Yellow	Malaya
July 14, 1958	Watermelon	Ta-Ho Yellow	Vietnam
July 22, 1958	Tomato	Taichung No. 3	Vietnam
	Cucumber	Improved Green Skin	
	Field pea	Pai-Hwa-Chuan-Chia	
Mar. 4, 1959	Cucumber	1) Native Green Skin 2) First of Autumn 3) Fu-Shi-Na-Li	Thailand
	Pickling melon	Green skin	

List 1. (Continued)

Date	Kind	Variety	Recipient country		
Mar. 11, 1959	Soup celery	1) Early Green 2) Yellow Heart	Thailand		
	Water convolvulus	Big Leaf			
	Edible Amaranth	Native White			
	Vegetable sponge	Taiwan Native			
	Tomato	Victor			
	Broccoli	Italian Green			
	Wax gourd	Taiwan Native			
	Eggplant	Pingtung Black Long			
	Sweet pepper	Ruby King			
	Radish	Taiwan Native Summer			
	Pai-tsai	Fengshan Pai-tsai			
	Asparagus bean	Native Green Pod			
Mar. 21, 1959	Pole bean	Kimugasa	U. S. A.		
	Pea	Taichung No. 9			
Apr. 6, 1959	Cucumber	First of Autumn	Laos		
	Pickling melon	Green Skin			
	Soup celery	Early Green			
	Water convolvulus	Big Leaf			
	Edible Amaranth	Native White			
	Pole bean	Kimugasa			
	Asparagus bean	Native Green Pod			
	Pai-tsai	Fengshan Pai-tsai			
	Apr. 21, 1959	Radish		1) Taiwan Native Summer 2) Mei-nung Early	Vietnam
		Tomato		Victor	
		Broccoli		Italian Green	
		Eggplant		Pingtung Black Long	
Sweet pepper		Ruby King			
Cabbage		Taiwan Native			
May 14, 1959		Rapeseed	1) Taichung Special No. 1 2) Chin-chi No. 32	India	
May 20, 1959		Cauliflower	1) Fengshan Mid-Season 2) Fengshan Early-Season	Thailand	
		Cauliflower	Fengshan Mid-Season		
Aug. 12, 1959		Sweet pepper		Laos	
Oct. 19, 1959		Broad bean	Hsinchu Yu No. 2	North Borneo	
Oct. 30, 1959	Garlic		Thailand		
Oct. 30, 1959	Garlic		Philippines		
Nov. 13, 1959	Chiao-pai	(<i>Zizania aquatica</i> L.)	Thailand		
Dec. 23, 1959	Broad bean	1) Hsinchu Yu No. 2 2) Hsinchu Yu No. 6	East Pakistan		

List 1. (Continued)

Date	Kind	Variety	Recipient country
Apr. 4, 1960	Eggplant	Pingtung Black Long	Paraguay
	Pai-tsai	Fengshan Pai-tsai	
	Pai-tsai	Fengshan Pai-tsai	
	Asparagus bean	Native Green Pod	
	Wax gourd	Native Variety	
	Cabbage	Native Variety	
	Leaf mustard	Native Variety	
	Table use soybean	Fengshan Green Early	
Apr. 14, 1960	Stem lettuce		Laos
	Rapeseed	Taichung No. 1	
	Cucumber	First of Autumn	
	Pickling melon	Green Skin	
	Water convolvulus	Big Leaf	
	Edible Amaranth	Native White	
	Asparagus bean	Native Green Pod	
	Pai-tsai	Fengshan Pai-tsai	
	Radish	Taiwan Native Summer	
	Tomato	Victor	
June 27, 1960	Cucumber	First of Autumn	France
	Pickling melon	Green Skin	
Sept. 22, 1960	Water convolvulus	Big Leaf	Philippines
	Edible Amaranth	Native White	
	Asparagus bean	Native Green Pod	
	Pai-tsai	Fengshan Pai-tsai	
	Radish	Taiwan Native Summer	
	Tomato	Victor	
	Watermelon	Sugar Baby	
	Tomato	Manalee	
	Sweet pepper	Ruby King	
	Eggplant	Pingtung Black Long	
Sept. 28, 1960	Cucumber	Improved Long Green	East Pakistan
	Broad bean	1) Hsinchu Yu No. 2 2) Hsinchu Yu No. 6	
Sept. 29, 1960	Eggplant	Pingtung Black Long	Nepal
	Pai-tsai	Fengshan Pai-tsai	
	Pai-tsai	Fengshan Pai-tsai	
	Cucumber	First of Autumn	
	Tomato	Victor	
	Pickling melon	Green Skin	
	Radish	Taiwan Native Summer	
	Water convolvulus	Big Leaf	
Asparagus bean	Native Green Pod		

List 2. Vegetable Varieties Introduced from Foreign Countries During 1957-60

Date	Kind	Variety	Supplying country	Result
Feb. 24, 1957	New Zealand spinach		U. S. A.	Good for fall planting
Oct. 1, 1957	Melon	Hamil Melon	Greece	Seedlings died from damping-off
	Broad bean	1-inch Broadbean	Japan	Not adaptable
November 1957	Irish potato	1) Kennebec 2) Merrimack 3) Saco 4) Katahdin 5) Red Lacodo 6) Teton 7) B-595-76 8) X-927-3 9) Sebago 10) Pontiac 11) Sequoia 12) Triumph 13) Pimgo 14) Cherokee 15) Huron 16) Delus 17) Early Gem 18) Boone 19) Plymouth 20) Tawa	U. S. A.	No conclusion (ditto)
Jan. 16, 1958	Musk melon	Petelee	Greece	Failed
Jan. 22, 1958	Irish potato	1) Kennebec 2) Nungling No. 1 3) Mary Queen	Japan	No conclusion (ditto) (ditto)
June 11, 1958	Cauliflower Lettuce Radish Garden pea Tomato Spinach Lady's finger (bean)		East Pakistan	Failed (ditto) (ditto) Heat resistance observed No conclusion (ditto) Heat resistance observed
Oct. 21, 1958	Kale	1) Siberian 2) Dwarf Curled Scotch	New Orleans, U. S. A.	Good for fall planting (ditto)

List 2. (Continued)

Date	Kind	Variety	Supplying country	Result
Nov. 4, 1958	Leaf mustard	1) 80-day Powdery Green Bone	Hongkong	Excellent
		2) Late-flower Green Bone		(ditto)
		3) Mid-flower Green Bone		(ditto)
Jan. 10, 1959	Sunflower	Russian Mammoth	Vietnam	Good
Apr. 21, 1959	Irish potato		Singapore	No conclusion
Nov. 2, 1959	Broccoli	1) Texas 107	U. S. A.	Low yield
		2) Green Italian		(ditto)
Feb. 15, 1960	Watermelon	Charleston Gray	U. S. A.	Good
	Muskmelon	1) Hearts of Gold		No conclusion
		2) Golden Beauty Casaba		(ditto)
Feb. 18, 1960	Melon	Honey Dew	Japan	(ditto)
	Carrot	1) Koyo 5-inch		(ditto)
		2) Koyo 5-inch (Kuroda-kei)		(ditto)
		3) Yokono 3-inch		(ditto)
		4) MS 3-inch		(ditto)
	Pea	1) Matsubara Pea		(ditto)
		2) Seikai No. 2		(ditto)
3) F6 (Akabanax Osaya)		(ditto)		
July 18, 1960	Lima bean	1) Bush Lima Bean	U. S. A.	(ditto)
		2) Pole Lima Bean		(ditto)
	Bean	Bush Bean (Stringless Green Pod)		(ditto)
July 18, 1960	Edible Pod Pea	Auaoua Sugar-C	Hawaii	(ditto)
	Cauliflower	Pua Kea 75		(ditto)
Sept. 15, 1960	Rapeseed	Janetzky	France	(ditto)
	Melon	Langchow Hamil Melon	Hongkong	(ditto)
Sept. 26, 1960	Radish	1) Chinese Chungpii	Korea	(ditto)
		2) Minong		(ditto)
		3) Simoo		(ditto)
		4) Ulsan		(ditto)
		5) Kung-Chong		(ditto)
	Chinese cabbage	1) Chung-Bang		(ditto)
		2) Autumn-Yaki		(ditto)
		3) Spring-Yaki		(ditto)
		4) Jik-Nye		(ditto)
		5) Seoul		(ditto)

DEVELOPMENT OF RAPE SEED PRODUCTION IN TAIWAN

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I. Introduction

Rape seed (*Brassica Napus*) was planted mainly for green manure and some for oil. As green manure, the crop is plowed-under into the paddy field as soon as it reaches the stage of full plant development while not blooming yet. The soil fertility of the field will then be replenished with additional supply of organic matters which are essential to the improvement of soil texture of a paddy field. For oil, the rape seed is pressed and processed into seed cakes, which are used as an important fertilizer in tobacco farming, and the oil obtained therefrom is collected for cooking purpose.

The shortage of edible oil supply in Taiwan has been a serious problem to the entire populace. With the total population increased to over 10 million, the annual requirement for edible oil supply on this Island is at present around 50,000 metric tons. Of this amount, the local production of peanut and soybean oil provides about 20,000 metric tons, while the remaining 30,000 metric tons or more are supplied by extracting oil from the imported soybean, primarily under the U.S. Aid Commodity Program. Consequently, considerable work on promoting the local oil production has been done by the local agricultural research and extension agencies since 1953. Rape seed was selected as one of the sources of edible vegetable oil. It is generally recognized that, although the rape seed improvement work in Taiwan had a rather late start and the improved varieties, developed within a short period of less than six years, were not released for extension until the fall of 1959, the improved varieties have had a considerably wide range of growing area. The acreage as occupied by these new varieties in 1959 is 4,027 hectares which is estimated as 55% of total rape seed acreage. The projected acreage of new varieties for the fall planting of 1960 is 12,000 hectares which will be 80% of the total acreage.

II. Varietal Improvement

A. The Native Varieties

Rape seed is planted in Taiwan in the fall (September to October). The native variety, Lung-ching, is believed to have been brought into this Island from the Fukien Province of the southeastern part of China proper. After many generations of planting in Taiwan without undergoing scientific improvement, the said variety had gradually lost its purity and yielded poorly, averaged at less than 300 kg. per hectare. The seed contained low oil content, which occupied only less than 30% of the seed weight on the average. Therefore, the native variety was planted largely for green manure purpose and only a limited acreage in Taichung, Changhua and Miaoli Prefectures was planted to it as a winter crop. Growers near the coast in the named prefectures occasionally extract oil from the seeds for edible oil. In a word, the native variety was not planted for an important economic crop in the past by the farmers of this Island.

B. Introduction of New Varieties

Viewing from the fact that growing of native rape seed variety under the Taiwan climatic conditions was possible, it was deemed feasible to produce vegetable oil from the rape seed on a larger scale when better varieties are planted. With the purpose of increasing the unit yield and the oil content for local rape seed production, rape seed improvement work was started in 1953 at the Hsinchu and Taichung District Agricultural Improvement Stations (DAIS) in cooperation with JCRR. As direct introduction of varieties was believed the short-cut and the most economical way toward varietal improvement among the existing ways, the six varieties, i. e. Esakuro, Chin-chi No. 32, and Nungling Nos. 6, 10, 20 & 22, were introduced into Taiwan during 1953 and 1956 through different channels and tested by the above-mentioned two stations. Among the varieties introduced, selection of better strains with early maturing character was made by each of the two stations for oil extraction purpose. Commercial planting of these selected strains have been commenced since 1959 after six years' systematic observation, testing, comparative study and extension.

C. Regional Adaptation Test and Demonstration Fields

After promising results of trial plantings of introduced varieties made at the Hsinchu and Taichung DAISs in 1954 and 1955 were observed, a regional adaptation test was followed in the fall of 1956 in order to map out the proper area for future demonstration and extension.

Four paddy fields and five dryland fields were selected as testing fields in each of the Taichung and Hsinchu areas. The varieties tested were Chin-chi No. 32, Nungling Nos. 20 & 22 and native Lung-ching for paddy fields and Nungling Nos. 6, 20 & 22 for dryland fields. It was found both Chin-chi No. 32 and Nungling No. 20 were good for paddy and dryland fields due to their high yielding and comparatively early maturing characters. The rest of the varieties also showed good adaptation and produced high yield, ranging from 1,500-2,500 kg. per hectare, but required longer growing period, which would affect the existing crop rotation system to a great deal. It was also noted that areas north of Hsinchu and south of Chiayi were not good for rape seed production because of the low yield in north due to the rainy weather during the blooming season of the crop and the hot drought in south during the early period of plant development.

Based on the encouraging results of the regional adaptation test, conducted in the fall of 1956, a follow-up work demonstrating the growing of new varieties was conducted in the fall of 1957. A total of 18 demonstration fields, i. e. 10 fields on dryland and 8 in paddy fields, were established at different localities in the Taichung and Hsinchu areas. Each demonstration field with an area of 0.01 hectare was operated by selected farmers.

The varietal characteristics of two selections obtained are tabulated as follows:

Variety	No. of days for flowering after planting (day)	Growing period (day)	Height of plant (cm.)	Yield. (kg./ha)
Hsinchu selection series No. 1	57	131	115	2,019
Taichung selection series No. 1	53	140	143	2,243

D. Multiplication and Distribution of New Varieties

In the fall of 1958, plantings for the stock seed production were made for varieties Nungling No. 20, Taichung series No. 1 and Hsinchu series No. 1 by the Hsinchu and Taichung DAISs. Some 400 kg. of stock seeds were produced from an area of 0.30 hectare in the spring of 1959. A total of 6,000 kg. of extension seeds from 4.4 hectares was multiplied by the Prefectural Farmers' Associations (FA) of Taichung and Hsinchu and the Puli Mill of the Taiwan Sugar Corporation in Nantou Prefecture.

In the fall of 1959, a total area of 0.25 hectare was used for the production of stock seed by the Hsinchu and Taichung DAISs. The seed was harvested in the

spring of 1960 and the amounts of seed multiplied were 110 kg. of Hsinchu selection series No. 1 and 150 kg. of Taichung selection series No. 1. A total of 9,600 kg. of extension seed of two varieties, Taichung selection series No. 1 and Hsinchu selection series No. 1, were multiplied by several prefectural farmers' associations concerned. The stock seed was distributed to a number of prefectural farmers' associations in the fall of 1960 for the production of extension seed, while 9,600 kg. of extension seed harvested in the spring of 1960 were distributed to farmers on cash basis for fall planting through different levels of farmers' associations.

E. Extension and Acreage of New Rape Varieties Since 1958 Fall

A preliminary extension of new rape varieties was made in the fall of 1958. Starting with 16 hectares of paddy field and 23 hectares of dryland in the Hsinchu, Taichung and Yunlin areas, varieties of Hsinchu selection series No. 1 and Taichung selection series No. 1 were adopted for paddy field and Nungling No. 20 and Chinchu No. 32 for dryland planting. Mud-in method was employed for paddy field and direct seeding practised for dryland. A total of 70 metric tons of seeds of the new varieties was produced from 39 hectares with an average yield of 1.8 metric tons per hectare.

A large scale extension of the new rape varieties was made possible in Taiwan in the fall of 1959 when 6 metric tons of extension seed became available in the spring of 1959. The extension areas were limited to the west coast covering Hsinchu, Miaoli, Taichung, Changhua, Yunlin and Chiayi Prefectures. The varieties used were Taichung selection series No. 1 and Hsinchu selection series No. 1 for paddy field (as relay-interplanting) and sugarcane field (as inter-cropping) and Nungling No. 20 for dryland. All the seeds were distributed on cash basis through different levels of farmers' associations. Acreage planted to new rape varieties in the fall of 1959 amounted to 6,000 hectares. However, only 4,027 hectares instead of 6,000 hectares were harvested with a total seed production of 5,050 metric tons due to the devastation of a torrential flood occurred in the fall of 1959 in central Taiwan.

The projected goal of extension of new rape varieties for the fall of 1960 was 12,000 hectares with an expected production of 14,400 metric tons to be harvested in the spring of 1961.

III. Cultural Improvement

A. Improvement in Seeding Rate

With the intensive farming technique developed specially for new rape varieties and the quality seed with good germinating ability produced, the amount of seed required for planting has been drastically reduced. Formerly, for the native variety, some 2-3 kilograms of seed were required for planting one hectare; but, for the new varieties, a seeding rate of 1 kilogram per hectare was practised without difficulty for the fall planting of 1959. In view of expanding acreage and the limited amount of seed available for the fall planting of 1960, the seeding rate has been further reduced to 0.80 kilogram per hectare. Less amount of seed required for planting is favorable to the farmers in terms of cost of production.

Raising seedlings in the nursery with quality seeds for transplanting into the field was found the most effective way of saving seeds for planting. Management of the nursery is more economical and effective than managing the field where seeds are directly sown. Young seedlings in the nursery can be effectively protected from damages caused either by insects or by drastic climatic changes, thus making possible the saving of seeds.

B. Development of Improved Cultural Practices

1. Winter relay-intercropping in the rice field—Seeds are sown in late September and the young seedlings reaching an age not older than 25 days are transplanted into the rice field where the rice is ready for harvest within 7-10 days. This practice is called the mud-in method. A space is provided at every fifth row of rice. The rice rows are spaced at 21-24 cm. apart. The rape seedlings are transplanted 30 cm. apart into the spaces between rice rows. When the rice is harvested, the field will become a well-developed rape field. The rape plants are spaced at 30 cm. in rows 105-120 cm. apart. Mounding is required in mud-in method and is completed before or after transplanting of seedlings.

2. Intercropping rape with sugarcane—A bed is prepared by plowing the soil between every one or two rows of fall planted sugarcanes. As the fall planted sugarcanes do not grow fast due to the decline of temperature, the quick growing rape will not produce any unfavorable effect on the sugarcanes. On the level bed with a width of 50 cm., a row of rape seedlings is planted at a planting distance of 30 cm. between plants. The sugarcane rows are spaced at 125-137 cm. apart, so

there is enough room for the rape to develop before the seed is harvested in the next spring when the sugarcane start the active growth in the field.

3. Dryland farming—When dryland is used for growing rape seed, land preparation should be finely made as soon as the previous crop, usually the soybean or some other crop, is harvested in the fall. A bed with a width of 100 cm. is recommended. Seeds are sown directly into the field and the plants are spaced at 30 cm. in rows 50 cm. apart after thinning out excess seedlings. Each bed will have two rows.

C. Fertilizing and Manuring

1. Kinds and amounts of fertilizers—At present, for a land of medium fertility, the following fertilizers are recommended for farmers' application.

Kind	Amount (kg./ha.)
Well-decomposed compost	5,000
Ammonium sulphate	300
Superphosphate	300
Potassium sulphate	150

2. Time and method of application—Time and method of fertilizer application vary greatly with the soil texture. The general principle governing the timing and method may be tabulated as follows:

Kind	Sandy and sandy loam	Loam to clay
Compost	100% applied during land preparation or before the transplanting as base dressing	100% applied during land preparation or before the transplanting as base dressing
Chemical fertilizer	(1) 50% to be used as base dressing (2) For top dressing, 20% applied when young plants reach a height of 20 cm., 15% applied at the production of flower stalk, and 15% applied at full blooming	(1) 70% to be used as base dressing (2) For top dressing, 10% applied when young plants reach a height of 20 cm., 10% applied at the production of flower stalk, and 10% applied at full blooming

D. Irrigation and Drainage

In the early stage of the plant development, a well-moistened field would be desirable. Irrigation is needed in the arid area in order to promote the plant growth. Although the rape is tolerant to wet condition, a good drainage must be provided when the plants reach the stage of flower differentiation and especially during full blooming till the harvest of the matured seeds.

E. Pest and Disease Control

At present, aphids spp. is probably the only injurious pest attacking the tender part of the rape plants. The young shoots are sometimes badly damaged by aphids. Spraying the field with Malathion and Derris emulsion periodically has been recommended and commonly practised by growers since the growing of new varieties in recent few years. This pest has been effectively put under control through the recommended control measure.

With regard to the disease, black spot is the most common disorder annoying the rape growers at present. Field sanitation and spraying the infested field with Bordeaux mixture are the only measures recommended by pathologists now.

Since the commercial growing of rape for seed production in Taiwan is more or less a new task, the knowledge about pest and disease control is still rather young. It is expected that improved control measures will be developed so as to keep pace with the development of crop production.

IV. Dissemination of Information on Rape Seed Improvement to Growers

A. Holding Training Classes

The training classes held are divided into three levels, i.e., provincial level for extension workers of prefectural FAs and operators of demonstration fields given by the Provincial Department of Agriculture & Forestry (PDAF), prefectural level for extension workers of township FAs given by the district agricultural improvement stations concerned, and township level for rape seed growers given by the extension workers of prefectural FAs concerned. There was one provincial level training class held by PDAF in August 1959, followed by prefectural level training classes held by Hsinchu, Miaoli, Taichung, Changhua and Yunlin Prefectures. In turn, over fifty township level training classes were held at different townships in August and September of the same year. Ten thousand copies of a pamphlet on rape seed culture were distributed free of charge to trainees during the 1-day training. Specimens of rape plants and samples of seeds of different varieties were exhibited for observation and reference. Problems and questions concerning the growing and marketing of rape seed as raised by the trainees were thoroughly discussed during the training so as to enable the trainees to have a better view of the future rape seed production in Taiwan.

B. Demonstration Fields

Demonstration on the growing of new rape seed varieties in selected farmers' fields has been found most effective in familiarizing the farmers with the improved cultural techniques. It also proved to be a short cut to convincing the farmers the beneficial effects of employing the new rape varieties and the improved cultural techniques as can be evidenced by the successful outcome of the demonstration patches operated by the selected farmers in accordance with the instructions given by agricultural workers of the government agencies. In the fall of 1957, a total of 18 demonstration patches were operated by selected farmers in the Hsinchu and Taichung areas. The size of each individual patch was 0.01 hectare. The harvest of rape seeds made from these demonstration patches in the spring of 1958 was very encouraging. Consequently, a small scale extension program was launched in the fall of 1958. A crop of 70 metric tons of seed was harvested in the spring of 1959.

In order to keep pace with a projected extension program on growing new rape varieties in the fall of 1959, 34 demonstration patches, each with an area of 0.1 hectare, were operated by selected farmers in paddy fields, and 8 in sugarcane fields for intercropping practices. The demonstration fields were technically supervised by personnel dispatched by the DAIS concerned. Operators of the demonstration fields were asked to attend the training given by PDAF. Besides, the expenses for labor, fertilizers and pesticides involved in operating the demonstration fields were partially subsidized to the operators as an incentive. The operators were also guaranteed the government purchase of the seeds to be produced from the demonstration patches so as to remove their doubt about the economical value of the crop.

Some 50 demonstration patches have been operated by selected farmers for the extension program projected for 1960 fall planting of 12,000 hectares with a production goal of 14,400 metric tons of rape seeds to be harvested in the spring of 1961. The demonstration fields will serve as model farms to the rape seed growers with respect to the application of improved cultural practices and special techniques involved in growing the new varieties. Moreover, most of the demonstration fields will be used as the sites for holding field days for the farmers in the respective areas.

C. Pamphlets and Holding Field Days

Based on the experimental data and experiences gained by the research workers, a pamphlet on the growing of rape seeds was prepared with the joint effort of the

relevant organizations. In the fall of 1959, a total of 10,000 copies of the pamphlet was printed and distributed to farmers during training classes and other occasions prior to planting. Sketches play the major part of the pamphlet, explanations were also given in simple sentences so as to supplement the ideas expressed by the sketches.

Province-wide field day was held at the demonstration fields two to three weeks prior to the harvest so as to enable the farmers to discuss freely the bumper crop raised by their fellow farmers with their own language expressed in their own terms and experiences. Localized field days were held in different areas sponsored by the township farmers' associations concerned. Exchange of views among farmers usually produces mutual understanding which is very beneficial to improving their farming techniques. Agricultural technicians played an important role in conducting the field days as they were much more able to offer scientific solutions to the technical problems raised by the farmers than the model farmers.

V. Future Rape Seed Production in Taiwan, China

As pointed out in the introduction, the annual requirement for edible oil in Taiwan is at present about 50,000 metric tons. The local production provides slightly over 20,000 metric tons. In order to supply locally as much edible oil as possible, the acreages of such oil crops as soybean and rape seed need to be energetically expanded. The acreage, unit yield and total production of rape seed in the past and the projected goals for the next few years may be tabulated as follows:

Year	Acreage (ha.)	Yield (kg./ha.)	Production (m.t.)
1949	961	376	361
1950	931	392	365
1951	2,011	258	518
1952	2,327	236	548
1953	2,673	378	1,009
1954	2,054	397	815
1955	3,384	277	659
1956	2,768	346	956
1957	3,222	366	1,179
1958	3,761	458	1,723
1959 (estimated)	7,000	840	5,880
1960 (projected)	12,000	1,000	12,000
1961 (projected)	20,000	1,200	24,000
1962 (projected)	40,000	1,200	48,000
1963 (projected)	60,000	1,200	72,000

It is expected that, by the year 1963, the rape seed production will reach the goal of 72,000 metric tons, which will be equivalent to slightly over 24,000 metric tons of edible oil.

PRODUCTION AND DISTRIBUTION OF MAJOR FRUIT CROP PLANTING MATERIALS IN TAIWAN

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I. Introduction

Pineapple, banana and orange are the three major commercial fruit crops of Taiwan. Millions of dollars' worth of these fruits are raised annually and marketed profitably on both the domestic and foreign markets. Among these three major fruit crops, banana is the only crop receiving no improvement in its production in the past decade, and the supply of its planting material has not been a problem to the growers as they have always been with the facility of their own selected planting material for raising the crop.

For the reference of the related Far East countries, this paper is intended to present briefly the efforts and accomplishments made in Taiwan since 1956 in the production of pineapple and citrus fruits and some other fruit crops of relatively less economic importance and in the distribution of planting materials for these crops.

II. Pineapple (*Ananas comosus*)

In the Past. Commercial growing of pineapple in Taiwan was started in 1910; and several introductions of varieties were made during 1910-1940 from Hawaii and southern Pacific areas. Multiplication station was established in the early years by the agricultural authority for the propagation of introduced varieties in the southernmost area of the Island. Innumerable pieces of pineapple seedlings had been multiplied till the eve of World War II. The multiplied planting materials were distributed to farmers on loan basis. Data on the exact quantity of seedlings produced and distributed and the number of farmers involved at that time are now not available; however, it is learned that the said multiplication program was limited to southern Taiwan only and no planned program was conducted for farmers in central Taiwan.

Since 1950. The degeneration of the variety Smooth Cayenne in Taiwan was noticed by horticultural workers in the early post-war years. The poor yield of the pineapple crop was resulted from the negligence in plantation management during the war years. Numerous kinds of off-types were commonly observed in most of the pineapple fields. The most popular ones were: (a) multiple crown, (b) tumor at fruit base, (c) bottleneck, (d) multiple fruit, (e) eye beauty, (f) long tom and (g) small fruit. Besides, some other pineapple varieties were found mingling together with the variety Smooth Cayenne in some pineapple fields.

With the aim of rehabilitating the pineapple industry from ruin, varietal improvement was designated as the keypoint among many farming practices. Before 1950, systematic production and distribution of planting materials were not possible, as there was no acceptable variety available at that time. Growers were obliged to acquire the needed planting materials principally from other farmers having extra seedlings for sale. In view of this situation, a joint effort has been made by the Taiwan Provincial Department of Agriculture & Forestry, Taiwan Pineapple Corporation and the Joint Commission on Rural Reconstruction to conduct a program on selecting the Smooth Cayenne variety among the farmers' fields. The selection scheme so far conducted may be presented as follows:

Scheme of selection and period		No. of seedlings 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 and establishment of nurseries	1954	120,701	4.80
	1955	226,767	9.00
Purification and close test	1956	400,000	15.00
	1957	1,000,000	40.00
Regional adaptation test	1958	2,000,000	80.00
	1959	4,000,000	160.00
Multiplication and extension	1960 (goal)	10,000,000	400.00
	1961 (as planned)	20,000,000	800.00

As the multiplication of planting materials of pineapple is different from that of other fruit crops, except, at present, the slicing method, the planting materials are multiplied on the same plant at the same time while the pineapple crop is produced. In another word, the conventional method of multiplication is simply growing the pineapple plant, then both the fruit and several types of planting materials (slip, crown, sucker, etc.) can be harvested from the same plant. Whereas in multiplying planting materials of other kinds of fruit crops, no fruit can be

produced during the propagation period. Consequently, for multiplying planting materials of pineapple, the conventional method is preferred by the growers.

However, the demand for planting materials for replantings on the old plantations and for new plantings is growing acute due to the increased planting density employed recently by growers. Formerly growers used to plant 25,000 plants per hectare, and now they are planting nearly 40,000 plants per hectare. Evidently, with the same areas, the growers are in need of more planting materials. The selected seedlings under government financed program are yet limited in quantity and not available for large scale extension. In order to insure that new plantings (re-plantings) can be made as much as possible with seedlings of good plant characters, the following two approaches have been schemed to meet the increasing demand with limited propagation materials:

A. Seedlings of better plant characters grown in fairly large amount on growers' farms are utilized to the best as a stopgap measure for preventing the spreading of the inferior seedlings. Starting the summer of 1956, growers who possess good stock of planting materials of Smooth Cayenne, preferably the slips, are encouraged to do better distribution through the support and certification of the Provincial Department of Agriculture & Forestry. They are approached by local governments concerned and assisted technically by personnel from the Fengshan Tropical Horticultural Experiment Station in eradicating the off-type progenies of Smooth Cayenne from their fields, so that only those of good characters are allowed to remain for planting.

After eradication, the remaining seedlings are marked in red and tagged with labels before distribution. After collection, trimming and sun-curing, all seedlings are required to be treated with Folidol at a concentration of 1:1,500. The seedlings (planting materials) so selected and treated will be bought directly from the owners by the prefectural governments concerned at a reasonable premium price. The end-using growers are required to pay for these seedlings plus shipping costs at the time of delivery. Seedlings so distributed will naturally form a source of better seedlings in the various prefectures under the close supervision of the local governments concerned. And such seedlings are further distributed through the arrangement of the prefectural governments.

B. The selected seedlings with good characters grown in limited amount on the farms of the Fengshan Tropical Horticultural Experiment Station, a government agency, are multiplied by slicing method (or stump section) instead of the normal practice. The old stumps are collected and sliced. The sliced pieces are disinfested

with Uspulum at a concentration of 1:800 for 15 minutes. After one or two days, the pieces are planted into the sand-bed. While in the bed, shading is needed when the newly-developed young leaves emerge from the sand surface. Each old stump is commonly good for 20 slices. The rate of multiplication is somewhat higher than that under the conventional practice, but the slicing method requires longer period of time, usually taking 12 months from slicing to planting the pieces into fields for commercial production. Moreover, it has been noticed that the fields planted to the sliced planting materials are not uniform in fruit bearing as compared with the fields planted to slips or crowns under similar climatic and management conditions. However, the slicing method is still found the most effective way of multiplication, especially for the very limited materials available.

Future Plan. For effective multiplication and distribution of planting materials of pineapple in the future, it is anticipated that the whole program will depend on both the well-organized growers and the systematic multiplication and distribution plan. Coordination between these two sides is more important than anything else apart from the varietal problem. The materials selected with the joint effort of the concerned parties under JCRR supported program will be carefully multiplied and distributed in accordance with the projected plan. Due to the nature of the pineapple crop, the multiplication of its planting materials at present needs to be conducted largely in farmers' fields designated for multiplication purpose under the technical supervision of the agricultural stations. With limited areas for experimental purpose at the agricultural stations, only limited amount of planting materials can be multiplied for distribution. Growers in a selected area who wishes to plant the good planting materials will be organized into groups in order to facilitate the distribution procedures involved. The advantages of planting good stocks will be made known directly by the growers to those who grow the common materials, as they can exchange their views and experiences more easily in their own terms. It is expected that, in this manner, the distribution work can be smoothly carried out.

III. Citrus Fruits (*Citrus spp.*)

In the Past. In the light of the mounting demand for oranges by the growing population, the planting of citrus fruit trees in Taiwan for more fruit production has continuously been expanding in recent years. Consequently, the demand for planting materials has become a serious problem confronting most of the citrus growers. However, it was not until 1951 when appropriate attention was given to the multiplication of orange trees by JCRR and the Provincial Department of

Agriculture & Forestry. Selection of mother-trees among farmers' orchards was conducted by horticultural workers in cooperation with the fruit marketing cooperatives. Fruit trees propagated by contracted nurserymen were marketed at a fixed price under government supervision. Young nursery trees propagated with reliable propagating materials were secured, but the multiplication work was more or less retarded due to government control on price. Therefore, the modification of multiplication program became imperative to stepping up the production of more planting materials.

Since 1956. Along with the effort in crop improvement, the multiplication of planting materials has also been successfully improved for commercial extension. The major achievements so far attained may be briefed as follows:

A. Employment of vinyl as binding and wrapping material—The percentage of taken after grafting is very much concerned by the nurserymen at all times. The low percentage of taken in the past was considered to be a result of the poor binding and wrapping techniques on the workers' part or the unfavorable climatic conditions; however, no scientific study had ever been made on the material used for binding and wrapping. Molding and decaying of the grafting union, which should be the principal cause for the low percentage of taken, were commonly found in most of the citrus nurseries with no effective remedies taken. In the past, the nurserymen suffered considerably loss from the low percentage of taken (usually as low as 50-70%), which caused a high cost for multiplying the young orange trees.

Experiments indicated the practical value of employing vinyl as binding and wrapping material in the course of grafting. Better grafting taken percentage (98%) was obtained from the lot with vinyl than the lot with such materials as jute and some herb leaves which had been commonly used for more than hundred years (usually not more than 85%).

It was also noticed that molding or decaying was no longer a problem on the grafting union when vinyl was used as binding and wrapping material. The scion and the cut surface of the rootstock were tightly bound together with a strip of vinyl, then the grafted part was covered with a vinyl tube as a protector preventing it from possible damage by moisture or sunshine. The cover should be removed as soon as new shoots emerged from the buds; and the presence of new growth from the buds would insure a good grafting taken.

The application of vinyl to the multiplication of young orange trees has become a new technique and has made the advanced nurserymen aware of the real

cause for the molding and decaying of grafting union that used to occur. It is expected that, within not too distant future, the nurserymen in Taiwan will all recognize the value of employing vinyl in their nursery operations.

B. Adoption of rootstock of adequate size—For at least several decade, the employment of one-year old rootstock for propagation has been a conventional practice adopted by the orange nurserymen in Taiwan, because: (1) shorter period of time is required to produce one-year old rootstock than the two-year old rootstock, (2) less cost is involved in raising one-year old rootstock than the two-year ones, and (3) the one-year old rootstock is easier to handle than the bulky two-year ones. However, the one-year old rootstock was found unsatisfactory to the growers and the research workers as the young trees multiplied with such rootstock had poor root system and slow growth after grafting or setting into the orchard. Whereas those trees multiplied with the two-year old rootstock are always found with good root system and relatively normal tree development after grafting and setting into the orchard. Consequently, quite a few advanced nurserymen have recognized the importance of adopting the two-year old rootstock instead of the one-year old rootstock, leading to a revolutionary change in the citrus industry of China.

In conclusion, through scientific demonstrations, the nurserymen have shown their confidence in the advantages of using vinyl as binding and wrapping material and two-year old rootstock in the multiplication of orange trees.

C. Lifting of government control on the price of multiplied young trees—In view of its retarding effect on the government supported multiplication program in the past, the government control over the price of the multiplied young trees was found necessary to be lifted so as to facilitate the program development. Now the selected nurserymen have the free hand to fix the price at their own will. As a result, the young orange trees have enjoyed a very favorable market price than ever before. The prices before and after the lifting of price control may be compared as follows:

Kind (1-year growth in the nursery after grafting)	Price (NT\$)	
	Before 1955	During 1956-1959
Ponkan and Tonkan	1.50-2.50/tree	2.50-6.00/tree
Sweet orange	1.00-2.00/tree	3.00-8.00/tree

From the above figures, it may be seen that the price of the one-year old young orange trees has been doubled since 1956 as a result of the lifting of price control.

D. Varietal trueness and mother-tree survey—The use of scionwood from reliable source has become a minimum requirement of a government supported nursery operation. Varietal trueness is maintained by the mother-tree survey conducted by the horticultural workers at agricultural stations concerned. The mother-tree survey which was initiated by JCRR in 1951 in Taiwan has become a routine practice adopted by the related agricultural stations. Nurserymen in each area are assisted by the prefectural governments to obtain the propagating material, principally the scionwood sticks, so as to ensure the varietal trueness of the young orange trees multiplied annually.

E. Distribution procedure—In addition to the lifting of control on the tree price, the prefectural governments are in the position to assist the nurserymen in their respective areas to market the acceptable young trees, whenever necessary. Information on the kind and quantity of orange trees needed in certain areas may be made known to the nurserymen by the prefectural governments, as a complete record is usually available near November of every year when a survey made among the growers is completed by such government agencies as township office, etc. Effective coordination between distribution and multiplication is deemed completely necessary for the future progress of the whole program.

Future Plan. In order to maintain a balanced supply and demand of young orange trees in future, a well-schemed multiplication and planting plan should be mapped out earlier ahead of time for implementation. If possible, the planting plan in each township and prefecture should first be worked out so as to enable the prefectural people to work on the supply plan in due course. The qualified nurserymen should be organized into groups, thus their multiplication work could be well distributed on an economically sound basis. In addition, the mother-trees from which the scionwood sticks are to be collected should be well protected from attacks by pests and diseases. Coordination among pathologists, horticulturists and nurserymen is urged for the multiplication of disease free, varietally true and healthy young trees for distribution and better fruit production.

IV. Other Fruit Crops

Litchi (*Litchi chinensis*). Indigenous to China mainland, litchi, the most delicious and delicate fruit of the Orient, was brought to the Island of Taiwan by early immigrants from Fukien and Kwangtung provinces some 260 years ago. However, for one reason or another, no commercial planting was developed in Taiwan. The existing litchi trees are scattered mostly over the west coast of the island as

garden fruit trees of the farmer houses. A planting over 100 trees per farm family is a rare case. The varieties raised are numerous, but very few of them are of leading quality. Consequently, the production of litchi is still rather limited in Taiwan.

On account of its excellent flavor, attractive look and tasting quality, the fruit is now getting popular on the market and is specially favored by people living a better life. High price has been created on the market due to limited supply. Thus stimulated by the price, growers are energetically engaged in making new planting of this fruit crop in the recent few years.

In order to explore dependable source of supply of better varieties and to prevent the spreading of inferior varieties, horticulturists of government stations have, with JCRR support, conducted a mother-tree survey in the summer of 1960 so as to locate the quality mother-trees for better multiplication. Meanwhile two training classes on propagation techniques were given to the selected nurserymen by the Chiayi Agricultural Experiment Station and the Fengshan Tropical Horticultural Experiment Station, respectively. According to the island-wide survey made in 1960, it is noticed that there are 134 hectares of bearing trees and nearly 100 hectares of non-bearing trees. A total of 160 trees are selected from 40,000 bearing trees as mother-trees of good variety and have been registered and tagged in serial numbers by agricultural stations. The owners of the selected mother-trees are encouraged to multiply their litchi trees with technical assistance directly from the stations or indirectly from the trained nurserymen.

Air-layering or marcottage is still the method used in the multiplication of litchi. It is an asexual method of propagation and has been in practice for hundred years in China. However, sphagnum mosses have replaced the traditional manure as rooting medium, and vinyl sheets have replaced the bamboo as covering material. It is expected that a total of 6,000 young litchi trees of the variety Black-leaf will be made available to fruit growers for new planting in January and February of 1961 as a result of the project implemented. An annual production of 10,000 trees for making 30 hectares of new planting is under consideration. Since the marcottage is carried out at individual farmers' gardens, the young fruit trees thus produced will naturally be marketed by the individual farmers themselves. There will not be a planned distribution program to be handled by government agencies at present time.

Deciduous Fruits. Deciduous fruit trees in Taiwan are of low economic importance as compared with the pineapple and banana. Persimmons (*Diospyros kaki*)

and peaches (*Prunus persica*) have been produced for years on very small scale in lowland areas but will not be developed into an industry. However, the mountain areas have been found feasible for the growing of some kinds of deciduous fruit crops due to the desirable climatic conditions there. The results of trial plantings indicate that a few varieties of pears and apples showed good adaptation and vigorous growth in certain areas with an elevation ranging from 1,700 to 2,300 meters. It is under the consideration of pomologists to select proper kinds of rootstocks before the multiplication work is carried out. Therefore, for the time being, it would be immature to discuss the multiplication and distribution of planting materials for this group of fruits in Taiwan.

Macadamia Nut (*Macadamia Ternifolia*). Macadamia nut is not a new crop in Taiwan. It was introduced into Taiwan before World War II, just for academic trial. However, it is the opinion of the pomologists that this nut crop may be developed into an industry as it is in Hawaii. Therefore, rootstocks are being raised from the seeds. The next step would be to obtain propagation materials of quality variety from abroad and from local sources through selection for multiplication purpose. The time for distribution is also not ripe yet.

Guava (*Psidium Guajava* & *P. Chinense*), Papaya (*Carica papaya*) and Mango (*Mangifera indica*). These fruit crops are grown extensively in the lowland areas of Taiwan. There are numerous varieties for each of these crops; however, there is not yet any systematic plan on the multiplication and distribution of any one of these fruit crops. Either for commercial planting or for garden planting, the growers usually get their planting materials from their neighboring growers or from the nearby nurserymen at costs.

At present, these three kinds of fruit trees are propagated from their seeds. Asexual methods, such as cutting of guava and grafting of mango, are increasingly employed. As soon as a better propagation method is developed and good varieties located, a systematic multiplication and distribution program will be mapped out for implementation.

BANANA PRODUCTION IN TAIWAN

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I. Introduction

Banana which has long been known as the king of fruits in Taiwan is one of the most important horticultural crops economically benefiting the Island. In addition to the large amount of locally consumed bananas, a remarkable quantity is exported annually. Among the foreign markets of Taiwan bananas, namely, Japan, Korea, Okinawa and Hongkong, Japan ranks the foremost, taking more than 90% of the total export. The export of Taiwan bananas to Japan in 1960 is valued at US\$8,500,000.

The planted acreage of banana in Taiwan in 1937 was 21,232 hectares (ha.) marking a record annual production of 218,589 metric tons (m.t.). During the War years, both the acreage and yield decreased sharply, especially in 1945 when only 5,687 ha. were planted with a production of 31,153 m.t. Since after the War, the banana production in Taiwan began to revive. The acreage of banana plantations in recent years is averaged at 13,838 ha. and the production around 110,000 m.t. in 1958. The banana production during recent five years may be shown in the following table:

Banana Production in Taiwan During 1955-1959*

Year	No. of plants harvested	Harvested area (ha.)	Production (kg.)	Average yield per plant (kg.)	Average yield per ha. (kg.)
1955	10,742,704	10,672.21	84,676,779	7.88	7,934
1956	9,853,395	9,573.42	58,695,963	5.96	6,131
1957	12,224,609	11,269.96	92,466,324	7.55	8,205
1958	14,531,327	11,838.05	111,265,555	7.66	8,041
1959	14,053,110	12,962.43	104,473,847	7.43	8,060

* Source of data: "Taiwan Agricultural Yearbook" 1960 Edition

II. Producing Areas, Environmental Conditions and Harvesting Seasons

The climatic conditions in Taiwan are generally favorable to banana raising, so bananas are grown almost everywhere on the Island. However, the commercial plantations are, more or less, concentrated in central and southern Taiwan. The environmental conditions, growing systems and harvesting seasons of banana in these two main producing areas are somewhat not alike.

Most of the banana plantations in central Taiwan, including Taichung, Chang-hwa and Nantou Prefectures, are located on the mountainous slopes. Proper water and soil conservation measures are needed in that area where irrigation facilities are not available. Growers there manage their own banana plantations in a rather extensive way. Planting distances between plants and rows are both averaged at 9-10 feet with 1,000-1,100 plants per ha. Manuring, fertilization and pest control measures have not been satisfactorily taken. Bunchy top disease and stem weevils are more serious in central Taiwan than in southern Taiwan. Hence, the yield per unit area is extremely low with an average per ha. production of 6,000 kg. annually. The fruit stalk emerges from the pseudo-stem within 10-16 months after planting, and another $2\frac{1}{2}$ - $5\frac{1}{2}$ months are needed for maturation. Bananas are harvested almost all the year round with the fall as the peak harvesting season.

Contrary to central Taiwan, most of the bananas of southern Taiwan are grown on plains. Banana plantations in this area are managed more intensively and planted more closely at a distance of $8 \times 7\frac{1}{2}$ to 8×8 feet with 1,600-1,800 plants per ha. With better irrigation facilities and water sources available, growers usually irrigate their banana plantations at 2- to 3-week intervals during the drought seasons. Nitrogen fertilizers are usually applied at a rate of 2 kg. per plant annually. Faster growth of banana plants is observed and shorter period is needed for maturation from planting. Consequently, the yield in this area is much higher than that in central Taiwan with an average yield of 18,000 kg. per ha. as against the 6,000 kg. per ha. in the latter area and the harvesting season adjusted to March-July with controlled irrigation and fertilization.

III. Varieties

A. Cultivated Varieties

According to a varietal survey of bananas made by the Chiayi Agricultural Experiment Station of the Taiwan Agricultural Research Institute, more than 60 varieties and strains including 4 species, namely, *Musa sapientum*, *M. cavandishii*, *M. acuminata* and *M. paradisiaca*, are grown in Taiwan. Among them, only varieties Pei-chiao, Hsien-jen-chiao, Chinese Dwarf, Lung-ya-chiao, Blue Field, Lacatan, Latundan, Feng-chiao, Kanabu, and 3-foot Banana are of commercial importance. Tests and surveys on the characteristics of 53 selected banana varieties have been lasted for more than ten years by the author. Emphases are laid on specific characteristics as regards pseudo-stems, leaves, florals, stamens, pistils, fruits and periods of growing and harvesting. Data on the ten given varieties are summarized as follows:

A List of Botanical Characteristics of 10 Commercial Varieties of Banana Grown in Taiwan

Variety	Pseudo-stem		Mature leaves		Average (per plant)			Fruit (finger)		Thick-ness of fruit skin (mm.)	% of flesh	Quality and other characters
	Height (m.)	Diameter (cm.)	Length (m.)	Width (cm.)	No. of hands	No. of fingers	Yield (kg.)	Weight (gr.)	Length (cm.)			
Hsten-jen-chiao	3.06	15.50	2.11	74.02	8.33	131.67	11.35	84.38	12.87	2.17	66.91	Excellent quality, shipping endurance and tolerance to bunchy top disease.
Pei-chiao	2.46	17.80	1.53	54.60	8.50	152.00	16.00	102.90	14.11	2.62	72.69	Excellent quality and shipping en- durance.
Feng-chiao	2.89	13.11	1.94	57.67	6.67	69.29	5.76	75.48	10.54	1.15	79.25	Good quality and less shipping en- durance.
Chinese Dwarf	1.58	11.50	1.12	54.05	6.50	86.50	4.48	49.67	10.54	2.21	64.03	Excellent quality and less shipping endurance.
3-foot Banana	1.59	14.80	1.53	74.70	11.83	113.00	6.73	57.04	11.33	1.89	65.01	Excellent quality and less shipping endurance.
Lung-ya-chiao	4.19	22.80	2.44	63.26	6.00	104.00	8.00	67.20	1.23	1.64	72.17	Good quality and resistance to bunchy top disease.
Blue Field	3.73	17.75	2.27	74.84	7.30	102.10	7.47	60.49	11.14	1.73	66.29	Good quality.
Lacatan	2.69	11.67	1.89	60.35	5.00	55.50	3.80	62.84	10.01	1.84	69.31	Fair quality.
Latundan	2.89	13.07	1.27	52.27	6.00	70.00	4.92	62.51	9.88	1.29	77.93	Fair quality.
Kanabu	3.92	17.10	2.30	70.15	12.20	168.40	13.93	82.32	10.86	1.18	82.18	Fair quality.

Both the Hsien-jen-chiao and Pei-chiao which belong to *Musa sapientum* species are grown on commercial scale, occupying 95% of the acreage of banana plantations as well as the production. They are famous not only for their high yield but also for their good flavor and good shipping quality. Other varieties such as Feng-chiao, Ammo, Apple, Chinese Dwarf, etc., are grown only on small scale.

B. Varietal Selection as a Measure of Bunchy Top Disease Control

Bunchy top disease is the most serious banana disease ever observed in Taiwan. Banana growers, especially those in the mountainous areas in central Taiwan, have been suffering from the losses by this disease for decades. Devastation by this disease was so serious in 1900-1911 that Pei-chiao, the only variety cultivated commercially at that time, was almost faced with a total destruction, with only a very few banana plants found remaining in normal growth in the field. A resistant mutant strain named later as Hsien-jen-chiao was hence derived. With the extension of this new variety, Taiwan banana industry was allowed to be rehabilitated.

In recent years, the said disease seemed to prevail again in several spots and farmers were much annoyed by the damage. It was reported recently that, during 1958-1960, severe damage by bunchy top disease caused losses ranging from 10% to 70% of the production in the Sin-shan area of Nantou Prefecture. Some plantations there were completely ruined. In view of this fact, a series of experiments on different varieties in relation to disease resistant properties have been carried out by the Taiwan Provincial College of Agriculture. Inoculation was made through disease carrying aphids on the healthy plants of each variety or strain. Different degrees of resistance of each variety or strain as observed from 2 years' preliminary experiments are shown as follows:

Variety	Resistance or susceptibility
Puerto Rico	Moderately resistant
Ice Cream	Susceptible
Blue Field	Susceptible
Golden King	Susceptible
Popul	Moderately resistant
Lung-ya-chiao	Resistant
Pei-chiao	Susceptible
Feng-chiao	Moderately susceptible
Lacatan	Moderately susceptible
Rastali	Moderately resistant

(Continued)

Variety	Resistance or susceptibility
Boyang	Moderately susceptible
Napah	Moderately susceptible
Cooking	Moderately susceptible
Awak	Moderately resistant
Ambon	Susceptible
Pitogo	Moderately susceptible
Chong-sheng-chiao	Moderately susceptible
Hsien-jen-chiao	Susceptible
Chinese Dwarf	Very susceptible

IV. Cultural Techniques

A. Propagation, Selection and Distribution of Planting Materials

Vegetative propagation with suckers is usually employed. Well developed and high yielding mother plants of 2-4 years old are first selected. Plants carrying bunchy top disease or banana corm weevil must be discarded. Suckers that sprout from parent plants during November to December at a height of 0.7-1.2 meter with no expanded leaf, or the so-called "Sword Suckers", are desirable. The selected suckers should be carefully removed from their parent plants by cutting vertically between the parent stump and sucker with a special kind of sharp hoe. Then the individual suckers are planted during March to May.

There are no commercial banana nurseries in Taiwan. Most of the planting materials used are obtained from growers' own fields or from other growers having surplus suckers for sale at a cost of NT\$2-NT\$3 per sucker. Agricultural experimental stations or improvement stations do not multiply large amount of planting materials for extension. It is only a few newly promoted varieties that are propagated by the stations and distributed through agricultural vocational schools or growers' own organizations. Distribution is usually made during February to June with suckers sprouting from mother plants during November of the previous year till February of the current year.

B. Selection of Suckers for Ratoon Crops

Once the banana bunch is harvested, the pseudo-stem will not produce fruit again. But it can be replaced with a sucker which has been selected for ratoon crop during the bearing stage of the mother plant. The relationships between

suckers sprouting in different periods in a year and their growth and yields have been carefully studied. The experimental results indicated that suckers sprouting during November to February could not only produce higher yield but could also render the crop to be harvested before the typhoon season. Only one sucker is allowed to grow to replace each mother plant, while the excessive ones are removed at proper times, usually 5 times a year.

C. Pests, Diseases and Their Control

Bunchy top disease caused by virus is the most serious handicap to Taiwan banana industry as discussed in the foregoing section. Selection and extension of resistant varieties or strains are the major measures for its control. In recent years, insecticides such as Malathion or Dieldrin have been used to control virus transmitting aphids, *Pentalonia nigroneroosa*, etc. Destruction and discarding of the disease-carrying mother plants is another necessary measure for controlling the disease.

Cercosporal leaf spot is also prevalent almost all over the banana plantations on the Island. It appears in every growing stage of the banana plants. Fortunately, it is not so serious in Taiwan as in Central America where severe damages have been reported. No chemicals have ever been used for its control.

Black spot, also known as Freckle, is another common banana disease in Taiwan. It attacks fruits and leaves, especially old leaves of banana. No serious damage by this disease has been reported so far.

Banana stem weevil (*Odoiporus longicallis*, Oliv.) is known as the most serious pest on bananas in central Taiwan. It was reported that approximately 5,000 ha. of banana plantations in central Taiwan were attacked by this pest in 1954 with a loss estimated at more than NT\$22,000,000. A special technical committee for emergency control of the pest was organized jointly by the Joint Commission on Rural Reconstruction, Taiwan Provincial Department of Agriculture & Forestry, Taiwan Provincial College of Agriculture, Taiwan Agricultural Research Institute, Farmers' Associations and the Fruit Marketing Cooperatives. The following control methods were recommended: (1) The banana plantations should be sprayed with 50% Dieldrin wettable powder and 19.5% Endrin emulsion diluted to 400-600 times of water; and (2) Banana plants, after harvest, should be chopped into small pieces followed by Dieldrin spray. Through the use of the recommended methods, most of the banana plantations were well protected against the attack by stem weevils.

Banana corm weevil (*Cosmopolitius sordidus*, Germ) and mealybug are also common in Taiwan. Spraying of 18.8% Dieldrin emulsion dissolved into 200-300 times of water is usually employed for controlling the former and 19.5% Aldrin dissolved into 200-300 times of water (to kill ants) and 1:1,000 Folidol for controlling the latter.

V. Research & Improvement Works

In addition to the ordinary researches on banana culture conducted by the colleges and agricultural stations, a committee on the improvement of banana production and marketing has been organized jointly by JCRR, Provincial Department of Agriculture & Forestry, National Taiwan University, Provincial College of Agriculture, Taiwan Agricultural Research Institute, District Agricultural Improvement Stations and Fruit Marketing Cooperatives. Four sub-committees respectively for (1) cultural improvement, (2) packing and shipping improvement, (3) pest and disease control and (4) processing are embodied in the Committee. Various phases of research and improvement works are being carried out by each of the sub-committees in close coordination with other agricultural organizations.

IMPROVEMENT PROGRAM OF LONG VEGETABLE FIBER CROPS IN TAIWAN

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The long vegetable fiber crops referred to herein include the jute, kenaf, ramie and flax. Among these crops, jute is of major importance while the others are only of minor importance due to their smaller acreage as well as limited production. All the products are either for making packaging materials, weaving and cordage making, or for scutching into fibers for domestic or for export use.

I. Jute

Jute (*Corchorus capsularis* L.) belongs to the basswood family or Tiliaceae, and is one of the most important long fiber crops in Taiwan. It is mainly used for making gunny sacks to pack rice and sugar. To meet our policy of self-sufficiency, jute production has been gradually increased through the efforts of our government in cooperation with jute farmers since 1948, and has reached the stage of providing enough raw material for domestic needs during the recent years.

A. Production and Demand

Taiwan produces annually about 800,000 metric tons of sugar and 1,850,000 metric tons of rice, which require a great amount of gunny sacks for packing. It is estimated that the domestic consumption of retted jute is around 20,000 metric tons annually. Though jute acreage in Taiwan reached its peak in 1939 when the Island was under the Japanese occupation, totalling about 23,121 hectares with a production of 15,426 metric tons of retted jute, it dropped to 2,503 hectares in 1946 producing only 1,279 metric tons of retted jute, which was merely about 9 percent of the production of the peak year. Emphatic attention has been paid by our Government to the increase of jute production since 1948. The yield of retted jute per unit area steadily increased from 1947 to 1959. As a result, a small amount of 150,000 kilograms of scratched jute was exported to Japan in 1959. Then again,

in 1960, more jute was exported from Taiwan to Japan and England, totalling about 1,800,000 kilograms of both scratched and retted jute.

The acreage, yield and production of jute from 1947 to 1959 are tabulated as follows:

Year	Acreage (ha.)	Retted jute	
		Unit yield (kg./ha.)	Production (kg.)
1947	3,778	685	2,587,600
1948	16,600	685	11,366,300
1949	11,094	797	8,839,800
1950	9,152	766	7,009,300
1951	12,174	890	10,840,600
1952	16,229	1,241	20,144,519
1953	6,791	787	5,342,570
1954	11,230	1,140	12,804,722
1955	14,959	1,252	18,729,239
1956	13,562	1,277	17,323,275
1957	6,755	1,340	9,052,741
1958	12,644	1,352	17,095,847
1959	17,864	1,344	24,009,216

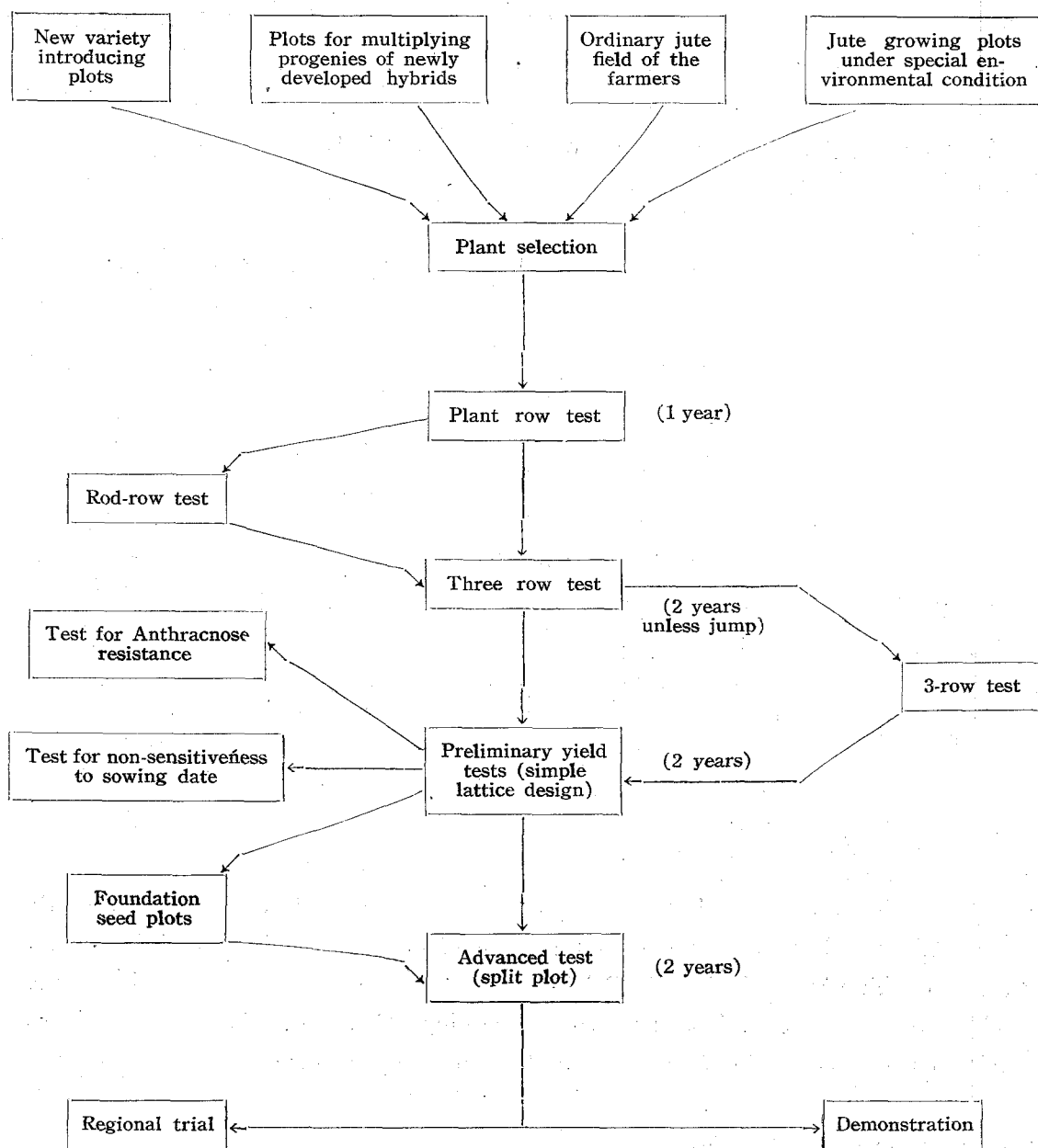
B. Producing Areas

The main jute producing areas are in the central and southern parts of this Island. Within these areas, over 80 percent of the acreage is located in the prefectures of Yunlin, Chiayi and Tainan where temperature and rainfall are most suitable for jute production; and the remaining 20 percent is scattered in the prefectures or municipalities other than those mentioned above.

C. Jute Improvement Program

1. Varietal improvement of jute:

Standardization of jute breeding program. Prior to 1952, no standard procedures in the jute breeding program were followed and the methods adopted varied with different plant breeders. From 1952 to 1953, through repeated discussions and revisions among the plant breeders in Taiwan, a set of standard procedures for jute breeding was established and put into effect. This set of procedures is outlined in the following diagram:



Pure line selection. Between 1948 and 1950, the Taiwan Agricultural Research Institute made selections on a limited scale from the then existing varieties and conducted regional tests at six localities. As a result, the varieties "Huwei Green Bark No. 7", "Hsinfeng Green Bark", "Taichung Special No. 1" and "Shuishang Green Bark" were selected as more desirable in their respective areas and were put into extension. Since 1952, extensive selections of plant materials from the fields of 1,000 farmers in the major jute producing area were made by Tainan Fiber Crops Experiment Station with the assistance of the Joint Commission on

Rural Reconstruction (JCRR). A total of 11,037 individual jute plants were obtained from over 300 villages in 83 townships located in 13 prefectures/municipalities. Through successive steps of selection and breeding, 9 new lines were obtained from the first preliminary yield test. In 1958-59, Y-6-466, the most promising line among all the selections, together with three other promising lines, were included into a regional trial conducted at nine localities. The results obtained have indicated that this new line Y-6-466 has taller stalk, is resistant to Anthracnose and less sensitive to photoperiod, and outyields the check variety. In 1960, the new variety, although not yet formally named by the Provincial Department of Agriculture & Forestry, has been put into demonstration in the jute producing areas. Its performance has attracted much attention of the jute farmers. It is planned that, in 1961, this new strain will be formally named and propagated for extension.

Hybridization. Crossings between existing varieties and of Halmaheira No. 5 with existing varieties have been carried out with the aim to combine high yielding capacity with disease resistance. This program is still in progress.

2. Cultural improvements:

The steady increase of unit yield of jute in the past decade is due mainly to the improved cultural practices. Mixing of jute seeds with Spergon (1:100) to prevent damping-off disease has been adopted by all the jute farmers; the liberal application of compost (20,000 kg./ha.) in addition to chemical fertilizers (ammonium sulphate 400 kg., fused phosphate 140 kg. and potassium chloride 120 kg. to each hectare), the repeated weeding and cultivations, etc. are all aimed at the goal of increased yields and improved quality.

Seed collection and multiplication in winter months. Ordinarily, jute is sown in April and harvested in August for fiber. The stalks are cut by hand, after that the bast layer is stripped from the stem. The bast layer, after being sun-dried, is called crude jute. Sometimes the tissues are scratched from the ribbons with a fix-positioned knife, then dried to give a product called scratched jute. Retting of green ribbons is accomplished in 10-14 days by immersion in water.

For seed collection, farmers usually keep a few rows of jute plants for 50-60 days after harvesting for fiber. Unfortunately, the threat of seed damage or destruction by typhoon is ever-present. Seed production would be badly affected and shortage resulted, should typhoon hit hard the Island. The serious seed shortage in 1957 was chiefly due to this reason.

Since 1956, experiments have been conducted to sow jute seeds (collected from the fall crop) in winter in the southern part of Taiwan where winter temperatures are comparatively mild. At first, jute seeds were sown at a fairly wide range of period from October to January to determine the time of blooming and capsule formation. Then, the sowing period was narrowed down to within the month of December so that seeds would mature in time (April) for fiber planting. The seeds multiplied in winter were normal unless otherwise attacked by insect pests. It was found that, during the growing period, Chlorobenzilate (controlling mite injury), Karathane and Triton (controlling powdery mildew) should be applied heavily in order to save the crop and to obtain seeds. The amount of seeds obtained through winter season was about 120 kg./ha.

Technically, the above practice could eliminate seed shortage caused by typhoon. However, due to the lower rate of seed production and the necessity of heavy application of pesticides, the costs for producing seeds are quite expensive; therefore, its practicability has yet to be determined.

Transplanting of jute. The practice of transplanting of jute seedlings has been proven to be successful through years of experimentation. This practice is to raise jute seedlings in a nursery where irrigation water is available. After the seedlings reach 20 days old, they are ready for transplanting into the field.

In the central part of Taiwan, the farm land has been used very intensively. Several crops are grown in the year on the same piece of land either in succession or overlapping with one another. To raise jute in the nursery for a period of 40-50 days and then to transplant the seedlings about 50-60 cm. in height into the paddy field under intercropping condition with the rice for 15 days would save a total of 45 days of land use. Then, in early August, when jute crop is harvested, the second rice crop can be planted. By adopting this practice, without affecting either one of the 1st and the 2nd rice crop, an additional crop of jute may be sandwiched in-between them. This practice has been accepted by farmers in central Taiwan.

While in southern Taiwan, the rainy season commences from April and ends up in October. After that, dry season prevails. In recent years, the rainy season sometimes commences 20-30 days late which makes it difficult to plant jute in time. If the farmer is to wait until the rainy season starts, the yield of the crop would be affected. By resorting to this practice, jute seedlings could be raised in a small acreage of land with adequate water source for irrigation. As

soon as rainy season commences, jute seedlings may be transplanted into the field. Also in areas where the previous crop, such as sweet potato, requires a longer period of growth to reach its maximum yield, the transplanting method is very useful in such case without affecting the yield of its predecessor nor its own yield.

In 1960, demonstration and field day on transplanting of jute were conducted in Kaohsiung, Chiayi and Changhua, respectively. Farmers were deeply impressed by the recommended improved practices.

Seed production from apical cuttings. In order to solve the problem of seed shortage due to typhoon damage, another method, in addition to sowing seeds in winter, is found also useful in seed production. During the harvesting time, the jute stalk is cut off from the ground. The apical portion bearing the flowering shoot which is quite tender does not give yield of much fiber. This apical portion may be cut off from the stalk and used as cutting. According to the experimental results, the apical portion could be tied on a piece of jute stem of 8-10 cm. long. By inserting the stem piece into a flooded field leaving the basal portion of the apical cutting immersed in water but above soil, it would hasten the fibrous roots to develop within 5-8 days. If properly managed, the rate of survival may reach as high as over 90%. After the cutting is set, new flowers may develop and capsules in formation. The seeds will mature after 80-90 days. Since the apical cutting is only about 80-120 cm. high, the damage from typhoon may be reduced to its minimum. Furthermore, it is convenient for crossing in breeding work.

II. Kenaf

Kenaf (*Hibiscus cannabinus* L.) belongs to the family of Malvaceae and is only of minor importance among the long vegetable fibers in Taiwan.

The history of kenaf cultivation in Taiwan dates back to 1908. Seeds of kenaf were introduced in that year from Bombay, India, by the Agricultural Branch of the Taiwan Central Research Institute for trial planting. After years of experimentation, it was found that kenaf could be used as an excellent jute substitute for making gunny sacks.

The physical and chemical properties of kenaf are similar to those of jute, while kenaf is more tolerant to drought and to less fertile soil. Furthermore, it is adaptable to a wide range of dryland soil.

A. Production of Kenaf

When the World War II broke out, kenaf was considered in Taiwan just as important a crop as jute, so its acreage increased rapidly to exceed 2,000 hectares.

After the war was over, the acreage of kenaf dropped down considerably. In 1949, the government began to extend this crop with the aim of producing enough raw material for making gunny bags. In 1952, the acreage of kenaf was increased to 1,271 hectares. Unfortunately the corn borer and Anthracnose infestation was very severe in that year. Followed by strong typhoon, the crop was therefore heavily damaged. Farmers became reluctant to plant kenaf. Consequently the acreage dropped down again. Ever since, the acreage of kenaf has dwindled around 100 hectares. The acreage, unit yield and production of kenaf from 1952-1958 are tabulated as follows:

Year	Acreage (ha.)	Unit yield in retted fiber (kg./ha.)	Production in retted fiber (kg.)
1952	1,271.17	1,242	1,579,207
1953	498.78	878	437,700
1954	282.23	619	174,667
1955	268.58	1,345	361,196
1956	155.40	883	137,233
1957	108.50	907	98,387
1958	83.10	657	54,575

B. Improvement Program of Kenaf in Taiwan

The improvement program of kenaf in Taiwan has been concentrated on 1) varietal improvement for developing disease resistant and high yielding varieties and 2) improvement of cultural practices.

1. Varietal improvement:

Since 1946, new kenaf varieties have been introduced from the United States to Taiwan for trial purpose. Among the 22 introduced varieties, Cuba A and Cuba C have been found quite promising. According to the experiments made at seven localities in a period of three years, Cuba A and Cuba C are proven to be resistant to Anthracnose disease and outyielding the check variety, Madras Red.

In 1957, another 81 new strains were introduced to Taiwan from the United States and Cuba. Among these introductions, BG-52-7 has been selected as one of the best strains.

Aside from these introductions, selection among the native varieties has also been conducted since 1953. One of the promising lines selected is 42-3112-1 which has been found resistant to Anthracnose disease and of high yielding capacity.

In 1960, BG-52-7, El Salvador and 42-3112-1 together with 2 check varieties, Cuba C and Madras Red, were included in a regional test carried out at five localities. All the three new strains outyielded the check varieties.

In order to transfer the characteristic of rootknot nematode resistance to kenaf, interspecific crosses have been made between kenaf and *Hibiscus eetveldianus*, which is claimed to be very resistant to nematode infestation. The program is still under-way.

2. Improvement of cultural practices:

The improvement of cultural practices has been emphasized on the basic methods of cultivation and the control of corn borer, a very serious insect infesting the kenaf. The important findings may be summarized as follows:

- a. The proper time for sowing kenaf should be in the middle of April while that for seed production could be postponed to late June or early July.
- b. Kenaf will give higher fiber yield of better quality, if allowed to grow 120 days after germination. For seed production, the plant should require another 30-40 days after the blooming time to reach the stage of seed maturation.
- c. The practical rate of fertilizer application for kenaf should be 100 kg. of N, 40 kg. of P_2O_5 and 60 kg. of K_2O .
- d. The European corn borer (*Pyrausta nubilalis* Hubner) is a kind of destructive insect causing occasionally 10-50% of kenaf to break down and thus resulting in serious losses. From 1952 to 1957, the life history, ecology and control methods of corn borer were thoroughly studied. By sowing corn as a trap crop around the kenaf field at the same time with kenaf, corn borer would infest heavily on corn from late May to early June but very lightly (below 5%) on kenaf. In early June, corn should be harvested and burnt to kill the borers. Spray a few rows of kenaf neighboring the trap crop with Endrin. Finally cut down the infested plants to prevent the further spreading of the insect. This

practice has been found very effective in controlling the European corn borer on kenaf.

III. Ramie

A. Ramie Production in Taiwan

Ramie (*Boehmeria nivea* Gaud.) has been cultivated in Taiwan for more than 300 years. After the World War II, the production of ramie fiber seldom exceeded 1,000 metric tons annually with the exception of 1954 when 1,024 metric tons of ramie fiber were produced. Ramie fiber in Taiwan is used for making fishing net, twine, etc., for weaving into yarn and also for export. In recent years, it is also used for weaving rug for various purposes.

The acreage and production of ramie fiber from 1946 to 1959 are tabulated as follows:

Year	Acreage (ha.)	Production (kg.)	Average yield (kg./ha.)
1946	925.42	755,398	816
1947	1,318.61	759,111	576
1948	1,455.17	761,689	523
1949	1,577.50	892,762	566
1950	1,124.86	688,117	612
1951	1,087.34	659,535	607
1952	1,044.30	675,555	647
1953	1,105.69	802,349	726
1954	1,266.23	1,024,238	809
1955	1,142.83	827,752	724
1956	1,122.09	844,969	753
1957	1,151.30	852,527	740
1958	1,125.10	857,152	762
1959	1,151.71	895,210	777

Ramie fiber is also an export item in Taiwan. During the first few years after the War, about 300 metric tons of dry fiber was exported to Japan annually. However, as a result of the establishment of ramie textile mills in Taiwan in recent years, the amount of ramie fiber exported annually has been reduced to around 200 metric tons only. The remainder is used for various purposes on the domestic market.

B. Ramie Improvement Program

1. Improvement in varieties:

In Taiwan, ramie is cultivated almost all in upland hillsides or slope areas.

In order to select varieties which would be adaptable to such areas, they should be resistant to drought, frost and diseases, and also high yielding. The main improvement work on ramie may be summarized as follows:

Introduction and selection. Since 1947, 92 varieties have been collected from domestic organizations and from abroad, including Japan, U.S. A. and the Philippines. Through continual studies, some good varieties such as "Miyazaki No. 112" and "Steel Wire No. 3" were selected from them. These selections outyielded the popular variety "Nanhua Green Skin" by 7-11% of crude fiber. From the offsprings developed from sexual propagation, 7 promising strains have also been selected and put under observation in the Tainan Fiber Crops Experiment Station.

Breeding through mutation induced by Colchicine and radiation. Colchicine has been used to treat ramie seeds for induced mutation. In 1959, 52 plants were selected from the offsprings developed from seeds treated with Colchicine. Some of them are found growing vigorously and producing more tillers. In 1960, 2,372 seedlings were developed from the 52 treated plants. In order to induce mutation by irradiation, ramie seeds and suckers were treated in 1960 with X-rays of various intensity and various length of time. From the preliminary results obtained, it seems that the intensity of radiation below 50,000 r is strong enough for treating ramie seed for induced mutation. All the 638 seedlings treated have been planted for observation.

Breeding through selfing and crossing. Some good varieties have been selected for selfing since 1957. Fifty-six selfed lines of the first generation, 7 lines of the second generation and 105 lines of the third generation are selected, and 18 excellent selfed lines of the third generation will be selected as materials for crossing among themselves and with good varieties. Besides, some male sterile plants were discovered in the selfed lines as breeding material.

Standardization of breeding procedures. In 1960, a draft on the methods and procedures of breeding ramie was prepared. The draft has been circulated to the plant breeders in Taiwan for suggestions and revisions. It is expected that a revised set of standard procedures for ramie breeding program may be formulated before long.

2. Improvement in cultivation:

Method of propagating ramie plant. Experiments on the propagating methods of ramie have been conducted. Young ramie plants can be successfully

propagated from seed, and the number of seedlings obtained is 3 times as many as that propagated asexually either from rhizomes or from root stocks within 3 years. However, the speed of rhizome development from seedlings is slower than those from asexually propagated plants. Rhizome is still the popular method used by farmers for propagating ramie.

Application of fertilizer and mulching of ramie plants with straw. According to the experimental results, 90 kg. of N, 30 kg. of P_2O_5 and 90 kg. of K_2O gave the maximum fiber yield. However, for economical application, especially when compost manure is available, a rate of 120 kg. of N, 20 kg. of P_2O_5 and 60 kg. of K_2O is recommended. Green manure and chemical fertilizers are suitable for land on the slopes, while compost, nightsoil and chemical fertilizers are suitable for land on the plain. Mulching of plants with straw in winter will prevent the crop from frost injury and will increase the yield of fibers.

Feeding value of ramie. Ramie leaves and young plants contain 20% of protein, vitamin A and other nutrients. Through continual studies from 1953 to 1956, it was found that ramie leaves and young plants of one month old may be used as forage. The leaves may be used as a supplementary feed for hog, goat and chicken. The yield of fresh leaves varies from 1 to 3 metric tons per hectare during the harvesting time. The nutrient feed for hogs may be obtained in 60 days after storing in silage with 2% of cane molasses or 0.1-0.2% of salt added.

3. Improvement in fiber processing:

Improvement of decorticators. With the assistance of JCRR, the Tainan Fiber Crops Experiment Station has purchased four different types of decorticators from other countries for trial use. In the scattered ramie fields in Taiwan, the Ikeda type of decorticator is the most common one in use. This type of decorticator could reduce the cost by 60% as compared with that by hand labor. However, there are still some defects in this type of decorticator. Therefore, the Fiber Crops Experiment Station has made some improvement of this type of decorticator, and the modified type is called "FCES Motor-operated Decorticator". This modified type of decorticator is easy to be transported and more efficient. Moreover, the Station has also designed another type of decorticator, in cooperation with the National Taiwan University. This is called "FCES Kaopan Type Pedal Operated Decorticator", which is operated by manual labor instead of mechanical and electrical power. It is light in weight, being only 84 kg. Therefore, it can meet the need in the mountainous areas, where communication and transportation are not convenient and power source is lacking. Such type of decorticator could produce 13 kg. of dry fiber in an 8-hour day, with

a team of 3 workmen. Its efficiency is about twice that of scratching by hand. The percentage of fiber decorticated is 4%. One such decorticator could handle 0.5 hectare of ramie field.

Irrigation of ramie field by using sprinkler in dry season. From winter to the following spring in the central and southern parts of Taiwan, ramie grows slowly and cannot be harvested due to the lack of irrigational water. By using sprinkler irrigation method at 15-day intervals during dry season, the number of harvests could be increased from 3 to 5. The yield of crude fiber from irrigated field is uniformly increased by 70% over that from the field without irrigation.

Fumigation and degumming of ramie fiber. After decortication, the wet crude fiber should be fumigated as soon as possible before drying in closed room with sulphur for 6 hours in order to avoid molding and to keep the fiber white and lustrous. The chemical methods of degumming are also studied.

IV. Flax

A. Production of Flax in Taiwan

Flax (*Linum usitatissimum* L.) is planted as a winter crop after the harvest of the second rice crop in Taiwan. The variety, Taichung Special No. 1, now under extension, is a fast growing one requiring only about 100 days to mature; so it can be sandwiched between the second rice crop of the current year and the first rice crop of the following year. The acreage, yield and production of flax from 1950 to 1959 are listed in the following table:

Year	Acreage (ha.)	Dried straw	
		Unit yield (kg./ha.)	Production (kg.)
1950	266	1,585	421,036
1951	667	2,071	1,380,560
1952	1,004	2,204	2,213,806
1953	413	1,946	804,695
1954	313	1,406	440,354
1955	753	2,304	1,735,997
1956	1,573	2,589	4,071,441
1957	1,526	2,453	3,742,893
1958	1,559	3,205	4,997,245
1959	2,435	3,303	8,041,735

Flax straw after thorough drying is sold at a pre-announced price to the two

scutching plants, both belonging to the Taiwan Industrial Development Corporation. Before planting, the Corporation will enter into contract with farmers and supply flax seeds to them on a loan basis. After harvesting, farmers will repay flax seeds to the Corporation with a premium of 50% of the original amount. The remainder of the seeds may be sold to any dealer, if desired.

Flax straw is scutched into line and tow fiber. The former is exported to Japan for spinning purpose and the latter sold to the local paper mills to make cigarette paper for domestic use.

Linseed is sold either to the Corporation or to other oil mills to extract linseed oil for industrial use. Flax textile mill is still lacking in Taiwan.

B. Improvement Program of Flax

1. Varietal improvement:

In order to produce new flax varieties high in both fiber and seed productions, some new varieties, i. e. Taichung No. 1, 2-127 and 2-192, have been selected from the progenies obtained through hybridization. All of these new varieties or strains are early maturing and are highly productive in seed and fiber. Their average growing days are 110, 107 and 125, respectively. Such characters are desirable for fitting into the present cropping system. The following table gives the results of the varietal improvement made during 1954-1960:

Year	Variety Yield	Taichung No. 1		2-127		2-192	
		Straw (kg./ha.)	Seed (kg./ha.)	Straw (kg./ha.)	Seed (kg./ha.)	Straw (kg./ha.)	Seed (kg./ha.)
1954-1955		3,242	855	3,442	1,052	3,882	855
1955-1956		3,861	1,213	3,904	1,096	5,956	1,076
1956-1957		6,514	1,197	6,401	1,407	7,910	1,235
1959-1960		5,272	1,001	4,771	774	—	—
Average		4,722	1,016	4,629	1,082	5,916	1,055

In 1955, the experiment work on seed-flax was started and 4 seed-flax varieties were first introduced to Taiwan from the United States. The results obtained are presented in the following table:

Variety	Growing days	Plant height (cm.)	Stem length (cm.)	Seed yield (kg./ha.)
Punjab 47	149	83.70	48.50	1,540
Punjab 53	155	96.10	63.90	1,347
Argentine C. I. 463	150	89.60	59.60	1,512
Red Wood	149	90.00	48.65	1,433

Remark: Sowing made on October 24, 1955.

Again in 1957, more than 150 flax varieties have been introduced from Japan, France and the United States to Taiwan for trial purpose. Although some are found quite promising, nevertheless none of them are as early maturing as Taichung No. 1 or 2-127; therefore they may not fit well between the two crops of rice.

In 1960, a set of the world collection of both fiber and seed flax varieties was introduced from USDA to Taiwan for observation and trial. A flax improvement program has also been started in the same year.

2. Cultural improvement:

From 1956-1958, an experiment on the sowing date was carried out with four seed-flax varieties as testing materials. The results are presented as follows:

Unit: kg./ha.

Year	Variety		Punjab 47		Punjab 53		Argentine C. I. 463		Red Wood	
	Sowing date	Yield	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw
1956/57	Oct. 16		868	4,500	559	6,500	793	5,546	518	4,500
	Nov. 1		797	4,500	700	5,637	993	6,000	788	4,136
	Nov. 16		1,013	3,773	711	4,546	1,120	5,182	1,084	3,773
	Dec. 1		886	3,409	529	3,773	856	4,409	1,059	3,682
	Dec. 16		145	3,136	102	3,364	209	4,500	229	3,591
1957/58	Oct. 15		885	4,630	1,100	6,500	1,290	6,075	1,125	4,830
	Nov. 1		1,355	4,535	1,195	6,140	1,150	6,105	855	5,140
	Nov. 16		1,480	4,540	1,195	5,360	1,152	6,140	755	5,250
	Dec. 1		1,185	3,325	840	3,765	1,050	4,790	1,245	4,210

From the experiment, it is obvious that the middle of November is the optimum time of sowing for seed production.

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1. H.S. Chang, C.Y. Chi and C.K. Chen:
Production and Improvement of Jute in Taiwan (Oct. 11, 1960)
2. C.Y. Chi:
Production and Improvement of Kenaf in Taiwan (Sept. 10, 1960)
3. H.S. Chang and C.Y. Chi:
Production and Improvement of Ramie in Taiwan (Oct. 10, 1960)
4. H.S. Chang and C.Y. Chi:
Production and Improvement of Flax in Taiwan (Dec. 27, 1960)

FORAGE CROP DEVELOPMENT IN TAIWAN

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I. Introduction

Taiwan is rather a mountainous island. There is only 31 per cent of plain area with elevation within 100 meters, and this has already been fully developed into crop land. Under the pressure of a rapidly increasing population, the 1,380,000 hectares of so-called agricultural and forestry marginal land with an elevation of less than 1,000 meters is the most important natural resource to be developed. According to a land survey program, 500,000 hectares of the said marginal land is suitable for crop and livestock production. How to develop this sloping land in the most proper, productive and profitable way is the most important undertaking at hand for the agriculturists of Taiwan.

Soil conservation is the most important item to be considered in the development of sloping land, especially to typhoon raided countries, such as Taiwan where erosion annually takes a heavy toll of soil resources and where floods often wreck havoc. The development of grassland which will not only protect soil but also build up soil fertility can play an important role in marginal land development as well as in food production in the form of livestock products.

The following is a brief report of forage crop development in 1960 in the Republic of China.

II. Introduction of Plant Material

Besides being a very important measure to improve a crop, plant introduction sometimes is the only way to obtain a better strain for certain types of forage crops, since many warm climate perennial grasses produce no viable seed or only apogamous seed.

Our introduction record shows the following number of species or strains of grasses and legumes that were introduced prior to and after 1956:

Group	No. of species/strains introduced			
	Before 1956	1956-59	1960	Total
Perennial grasses	16	62	28	106
Annual grasses	1	35	8	44
Perennial legumes	4	39	13	56
Biennial legumes	—	5	1	6
Summer legumes	16	16	1	33
Winter legumes	4	33	2	39
Total	41	190	53	284

The procedure for handling these materials is as follows:

All the introduced planting material is treated and tested at the Seed Laboratory of National Taiwan University. Germinated seedlings are then planted in pots and kept in an insect proof screen net for up to three months to insure against introducing disease or insect pests from abroad. Then the cuttings from the pots or the remaining seeds are planted to a fundamental observation plot for further close observation. In the next planting season, these promising newly introduced strains are released to regional observation nurseries.

Collection and survey of native grasses and legumes also has been given attention. Prof. DeVol of National Taiwan University and his assistants are working on the taxonomical side of a forage crop improvement. A monograph on *Digitaria* will be published soon.

III. Observation Nursery (Preliminary Test Plots)

A total of 22 forage crop observation nurseries have been established throughout this island on different soil types and climatic areas, and at elevations from sea level to 2,200 meters.

Four observation nurseries are used to keep all the sustainable strains. Strains at the other nurseries will be discarded after three years' observation if their performance is unsuitable. Outstanding strains are multiplied at observation nurseries to a limited extent.

This year's observation indicates that the following newly introduced strains are quite promising: Other promising strains for previous years were reported in

a paper entitled "Grassland Development in Taiwan" by Mr. Howard W. Ream at the Second Far East Seed Improvement Workshop in May 1959 held in Tokyo, Japan.

South African pigeon grass (*Setaria sphacelata*). We have four strains of this grass: A68 and A71 were introduced from the Philippine Bureau of Animal Industry, A88 and A89 from Pretoria, South Africa, in 1960. A68 out-yielded A71 and was more leafy. A88 looks similar to A68 but their yield has not been compared yet. A89 is a red stemmed one and is much coarser than the other three. The latter two were introduced in mid 1960 and have not been tested to any degree for productivity.

A68 is palatable to cattle. It has a very wide adaptability and performed very well both on acid red earth and on alkaline tidal land. It survived through the winter at an elevation of 2,200 meters but a varietal test indicated it grew much faster under high temperatures than in winter months.

A82 Woolly finger grass (*Digitaria pentzii*) Nelspruit, from Pretoria, South Africa in 1960. It looks very much like our variety A24 Pangola, which has been widely extended on Taiwan.

A85 Guinea grass (*Panicum coloratum*, Makarikari strain) from Pretoria, South Africa, in 1960. It is a bunch type grass but it sets roots freely from nodes of tender dropping stems. This is an advantage in establishment and in providing a dense cover to protect the soil better than our other upright strains of *Panicum maximum*.

Rhodesian kudzu (*Glycine javanica*). We have two collections, i. e. C47 from the Australian Department of Agriculture and Stock in 1957 and C53 from Pretoria, South Africa, in 1960. Both are creeping legumes with slender vines. C53 seems tenderer than C47 and grows faster.

Vetches. Among our winter annual legume collection, the true vetches (*Vicia spp.*) perform quite well in northern Taiwan. Lana vetch (*Vicia dasycarpa*) looks better than hairy vetch (*V. villosa*); common vetch (*V. sativa*) and purple vetch (*V. atropurpurea*). So far no seed has been produced by any of the vetches at different locations and at elevations up to 2,200 meters. A small portion of flowers did set pods then the pods wilted away when about 7 days old.

Papago peas. Introduced from the U. S. in 1959 also appears promising particularly as a winter forage and green manure for paddy fields. It, as well as Lana vetch, is particularly good in combination with winter oats as a winter forage in northern Taiwan. No seed was produced either at any location.

IV. Field Trials

A. Varietal Tests

Promising strains selected from regional observation nurseries are included in varietal tests. Following are preliminary data from field tests conducted in 1960:

1. Varietal test at Taiwan Livestock Research Institute:

This location is in southern Taiwan with an average annual rainfall of 1,750 mm. The dry spell extends from October to April. The average annual temperature is 23.1°C (with an average for the summer months of 28.2°C and an average of 18.9°C for winter months). The soil is an acid yellow sandy loam. The following yield data was obtained from the number of cuttings indicated which were made during the growing season (May to October) of 1960. The first cutting was made on May 24 and the last on October 20.

Variety	Yield in fresh wt. (kg./ha.)	Dry matter (kg./ha.)	Crude protein (kg./ha.)	No. of cuttings
A24 Pangola (<i>Digitaria decumbens</i>)	82,150	18,323.3	1,534.4	5
A 1 Para (<i>Panicum purpurascens</i>)	65,550	16,119.3	1,175.5	5
A 2 Rhodes (<i>Chloris gayana</i>)	55,200	15,105.8	1,386.8	5
A29 Alabang X (<i>Andropogon nodosus</i>)	54,725	12,982.4	1,175.5	5
A43 Suwannee Bermuda (<i>Cynodon dactylon</i>)	54,475	18,859.1	1,581.3	5
A42 Coastal Bermuda (<i>Cynodon dactylon</i>)	51,025	17,618.6	1,128.8	5
A32 African Blue grass (<i>Digitaria pentzii</i>)	46,100	11,919.7	1,026.4	4
A32 Pensacola Bahia (<i>Paspalum notatum</i>)	40,200	10,377.8	927.4	4

The A24 Pangola grass, as reported by Mr. Howard W. Ream in the last Workshop, is still the leading variety this year. Both Bermuda grasses, even though less in fresh weight, nevertheless, yielded about the same amount of dry matter and Suwannee Bermuda produced equally as much crude protein as Pangola grass. However, all varieties had more weeds than A24 Pangola and future productivity will no doubt be impaired by excessive weed growth. This coincides with reports from other countries that the Bermuda grasses are better adapted than Pangola grass to light and dry soil, particularly Suwannee.

2. Tall grass varietal test at the Taiwan Sugar Corporation Farm Animal Breeding Station:

Due to the need for soil conservation on sloping land and the difficulty of keeping out weeds between rows of tall grasses such as Napier grass, we are not very enthusiastic in developing tall bunch type grasses for such areas. But where

dairy farmers can afford to use expensive level land to produce forage and the barn yard liquid manure can be directly used to irrigate the forage land close by, then the tall grasses may have a place. This field test is located on irrigatable, fertile, level land and includes four replications.

Each plot was fertilized with 500 kg./ha. of ammophosphate on March 15. In a period of seven months, six cuttings were obtained.

(kg./ha.)

Variety	Yield		Crude Protein
	Fresh wt.	Dry matter	
A68 South African Pigeon grass (<i>Setaria sphacelata</i>)	204,350	32,436.6	3,040
A26 Napier grass (<i>Pennisetum purpureum</i>)	203,180	43,933	3,754
A25 Napier grass (Hawaiian strain) (<i>Pennisetum purpureum</i>)	166,920	31,600	2,982
A27 Guinea grass (<i>Panicum maximum</i>)	97,060	19,228	1,912

Napier grass, although it produced the most dry matter and protein in this experiment, has a very serious shortcoming in that, it elongates too fast during the rainy summer season to be cut at the right stage for a soiling crop. When it reaches a height of more than 2 m., only about two-thirds of the fresh forage is utilized, while the remaining portion consists of a cane-like stem which is not consumed by cattle. On the other hand, *Setaria sphacelata* has no above-ground stem except flowering stalks and with slightly less dry matter and crude protein may actually be more productive than Napier since cattle eat almost all of the forage produced. A27 Guinea grass is the oldest forage grass introduced and released by the Japanese and was the least productive in this experiment.

3. Cowpea varietal test:

Cowpea (*Vigna sinensis*) is a fast growing summer annual legume. A varietal test was conducted at the Taiwan Livestock Research Institute from March 26 to May 24, 1960. Groit, Victor, California strain of Victor and Reeve's selection all proved to be more productive and higher in protein than the other three varieties tested when cut for forage as shown in the following table:

(kg./ha.)

Variety	Yield		Crude protein
	Fresh wt.	Dry matter	
E26 Groit	28,250	3,520.0	768.4
E11 Victor	27,750	3,540.9	823.8
E11-1 Victor-California	24,000	2,983.0	811.2
E37 Reeve's selection	23,500	2,674.3	881.3
E31 C. P. I. 8085	20,250	2,367.2	562.3
E27 Suwannee	17,000	2,153.9	544.0
E35 Poona	13,000	1,664.0	468.2

B. Fertilizer Requirement of Pangola Grass

A preliminary field test to determine the fertilizer requirement of Pangola grass (strain A24) was conducted at the Taiwan Livestock Research Institute on a sandy loam soil of low fertility. The Pangola grass pasture used for this test had been established for 3 years and no fertilizer was applied in 1959. The growth of grass before the test was very poor and the whole field very uniform. One hundred kilograms of ammonium sulfate was broadcasted on May 15, 1960 over the whole area. The grass was cut on June 14 following which the various treatments were applied. The three levels for nitrogen were 0, 20 and 100 kg./ha.; for phosphoric acid 0, 16, 60 kg./ha.; and for potash 0, 60, 120 kg./ha.

The results of the first cutting may be seen in the table as shown hereunder. Subsequent cuttings showed no differences between treatments indicating that the nitrogen "ran out". The experiment is being re-designed for next year to include much higher rates of nitrogen in split applications.

Fertilizer treatment	Yield		Crude protein (kg./ha.)
	Fresh weight	Dry matter	
(A) 0- 0- 0	9,250.00	2,902.65	172.98
(B) 0-16- 60	10,375.00	3,202.76	201.61
(C) 20-16- 60	17,125.00	4,556.96	409.29
(D) 20-64-120	19,250.00	5,222.53	408.10
(E) 100-16- 60	33,125.00	7,039.06	351.13
(F) 100-64-120	37,750.00	7,497.15	664.16

Response to nitrogen was quite significant with nearly doubled the yield for 20 kg. of nitrogen per hectare and almost four times for the 100 kg. rate.

Response to phosphate and potash is insignificant as indicated above by comparing (A) & (B); (C) & (D); and (E) & (F). However, the high protein content of (F) shows some interaction at the higher levels of N, P and K.

The nitrogen fertilizer applied in this test was ammonium sulfate. Three months after the application of fertilizer, the pH value of soil from the plots where 20 kg./ha. of nitrogen was applied dropped from an original 5.5 to 5.2 while the N100 plots dropped to 4.8. The residue from ammonium sulfate has a marked effect in increasing soil acidity. The response on Pangola grass to nitrogen from different sources will be tested next year, particularly the effect on soil acidity.

C. Pangola Grass Cutting Experiment

Heights of cutting Pangola grass were 20, 40, and 60 cm. with three nitrogen levels, i. e. 50, 100 and 200 kg./ha. This test was started on June 18, 1960 at the Taiwan Livestock Research Institute Farm and ended in October 1960. The soil was a sandy loam of low fertility. Phosphate and potash were supplied in sufficient amounts on all plots so they were not limiting factors. The data is presented in the following table in terms of kilograms per hectare per day.

Treatment		Yield (kg./ha./day)		Crude protein (kg./ha./day)	Days to recover	No. of cuttings
Cutting height (cm.)	N (kg./ha.)	Fresh weight	Dry matter			
20	50	226.30	33.47	4.096	28	3
	100	375.00	55.43	11.175	21	4
	200	521.00	70.08	15.317	21	4
40	50	326.30	53.84	6.526	33	3
	100	455.00	62.47	8.418	33	3
	200	636.00	84.52	15.391	27	3
60	50	379.50	75.33	3.795	37	2
	100	551.00	100.60	7.604	37	2
	200	485.50	88.26	6.300	40	3

These data indicate that:

1. The optimum cutting stage of Pangola grass seems to be at a height of about 40 cm.
2. With adequate nitrogen fertilizer, Pangola grass can endure frequent cutting.
3. Enough Pangola grass can be produced each day to provide sufficient feed for 8 to 10 animal units to the hectare.

V. Chemical Composition of Forage Crops

The following chemical composition of forage crops were determined by the Feed Laboratory, Farm Animal Breeding Station, Taiwan Sugar Corporation under a cooperative project with the Chinese-American Joint Commission on Rural Reconstruction (JCRR). Samples were taken at soiling stage except noticed.

Variety	Dry matter (%)	Dry matter basis (%)							No. of analyses
		Crude protein	Fat	Fiber	Ash	N. F. E.	Ca.	P ₂	
Grass									
Alabang × A29 (<i>Andropogon nodosus</i>) 65 cm high	24.33	9.29	3.91	32.55	7.64	46.54	0.29	0.21	8
African blue grass A32 (<i>Digitaria pentzii</i>) 60 cm high	23.72	8.97	3.27	31.77	9.64	46.37	0.17	0.18	—
Bahia grass (<i>Pensacola</i>) A33 (<i>Paspalum notatum</i>) 60cm high	26.72	8.35	3.43	32.21	8.14	47.87	0.22	0.23	6
Bermuda grass (Coastal) A42 (<i>Cynodon dactylon</i>) 50cm high	36.88	7.05	3.96	34.30	6.53	48.29	0.16	0.22	8
Bermuda grass (Suwannee) A43 (<i>Cynodon dactylon</i>) 50cm high	38.08	7.59	3.28	34.39	6.40	48.36	0.17	0.23	8
Guinea grass A27 (<i>Panicum maximum</i>) 80 cm high	21.67	9.08	3.63	34.69	9.83	42.77	0.39	0.10	6
Napier grass A25 Hawaiian (<i>Pennisetum purpureum</i>) 150 cm high	14.36	10.57	4.05	32.28	8.23	49.49	0.11	1.14	4
Napier grass A26 (<i>Pennisetum purpureum</i>) 150 cm high	13.52	9.94	5.03	33.03	7.10	44.59	0.12	0.17	4
Pangola grass A23 (<i>Digitaria decumbens</i>) 60 cm high	23.72	9.90	3.90	34.06	7.92	44.22	0.30	0.38	4
Pangola grass A24 (<i>Digitaria decumbens</i>) 60 cm high	22.54	10.51	3.72	37.50	8.22	39.04	0.27	0.29	10
Para grass A1 (<i>Panicum purpurascens</i>) 80 cm high	25.00	9.03	4.16	32.89	6.37	47.55	0.18	0.24	8
Rhodes grass A2 (<i>Chloris gayana</i>) 80 cm high	26.63	10.35	3.22	34.18	7.77	44.48	0.22	0.43	8
Pangola grass A24 cut at different heights and N fertilizer levels									
20 cm. { N 50 kg/ha	14.79	12.26	5.01	34.81	10.79	37.13	0.25	0.36	2
{ N 100 kg/ha	14.78	20.15	5.64	33.65	10.91	29.65	0.22	0.29	2
{ N 200 kg/ha	13.45	21.83	4.77	34.54	10.63	28.44	0.22	0.35	2
40 cm. { N 50 kg/ha	16.50	12.12	5.15	36.73	8.54	37.46	0.19	0.36	2
{ N 100 kg/ha	13.73	13.46	5.23	38.89	9.23	33.19	0.20	0.43	2
{ N 200 kg/ha	13.27	18.22	5.61	35.18	9.57	31.43	0.27	0.37	2
60 cm. { N 50 kg/ha	19.85	5.05	3.62	35.62	7.45	48.26	0.24	—	2
{ N 100 kg/ha	19.86	8.87	5.72	42.11	6.91	36.34	0.24	—	2
{ N 200 kg/ha	14.94	10.39	3.85	43.75	5.35	36.66	0.10	0.08	2
Legumes									
Cowpeas (Av. 7 varieties) (<i>Vigna sinensis</i>) at full bloom	12.20	24.83	4.75	19.70	15.91	34.79	2.10	0.23	14
Kao haole (Ipil-ipil) C32 (<i>Leucaena glauca</i>) 1 m high	26.56	26.54	2.61	26.50	6.58	37.77	0.80	—	12
Kao haole (Ipil-ipil) C32 Sun dried leaflets	71.30	24.92	10.80	15.98	2.76	55.54	1.40	0.20	4
Milk vetch F11, before bloom (<i>Astragalus sinicus</i>)	11.50	26.09	6.09	11.30	7.83	38.69	0.50	0.10	2
After full bloom	11.60	20.69	6.03	13.79	9.51	49.88	0.40	0.10	2
Tropical kudzu C20 (<i>Pueraria phaseoloides</i>)	22.30	20.18	6.27	30.94	8.10	34.51	—	—	2

VI. Stunting Disease of Pangola Grass

Of the 9 strains of Pangola grass (*Digitaria decumbens*) and its closely related species introduced before 1959, all except A24 have shown symptoms of shortening blades and internodes which result in a reddish colored dwarf plant of witches broom type. The A24 strain introduced from the College of Agriculture, University of the Philippines, in 1957 by Mr. Ream, has been planted in observation nurseries and fields neighboring to stunted strains for 3 years and thus far has shown a high degree of resistance to this disease.

A communication from Dr. K.W. Kreitlow of USDA to Mr. Ream of JCRR states that Dr. A. van Hoof of Surinam, South America, suggested that there was a virus disease on Pangola grass in Surinam. Puerto Rico's specialists (L. Rivera-Brenes et al J. Agric. Puerto Rico University, April 1954; S. Little et al, Agron. J. 51: 111-113, 1959) pointed out that the Pangola grass was frequently attacked by aphids and the growth of grass was poor. Besides aphids, we have a long list of insects collected on stunted Pangola. To date, however, the specific cause of this disease has not been determined.

On a native *Digitaria* grown annually on the coastal waste-land of eastern Taiwan, similar stunting symptoms were found. The tendency of affected Pangola grass plants to recover from this stunting leads us to believe that the disease may be insect toxicogenic.

VII. Multiplication and Distribution of Planting Material

A24 Pangola grass has been selected as the most promising grass for Taiwan through observation and field tests. It is recommended especially for sloping land below 1,000 meters elevation. Since it sets no viable seed and is propagated by stolons, the problems in maintaining its purity are relatively simple. Caution has been taken to maintain the purity of this strain in multiplication plots established at various locations for furnishing planting material to farmers. The multiplication and distribution of this strain is under the direction and supervision of forage technicians stationed in different parts of Taiwan. The area planted to this strain reached 600 hectares this year.

Centro (*Centrosema pubescens*) C25 has been recognized as an excellent cover crop as well as a forage legume. It was first introduced from the Philippines for trial purpose in 1957. Around three tons of seeds will be available from farmers' fields in Taitung and some experiment stations and will be distributed through the

farmers' associations. This seed is grown under supervision of district agricultural improvement station technicians.

Other forage crops which have been multiplied for demonstration planting are:

Oats B9. One ton of seed was harvested at the Hualien District Agricultural Improvement Station in March 1960 and was distributed to dairy farmers in northern Taiwan for a winter forage demonstration project in November 1960.

Elbon rye B18. Five hundred kilograms of seed was produced by the Provincial Seed Farm and planted as a cover and forage crop at farms at higher elevations.

Alyce clover B3. It is a productive summer legume and is capable of growing along with Pangola grass. A strain was introduced from the United States to renew the seed stock at the Livestock Research Institute Farm. Four hundred kilograms of seeds were obtained from the seed crop this fall.

Tropical kudzu C20. The established seed plots at Hengchun will yield an estimated 1 ton of seed in January 1961.

Victor cowpea E11 and Tapilan E12 (*Phaseolus calcaratus*) have been used for artificially dried legume meal by the Puli Green Feed Factory. Around 100 ha. for each species have been planted every year for this purpose.

***Setaria sphacelata* A68** is a promising variety. It has been multiplied resently to provide sufficient seed to plant a grazing experiment next year.

VIII. Methods of Getting Seed Improvement Information to Farmers

A project entitled "Training Program for Dairy Farmers" was carried out this year. A series of training class were held at three of the leading dairies. A total of 428 farmers attended the classes. Twelve hours of lecture and 9 hours of field practice have been given to forage crop improvement each class.

The Animal Industry Division of JCRR also sponsors a project devoted to the production of educational materials for farmers and rural extension workers. Leaflets and pamphlets written for forage crop improvement during the year were:

1. Planting Pangola grass.
2. Fertilization and management of Pangola pasture.
3. Winter forage crops for northern Taiwan.
4. Green feeds for hogs.

5. Planting hybrid corn for feeds.
6. Ensiling forages.

These educational materials are distributed through extension workers of the farmers' associations.

IX. Training of Personnel for Forage Crop Improvement

Seven college graduates worked with the forage crop improvement project and received on the job training in 1960.

For the purpose of training more agricultural college students in forage crop improvement work, a project was established this year by JCRR to support undergraduate students who are working with the following topics as their thesis:

1. Investigation of root system of forage crops.
2. Chemical composition of forage crops, in relation to stages of growth and fertilizers applied.
3. The effect of different forage crops used as green feeds for poultry.
4. Vitality of grass stolons after storage and transportation.
5. Investigation on the feeding condition of draft animals.

LIST OF IMPORTANT COMMERCIAL VARIETIES OF CROPS
IN TAIWAN
AVAILABLE FOR INTERNATIONAL EXCHANGE

Compiled by
Plant Industry Division, JCRR

List of Important Commercial Varieties of Crops in Taiwan Available¹ for International Exchange

Common and scientific name	Country of origin	Economic importance	Varietal description	Climatic requirements	Season of seed supply
Field Crops					
1. Jute (<i>Corchorus capsularis</i> L.)					
a. Hu-wei green bark No. 7	Taiwan, China	It is one of the two most widely planted varieties in Taiwan. These two varieties constitute more than 80% of total jute acreage in Taiwan.	Medium maturity; high yield; thrives well in moist area; resistant to Anthracnose; no axil bud.	Planting season: April Harvesting season: Late July-early Sept. Soil requirement: Clay loam, loam with abundant humus Temperature: 25°C Elevation: Sea level Latitude: 22-24°N	Oct. - Nov.
b. Shui-shang green bark	Taiwan, China	- Ditto -	Late maturity; nonsensitive to day-length; less branching; very resistant to Anthracnose; no axil bud; high yield.	- Ditto -	Dec. - Feb.
2. Peanut (<i>Arachis hypogaea</i>)					
a. Tainung 1	Taiwan, China	For food and oil. Its cakes for feed and sometimes for fertilizer uses.	Wide adaptability; large kernel; good quality; high yield; adaptable for both spring and fall plantings; Spanish type.	Planting season: Mar. - Apr. July - Aug. Harvesting season: June - July Nov. - Dec. Soil requirement: Sandy loam to loam Temperature: 20-27°C Elevation: Sea level to 800 m. Latitude: 22-25°N	Aug. - Sept. Feb. - Mar.
b. Tsingtao	Taiwan, China	- Ditto -	Narrow regional adaptability, some acreage being planted in central and southern Taiwan; good yield and quality; adaptable for both spring and fall plantings; Spanish type.	- Ditto -	- Ditto -
c. Tainan Pei-yu-tou No. 1	Taiwan, China	It occupies at present about 30% of total peanut acreage in Taiwan. Used for food, oil and its cakes for feeding purposes.	Short and plump kernels with high oil content; high yield; adaptable for both spring and fall plantings; Spanish type.	- Ditto -	- Ditto -
d. Tainan Pei-yu-tou No. 2	Taiwan, China	For food and for oil processing.	Narrow regional adaptability, some acreage being planted in Hsinchu district; kernels flattened but with high oil content; Spanish type.	- Ditto -	- Ditto -

(To be continued)

(continued)

Common and scientific name	Country of origin	Economic importance	Varietal description	Climatic requirements	Season of seed supply
e. Tainan No. 6	Taiwan, China	Released for commercial planting in 1960. For food and oil.	Short plump and small kernels with thin shells; high yield; adaptable especially for spring planting on good soil; Spanish type.	Planting season: Mar. - Apr. Harvesting season: July - Aug. Soil requirement: Sandy loam to loam Temperature: 20-27°C Elevation: Sea level to 800 m. Latitude: 22-25°N	Aug. - Sept. Feb. - Mar.
f. Tainan No. 7	Taiwan, China	- Ditto -	Long kernels of fair size; fairly wide adaptability, but at present primarily planted in Tainan district; especially adaptable for fall planting; Spanish type.	- Ditto -	- Ditto -
3. Ramie (<i>Boehmeria nivea</i>) Nan-hwa green bark	Taiwan, China	About 25% of total ramie acreage in Taiwan is planted to this variety.	Medium maturity; high yield; thrives well in dry season; good fiber quality.	Planting season: Sept. - May Harvesting season: 3-5 times a year Soil requirement: Loam of pH 4-6 Temperature: 5-38°C Elevation: From sea level to 1,000 m. Latitude: 23-30°N	Nov. - Feb.
4. Rice (<i>Oryza sativa</i> L.) <i>japonica</i> type a. Chianan 2	Taiwan, China	One of the popular varieties in southern Taiwan.	Wide adaptability; moderately susceptible to blast; responds well to heavy fertilization; stiff straw; does not shatter; high yield; adaptable to saline soil.	Planting and harvesting season: 1st crop: Feb. - June 2nd crop: July - Nov. Soil requirement: Clay loam Temperature: 17-29°C Elevation: 50 m. above sea level Latitude: 22-24°N	July & Dec.
b. Chianan 8	Taiwan, China	Most popular variety in southern and eastern Taiwan.	High yield; wide adaptability; moderately resistant to blast; stiff straw; does not shatter; responds well to heavy fertilization.	- Ditto -	- Ditto -

(To be continued)

(continued)

Common and scientific name	Country of origin	Economic importance	Varietal description	Climatic requirements	Season of seed supply
c. Chianan 14	Taiwan, China	Grows only in limited acreage.	Early maturity; resistant to drought; stiff straw; susceptible to blast; shatters easily; excellent table quality.	Planting and harvesting season: 1st crop: Feb. - June 2nd crop: July - Nov. Soil requirement: Clay loam Temperature: 17-29°C Elevation: 50 m. above sea level Latitude: 22-24°N Planting and harvesting season: 1st crop: Jan. - June 2nd crop: July - Dec. Soil requirement: Sandy loam, loam, clay loam Temperature: 15-35°C Elevation: 20-200 m. above sea level Latitude: 22-25°N	July & Dec.
d. Chianung 242	Taiwan, China	One of the most promising new varieties released recently.	High yield; resistant to blast; wide adaptability; responds well to heavy fertilization.	Planting and harvesting season: 1st crop: Jan. - June 2nd crop: July - Dec. Soil requirement: Sandy loam, loam, clay loam Temperature: 15-35°C Elevation: 20-200 m. above sea level Latitude: 22-25°N	- Ditto -
e. Hsinchu 56	Taiwan, China	Newly released for Hsinchu area.	Responds well to heavy fertilization; resistant to blast; stiff straw.	Planting and harvesting season: 1st crop: Jan. - July 2nd crop: July - Nov. Soil requirement: Sandy loam Temperature: 15-35°C Elevation: 80 m. above sea level Latitude: 22-25°N	Aug. & Dec.
f. Hsinchu 58	Taiwan, China	One of the popular varieties in Hsinchu area.	Large and long panicle; high yield in the 2nd crop; stiff straw.	- Ditto -	- Ditto -
g. Kaohsiung 10	Taiwan, China	One of the popular varieties in Kaohsiung area.	Long panicle; heavy bearing; resistant to Sclerotium disease; good table quality; susceptible to blast.	Planting and harvesting season: 1st crop: Dec. - May 2nd crop: June - Oct. Soil requirement: Loam and clay loam Temperature: 15-35°C Elevation: 200 m. above sea level Latitude: 22-25°N	June & Nov.
h. Kaohsiung 22	Taiwan, China	- Ditto -	Long panicle; heavy bearing; high yield; responds well to heavy fertilization; moderately resistant to blast.	- Ditto -	- Ditto -

(To be continued)

(continued)

Common and scientific name	Country of origin	Economic importance	Varietal description	Climatic requirements	Season of seed supply
i. Kaohsiung 24	Taiwan, China	One of the popular varieties in Kaohsiung area.	Medium maturity; responds well to heavy fertilization; high yield; susceptible to blast.	Planting and harvesting season: 1st crop: Dec. - May 2nd crop: June - Oct. Soil requirement: Loam and clay loam Temperature: 15-35°C Elevation: 200 m. above sea level Latitude: 22-25°N	June & Nov.
j. Kaohsiung 27	Taiwan, China	- Ditto -	Long panicle; heavy bearing; responds well to heavy fertilization; good table quality; moderately resistant to blast.	- Ditto -	- Ditto -
k. Kaohsiung 45	Taiwan, China	Limited acreage.	Medium maturity; responds well to heavy fertilization; good quality; moderately resistant to blast.	- Ditto -	- Ditto -
l. Kaohsiung 53	Taiwan, China	Popular in Kaohsiung area.	Medium maturity; responds well to heavy fertilization; moderately resistant to blast; high yield.	- Ditto -	- Ditto -
m. Kaohsiung 64	Taiwan, China	Newly released for Kaohsiung area.	Medium maturity; responds well to heavy manuring; moderately susceptible to blast; good table quality.	- Ditto -	- Ditto -
n. Kaohsiung 68	Taiwan, China	- Ditto -	Medium maturity; stiff straw; responds to heavy manuring; moderately resistant to blast; good quality.	- Ditto -	- Ditto -
o. Taichung 65	Taiwan, China	The second most popular among all <i>Japonica</i> varieties.	Very wide adaptability; high yield; stiff straw; good table quality; responds to fertilizers; susceptible to blast.	Planting and harvesting season: 1st crop: Jan. - July 2nd crop: July - Dec. Soil requirement: Loam or clay loam Temperature: 15-35°C Elevation: From sea level to 1,000 m. Latitude: 22-25°N	Aug. - Dec.

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Common and scientific name	Country of origin	Economic importance	Varietal description	Climatic requirements	Season of seed supply
p. Taichung 150	Taiwan, China	One of the popular varieties in Taichung area.	Medium tillering; large panicle; early maturity; moderately susceptible to blast.	Planting and harvesting season: 1st crop: Feb. - June 2nd crop: July - Oct. Soil requirement: Loam and clay loam Temperature: 15-35°C Elevation: From sea level to 1,000 m. Latitude: 22-25°N - Ditto -	July & Nov.
q. Taichung 153	Taiwan, China	- Ditto -	Performs well on low soil fertility; non-shattering; moderately resistant to blast.	Planting and harvesting season: 1st crop: Jan. - Nov. 2nd crop: July - Nov. Soil requirement: Loam and clay loam Temperature: 15-35°C Elevation: From sea level to 1,000 m. Latitude: 22-25°N	- Ditto -
r. Taichung 155	Taiwan, China	- Ditto -	Wide adaptability; high yield; medium maturity; susceptible to blast.	Planting and harvesting season: 1st crop: Jan. - Nov. 2nd crop: July - Nov. Soil requirement: Loam and clay loam Temperature: 15-35°C Elevation: From sea level to 1,000 m. Latitude: 22-25°N	July & Dec.
s. Taichung 178	Taiwan, China	- Ditto -	Medium maturity; good table quality; responds well to heavy fertilization; resistant to blast.	Planting and harvesting season: 1st crop: Feb. - June 2nd crop: July - Oct. Soil requirement: Loam and clay loam Temperature: 15-35°C Elevation: From sea level to 1,000 m. Latitude: 22-25°N	July & Nov.
t. Taichung 179	Taiwan, China	- Ditto -	Resistant to blast; responds well to heavy fertilization; good table quality; more tillers; short awn.	Planting and harvesting season: 1st crop: Jan. - July 2nd crop: July - Dec. Soil requirement: Loam and clay loam Temperature: 15-35°C Elevation: From sea level to 1,000 m. Latitude: 22-25°N	Aug. & Jan.
u. Taichung 181	Taiwan, China	Newly released for Taichung area.	Resistant to blast; stiff straw; responds to heavy manuring; good table quality.	Planting and harvesting season: 1st crop: Jan. - July 2nd crop: July - Dec. Soil requirement: Loam and clay loam Temperature: 15-35°C Elevation: From sea level to 1,000 m. Latitude: 22-25°N - Ditto -	- Ditto -

(To be continued)

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Common and scientific name	Country of origin	Economic importance	Varietal description	Climatic requirements	Season of seed supply
v. Tainan 1	Taiwan, China	Recently released for Tainan area.	Medium maturity; high yield on medium soil fertility; moderately resistant to blast.	Planting and harvesting season: 1st crop: Jan. - July 2nd crop: July - Dec. Soil requirement: Loam and clay loam Temperature: 15-35°C Elevation: From sea level to 1,000 m. Latitude: 22-25°N	Aug. & Jan.
w. Taipei 127	Taiwan, China	One of the popular varieties in northern Taiwan.	Responds well to heavy fertilization; moderately susceptible to blast; resistant to lodging; good table quality.	Planting and harvesting season: 1st crop: Mar. - July 2nd crop: July - Nov. Soil requirement: Sandy loam Temperature: 15-32°C Elevation: 80-650 m. above sea level Latitude: 22-24°N	July & Nov.
x. Taipei 306	Taiwan, China	Newly released for northern Taiwan.	Weakly resistant to blast; stiff straw; late in maturity; good quality.	- Ditto -	- Ditto -
<i>indica</i> type					
a. Taichung (native) 1	Taiwan, China	Newly released for central Taiwan.	Medium maturity; stiff straw; responds to heavy manuring; resistant to blast; less sensitive to delayed transplanting than most <i>Japonica</i> varieties; susceptible to bacterial leaf blight and sheath spot; good for the 1st crop in Taiwan.	Planting and harvesting season: 1st crop: Mar. - July 2nd crop: July - Nov. Soil requirement: Sandy loam to clay loam Temperature: 15-32°C Elevation: 20-100 m. above sea level Latitude: 22-25°N	July & Nov.
5. Soybean (<i>Glycine max</i>)					
a. Palmetto	U. S. A.	For food, feed and oil.	Tall type; early maturity; high yield; adaptable for spring, summer and fall plantings in southern Taiwan.	Planting season: Mar., June, early Oct. Harvesting season: June, Sept., Jan. Soil requirement: Sandy loam and clay loam Temperature: 20-24°C Elevation: Sea level to 600 m. Latitude: 22-25°N	Jan., June & Sept.

(To be continued)

(continued)

Common and scientific name	Country of origin	Economic importance	Varietal description	Climatic requirements	Season of seed supply
b. Sankuo	Japan	For food, feed and oil.	Tall type; medium maturity; high yield; adaptable for spring and summer plantings.	Planting season: Feb. & July Harvesting season: June & early Nov. Soil requirement: Sandy loam and loam Temperature: 20-23°C Elevation: Sea level to 600 m. Latitude: 22-25°N	July & Nov.
c. Shihshih	Japan	- Ditto -	Short type; early maturity; fairly good yield; susceptible to purple speck disease; adaptable for spring, summer and fall plantings.	Planting season: Mar., July, early Oct. Harvesting season: May, Sept., Jan. Soil requirement: Fertile land Temperature: 20-23°C Elevation: Sea level to 500 m. Latitude: 22-25°N	Jan., June & Nov.
d. Acadian	U. S. A.	- Ditto -	Tall type; medium maturity; high yield; adaptable for spring and fall plantings in southern Taiwan.	Planting season: Mar. & early Oct. Harvesting season: June & Jan. Soil requirement: Sandy loam, loam and clay loam Temperature: 20-24°C Elevation: Sea level to 600 m. Latitude: 22-25°N	June & Sept.
e. Wakashima	Japan	- Ditto -	Tall type; medium maturity; high yield; adaptable for fall planting in southern Taiwan.	Planting season: Early Oct. Harvesting season: January Soil requirement: Loam and sandy loam Temperature: 20-24°C Elevation: Sea level to 600 m. Latitude: 22-25°N	January
6. Sweet Potato (<i>Ipomoea batatas</i>) a. Tainung 10	Taiwan, China	Primarily used for hog feed.	Pale pinkish skin color; flesh massicot yellow; leaf cordate; high yield; wide adaptability; late maturity; susceptible to Sphaceloma disease, but resistant to Fusarium stem rot.	Planting season: Sept. - Oct. Harvesting season: Mar. - May Soil requirement: Loam and sandy loam Temperature: 22-23°C (optimum) Elevation: Sea level to 860 m. Latitude: 22-25°N	June - Sept.

(To be continued)

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Common and scientific name	Country of origin	Economic importance	Varietal description	Climatic requirements	Season of seed supply
b. Tainung 17	Taiwan, China	Good table quality. Feed and industrial material.	Daphne red skin color; white flesh; high in starch content; yield medium; late maturity; adaptable to summer planting; susceptible to both Sphaceloma and Fusarium diseases.	Planting season: Apr. - Aug. Harvesting season: Sept. - Feb. Soil requirement: Sandy loam, loam and clay loam Temperature: 22-23°C Elevation: Sea level to 800 m. Latitude: 22-24°N	Oct.-Feb.
c. Tainung 31	Taiwan, China	Feed and industrial material.	Dark violet skin color; ivory yellow flesh; trilobed leaves; high in yield; fairly tolerant to both drought and cold condition; late maturity, but with wide adaptability; highly susceptible to Sphaceloma disease but resistant to Fusarium stem rot. At present, it is the most widely grown variety of sweet potatoes in Taiwan.	Planting season: Oct. - Nov. Harvesting season: May-June, not for summer planting Soil requirement: Most types of soils Temperature: 20-23°C Elevation: Sea level to 800 m. Latitude: 22-25°N	June-Sept.
d. Tainung 45	Taiwan, China	Food and feed material.	Creamy yellow skin color with light purple blotches; flesh white; leaf hastate; high in yield; early maturity; resistant to both Sphaceloma and Fusarium diseases; tubers liable to crack.	Planting season: Mar. - Nov. Harvesting season: Aug. - Feb. Soil requirement: Most types of soils Temperature: 22-23°C Elevation: Sea level to 500 m. Latitude: 22-24°N	Sept.-May
e. Tainung 57	Taiwan, China	Good eating quality for table uses.	Chamois skin color, yellow flesh but turned into deep golden color when cooked; leaf pentalobed; high in yield; early maturity; wide adaptability but not tolerant to drought; resistant to both Sphaceloma and Fusarium diseases.	Planting season: July-Aug.; Apr. Harvesting season: Jan. - Feb.; Sept. Soil requirement: Loam and sandy loam Temperature: 22-23°C Elevation: Sea level to 500 m. Latitude: 22-24°N	Mar.-June Nov.-Jan.
f. Tainung 58	Taiwan, China	Primarily for feed.	White skin; light yellow flesh; ovate leaves; early maturity variety; fairly high in yield; adaptable for spring planting only.	Planting season: Mar. - May Harvesting season: Sept. - Oct. Soil requirement: Loam and sandy loam Temperature: 22-23°C Elevation: Sea level to 500 m. Latitude: 22-24°N	Nov.-Mar.

(To be continued)

(continued)

Common and scientific name	Country of origin	Economic importance	Varietal description	Climatic requirements	Season of seed supply
7. Wheat (<i>Triticum vulgare</i>)					
a. Taichung 2	Taiwan, China	It is one of the five varieties of wheat now grown in the central part of Taiwan. However, the acreage occupied by this variety at present is rather small.	Late maturity; high in yield; soft in texture; long awns and tall stalk; fairly susceptible to rust disease.	Planting season: Late Oct. - early Nov. Harvesting season: March Soil requirement: Loam, sandy loam and clay loam Temperature: 15-25°C Elevation: Sea level to 600 m. Latitude: 23-25°N	May-Sept.
b. Taichung 23	Taiwan, China	Also one of the minor wheat varieties now grown in the central part of Taiwan.	Early maturing variety; medium in yield; awns medium in length; hard in texture; fairly susceptible to rust disease.	- Ditto -	- Ditto -
c. Taichung 29	Taiwan, China	One of the common wheat varieties grown on the paddy fields in central part of Taiwan. It constitutes about 17% of the total wheat acreage.	Early maturity; medium in yield; awns medium in length; somewhat hard in texture; susceptible to rust disease, but fairly good in adaptability.	- Ditto -	- Ditto -
d. Taichung 31	Taiwan, China	The leading wheat variety now grown in Taiwan, occupying about 70% of the total wheat acreage.	Wide adaptability; high in yield; medium maturity; awns medium in length; hard in texture; susceptible to rust disease.	- Ditto -	- Ditto -
e. Taichung 32	Taiwan, China	This variety occupies at present about 5% of the total wheat acreage in Taiwan.	High in yield but late in maturity; long awns and long stalks; hard texture and fairly resistant to rust disease.	- Ditto -	- Ditto -
Vegetable Crops					
1. Eggplant (<i>Solanum melongena</i> var. <i>esculentum</i>)					
a. Pingtung black long	Taiwan, China	Most important fruit crop for southern Taiwan during spring and summer.	Fruit dark purple in color and slender-cylinder in form; plant resistant to high temperature; high productivity.	Planting season: April Harvesting season: June - Oct. Soil requirement: Sandy loam Temperature: 20-28°C Elevation: Sea level Latitude: 20-25°N	Oct.-Mar.

(To be continued)

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Common and scientific name	Country of origin	Economic importance	Varietal description	Climatic requirements	Season of seed supply
2. Broad Bean (<i>Vicia faba</i>) a. Hsinchu No. 2	Japan	Profitable winter crop for dryland.	Flower white; large size seed.	Planting season: October Harvesting season: April Soil requirement: Loam Temperature: 11°C Elevation: Below 1,000 m. Latitude: North of 23°N	May
b. Hsinchu No. 6	Japan	- Ditto -	Flower purple; seed small size; short growing period.	Planting season: November Harvesting season: March Soil requirement: Loam Temperature: 11°C Elevation: Below 1,000 m. Latitude: North of 23°N	- Ditto -
3. Pai-tsai (<i>Brassica chinensis</i>) a. Fengshan Pai-tsai	Taiwan, China	Principal green leafy vegetable during summer season.	Resistant to high temperature; leaf blade light yellow in color with white petiole; tender in texture; sensitive to low temperature flowering.	Planting season: May - Sept. Harvesting season: 30 days after planting Soil requirement: Loam with abundant humus, pH 6-6.7 Temperature: 24-26°C Elevation: Sea level Latitude: South of 25°N	April
4. Cauliflower (<i>Brassica botrytis</i>) a. Fengshan Hsiashang (summer var.)	Taiwan, China	Only cauliflower for summer season.	Resistant to high temperature; plant small with medium quality flower head.	Planting season: May - Aug. Harvesting season: 65-75 days after planting Soil requirement: Fertile sandy loam, pH 6-6.7, medium soil moisture Temperature: 24-26°C Elevation: 0-300 m. Latitude: 23-25°N	- Ditto -
b. Fengshan Extra Early	Taiwan, China	Profitable early market variety.	Plant medium size; resistant to heat; early maturity.	Planting season: Apr. - May July - Sept. Harvesting season: 55-65 days after planting Soil requirement: Fertile sandy loam, pH 6-6.7, medium soil moisture Temperature: 20-23°C Elevation: Sea level Latitude: South of 25°N	- Ditto -

(To be continued)

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Common and scientific name	Country of origin	Economic importance	Varietal description	Climatic requirements	Season of seed supply
Forage Crop²					
1. Alyce clover (<i>Alysicarpus vaginalis</i>)	U. S. A. (Asia)	A good green manure and forage crop.	Summer annual legume; a spreading and moderately branched plant attaining a height of about 3 ft.; 300,000 seeds in a pound; self-reseeding.	In Taiwan it is always seeded in the beginning of May. It can be grazed or plowed under in July, does not tolerate wet land and makes poor growth when soil fertility is low.	December
2. Centrosema (<i>Centrosema pubescens</i>)	Philippines (S. America)	A good forage and cover crop.	Perennial vinelike legume; shows a tendency to climb.	Best time for seeding is early spring. It does not tolerate wet condition.	March
3. Desmodium intortum	Hawaii	A very good forage and cover crop.	A prostrate type of legume, hairy and vigorous; very palatable and high in nutritive value.	It can be propagated either by cutting or by seeds. Grows better under humid conditions.	- Ditto -
4. Pangola grass (<i>Digitaria decumbens</i>)	Philippines (Africa)	The best pasture grass in Taiwan.	A prostrate perennial grass; vigorous growth and high in nutritive value.	Not tolerant to low temperature or frost. Can only be propagated by vegetative means.	May
5. South African pigeon grass (<i>Sataria sphaacelata</i>)	Africa	A promising forage crop.	Perennial bunch type grass.	It has a wide adaptability to climate and soil types.	All year-round.
6. Tropical kudzu	U. S. A. (C. America)	An excellent forage crop as well as cover crop.	Perennial legume vine.	Not tolerant to low temperature. Adaptable to sub-tropical weather.	Year-round
Green Manure Crops					
1. Sesbania aculeata	Taiwan, China	It is one of the most widely planted green manure crops in central and southern Taiwan. It can be used for green manuring both on rice and sugarcane, occupies about 40% of the total acreage of green manure crop.	An annual erect plant with vigorous root system and nodules, tolerant of damp and saline soils, well adapted to moist and moderately hot climate; seed pod, 18-25 cm. long, upright and sickle shaped.	Planting season: May-June (t. 25-28° C) or Oct.-Nov. (t. 20-27° C): green manuring for 2nd or 1st crop of rice; Mar.-Apr. (t. 19-24°C): green manuring for sugarcane Harvesting season: Sept.-Nov. (for seeds) Soil requirement: Wide adaptability. It can be grown on moist sandy soil, loam and clayey loam.	Dec.-Jan.

(To be continued)

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Common and scientific name	Country of origin	Economic importance	Varietal description	Climatic requirements	Season of seed supply
2. <i>Mucuna capitata</i>	Taiwan, China	It is a common green manure crop used for sugarcane and pineapple, and also a good cover crop on hilly land.	An annual prostrated plant, with big compound leaf consisting of three leaflets and butterfly-shaped blossom; having deep but not vigorous root together with nodules; vine length about 30 cm; pods with a size like that of broad beans, black when mature.	Planting season: Mar.-Apr. (t. 19-24°C) Harvesting season: Dec.-Feb. (t. 16-20°C) Soil requirement: It can be grown on acid, neutral and slightly alkaline soil. It grows well on sandy loam, or loam of good drainage.	Feb.-Mar.
3. <i>Astragalus sinicus</i>	Japan	It can be grown on northern Taiwan, used as green manuring for paddy rice and also for hog and cattle feed.	A winter herbaceous legume with many nodules on its roots and crawling stalks as long as 60-100cm., many branch stalks, alternate leaves, odd number of feather-shaped compound leaves and 9-11 small leaves of inverted oval shape; flower stalks 10-30 cm. in length grow in spring from the side of the leaves and butterfly-shaped flowers with deep purple color come out arranged in cymb-like raceme.	Planting season: Oct.-Nov. (t. 21-25°C) Harvesting season: Apr.-May (t. 21-26°C) Soil requirement: Moist sandy loam, loam and clay loam, preferable to acid to neutral soils.	May-June

¹ Only crop varieties available for international exchange are listed above while those requiring special permit from the Government for exportation, i.e. sugarcane, tea, citronella and pineapple, are not included in this list.

² Forage crop improvement work has been conducted only recently so all the crops included in the list were introduced from other countries.

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