DEVELOPMENT OF SEED TECHNOLOGY IN TAIWAN

Plant Industry Series 27

By

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I. Introduction

Rice is the staple food for the entire populace of Taiwan. Terraces and small pieces of paddy fields can be seen almost everywhere on the Island. In 1964, the total cnltivated rice acreage was 764,935 ha. with a gross output of 2,246,639 M. T. of brown rice, marking the highest record in the history of rice production in Taiwan.

The cultivation of rice in Taiwan can be traced back to the first immigrants from mainland China several hundred years ago. Numerous rice varieties were brought along with them; and in early years before 1910 there were 1,365 varieties planted by the local farmers. The then Japanese Governor-General's Office in Taiwan carried out three programs for the improvement of rice production, i.e., a) elimination of red rice; b) reduction of the number of rice varieties; and c) commencement of the varietal selection and breeding program. Resulting from such efforts, the red rice was eliminated in 1905; the number of local rice varieties was reduced from 1,365 to 485 in the succeeding few years; and the first improved rice variety, Nakamura, ever available in the history of Taiwan was released for commercial planting in 1924. This improved rice variety though enjoyed popularity for a span of years due to its satisfactory performance, failed to last long because of its susceptibility to the rice blast disease. Taichung 65, thc second improved rice variety bred by the Taichung District Agricultural Experiment Station (DAIS) and released in 1926, was the most popular one ever existent in Taiwan and is now still enjoying a lasting popularity among the rice growers all over the Island. A handful of breeder's seeds of the improved varieties were first multiplied by the named station itself as foundation seeds, which were distributed to various prefectural and township Farmers' Associations (FA) for further multiplication. No laboratory analyses of the seeds produced at any level were conducted at that time, and no field inspections of the contracted seed farms were made by the concerned government organizations with only irregular supervision rendered by the local agricultural quarters. In other words, seeds were not certified before distribution at that time, and they were multiplied by inexperienced contract growers without any dependable

measures to safeguard their purity, vareital identity and other factors related to seed quality.

Seed technology is a modern term to include various branches of agricultural science such as seed harvesting, processing, drying, grading, treating, packaging, shipping and storaging. It also embodies researches on seed physiology, taxonomy and morphology. Seed multiplication and certification and the techniques of seed production and marketing also fall into the realm of seed technology. The development of seed technology will directly enable the farmers to obtain best quality seeds and will indirectly benefit the seed researches and administration and various branches of the seed industry.

The development of seed technology in Taiwan was centered upon the seed multiplication program particularly the rice seed multiplication program. Practically, most of the efforts exerted to increase the food production in Taiwan are first aimed at rice improvement and then at others. The importance of rice in Taiwan's agriculture can be illustrated by Table 1 which shows the rice acreage in the past fifty years as against the acreages of other miscellaneous crops.

Table 1.

(Unit: hectare)

Year	Rice	Sweet potato	Wheat	Peanut	Soybean	Beans	Corn	Cassava
1900	325,653	39,855	1,801	11,598	—	11,023	—	—
1910	456,276	102,203	5,648	19,166	—	25,915	—	—
1920	500,169	112,825	6,327	22,835	13,500	14,091	—	—
1930	614,390	125,180	400	26,712	8,602	9,881	1,237	—
1940	638,622	132,472	5,614	30,617	4,257	11,106	1,924	7,593
Peak-year during Japanese occupation								
	681,548	165,570	10,450	30,772	17,949	34,396	2,677	7,593
	(1936)	(1944)	(1941)	(1934)	(1913)	(1907)	(1941)	(1940)
1950	770,262	233,057	18,333	83,387	20,300	16,805	5,013	9,786
1956	783,629	230,236	15,615	98,258	37,505	31,552	7,716	10,566
1964	764,935	246,002	9,397	100,775	50,904	22,340	20,014	17,314

II. Rice Seed Multiplication and Distribution

A. Rice Seed Multiplication System

For a general knowledge of the development of seed technology in Taiwan, it is necessary to realize the rice seed multiplication system as practised in Taiwan. Several years after the first improved rice variety Nakamura was released sometime in 1924, a 3-level seed multiplication system was introduced; viz., tht foundation seeds, the stock seeds, and the extension seeds.

1. Foundation seeds: This top level of seeds is produced only by the district agricultural improvement Stations. On the foundation seed farms, utmost care is taken in field management so as to ensure that the plants are absolutely pure and true to their varietal characteristics. In order to facilitate the observation of field operations, and, most important of all, characteristics of the individual plant, the "single plant per hill" method is practised. Rice is transplanted in straight rows with set distances between rows and hills. Any off-types or doubtful plants are rogued. The yield expected from the foundation seed farms is no less than 2,000 kg. per hectare; however, as the purpose of a seed farm is to produce quality seeds, its yield is of less concern. The low yield of foundation seeds may be explained by a) the single plant per hill instead of the 5-7 plants per hill as generally practised, and b) vigorous roguing of the off-types and doubtful plants of the slightest degrees.

Preservation of foundation seeds: The foundation seeds of rice are preserved in Taiwan by the following two methods:

a) About 15-20 stalks of rice are carefully selected from the foundation seed farm. From each stalk, 100-200 seedlings are obtained for planting of 10 rows, 10-20 seedlings each. Only one seedling is planted in each hill. Frequent and careful inspections are made to ensure that all the off-types and doubtful plants are removed. In case a doubtful plant is found the entire row of seedlings are discarded. The remaining plants are harvested and processed for use of the foundation seed farm in the next cropping season.

b) A small plot for preserving the breeder's seeds is maintained. A single seedling is planted to each hill. Frequent and careful inspections are made to ensure that all the off-types and doubtful plants are removed.

The border lines on the four sides are not harvested for seeds. A few stalks bearing the most true genetic identity and varietal characteristics are harvested separately for preservation as breeder's seeds for the next planting. The remaining stalks are harvested in bulk for use in foundation seed production.

2. Stock seeds: Seeds of this level are the progeny of the foundation seeds. In Taiwan, stock seeds are mostly produced by contract farmers, while a small portion is produced by the prefectural farmers' associations. The method of cultivating rice stock seeds is similar to that of foundation seeds, except that 4-6 plants per hill are planted instead of a single plant. Since 50 kg. of rice seeds is needed for planting one hectare of paddy rice, the 2,000 kg. of foundation seeds produced from one hectare of foundation seed farm is enough for planting 40 ha. of stock seed farm. The yield of rice stock seeds is estimated at 3,600 kg. per hectare.

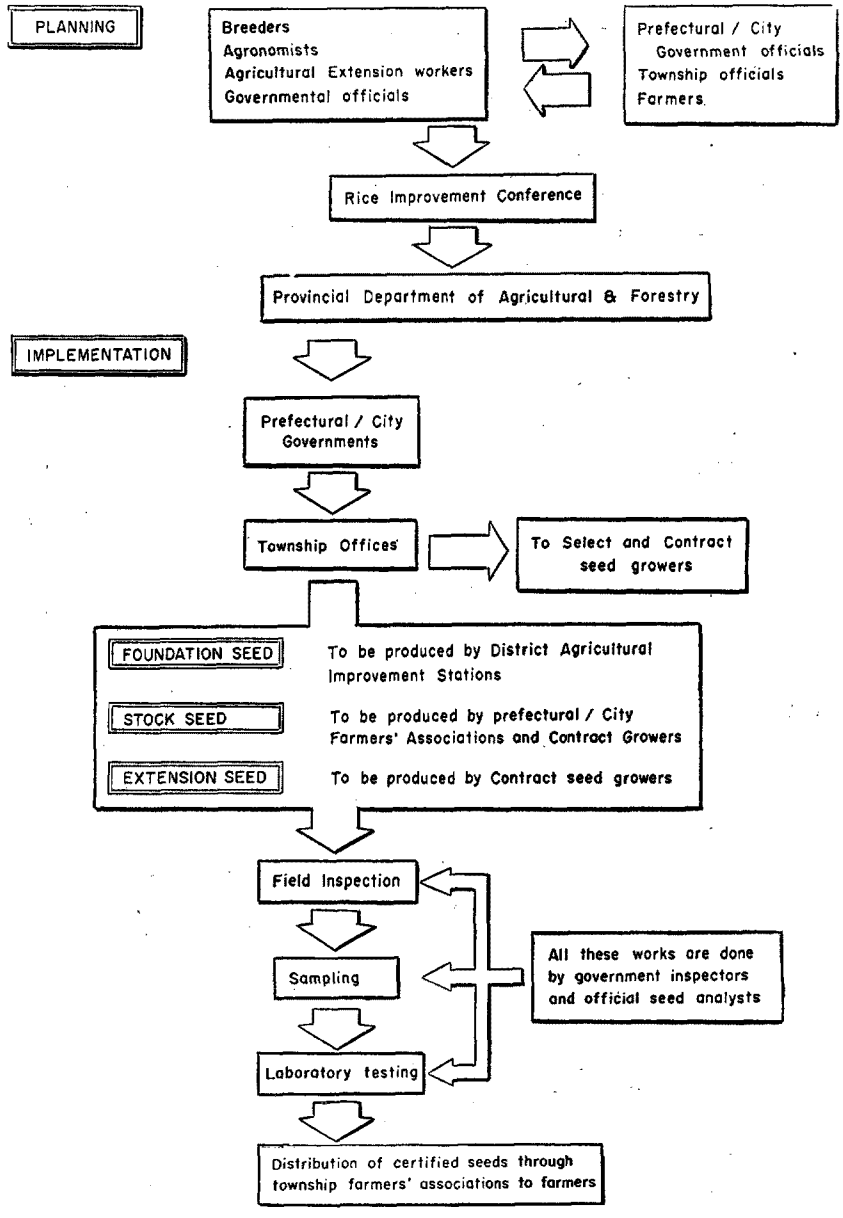
3. Extension seeds: This is the third level of seeds in the entire rice seed multiplication system in Taiwan. It is the progeny of the stock seeds and is equivalent to the certified seeds in the United States. After the seeds are certified, they are distributed to the ordinary farmers for renewal of their own seed stocks. The extension seeds are produced by contract farmers. The method of cultivating extension seeds is not much different from that for stock seeds, although the minimum certification standards are relatively lower. Under normal rate of seeding, the 3,600 kg. of stock seeds produced from one hectare of stock seed farm is enough for planting of 72 ha. of extension seed farms, which are in turn sufficient for renewing 5,184 ha. of rice field. Thus, through the three-level seed multiplication system, one hectare of foundation seed farms is enough to renew 207,360 ha. (1 ha. x 40 x 72 x 72) of rice paddy.

Under the tropical conditions of Taiwan, this three-level rice seed multiplication system takes one and half years for its completion from the production of foundation to extension seeds.

B. Actual Implementation of the Rice Seed Multiplication System

How the rice seed multiplication and certification system is implemented? The following is a detailed account of the working procedures of the system:

RICE SEED MULTIPLICATION & CERTIFICATION SYSTEM IN TAIWAN



1. **Planning of the seed multiplication work:** In Taiwan, the overall planning of the seed production program is made by the government each year. Basic information on the varieties and the amount of seeds to be multiplied for each variety are collected through a two-way traffic: from the breeders and extension workers of the agricultural experiment/improvement stations regarding the prospects of extending the new and improved varieties, and from the rice farmers through the prefectural governments and township offices regarding their preference over the different rice varieties. The authority to make final decisions on the varieties to be multiplied is vested in the Taiwan Rice Improvement Conference (RIC) under the PDAF. The RIC, established by the PDAF to take up the task of technical improvement of Taiwan's rice production, is represented by the various experiment/improvement stations of PDAF, agricultural colleges, JCRR, Provincial Food Bureau, Provincial Farmers' Association (PFA), extension staff of the prefectural/city governments and other relevant parties. In studying and screening the seed multiplication program for the next year by the conferees of RIC during its annual meetings, the following factors are considered: a) the actual planted acreage of each variety in the past years; b) the trends of changes in both the acreages and the farmers' preference over the varieties; c) the results of regional and varietal testings; and d) recommendations by the prefectural/city governments. The conclusions reached at the meetings are referred to the PDAF for adoption and action.

2. **Working procedures of the program:** Instructions concerning the whole plan of the seed multiplication program, including information on varieties, acreages to be planted, and the amounts of seeds to be produced by various prefectures and cities, are given by the PDAF to the prefectural/city governments. The plan is further broken down to the township level by the prefectural/city governments. Seed producers in this case are selected and contracted by the local government. The selection of the seed growers are based on the following consideration: a) farmer's reputation and integrity; b) enthusiasm to serve the public; c) drying and processing facilities; n) storaging facility. The contract stock seed growers are selected by the prefectural/city governments and the extension seed growers by the township offices with the concurrence of the respective prefectural/city governments. Foundation and stock seeds are then delivered to respective seed growers for actual planting both free of charge. The concerned personnel of the local governments are responsible for field supervision of the seed farms, and sometimes five to six or even more supervision trips are made to those farms which are found not properly managed.

3. **Field inspection:** In order to conduct field inspections efficiently to cover such a large number of seed farms (Please refer to Tables 5, 6 on pages 15, 16) within a short period of time, a pre-arranged time schedule for each township is formulated by the local prefectural/city government. The PDAF field inspectors in company with the prefectural/city government personnel, and in most cases, also accompanied by township personnel, make the field inspection trips according to the pre-arranged time schedule. The seed growers are usually informed in advance for interviews by the inspectors. In general, only one field inspection is made of the rice field; but the inspection may be made twice, if the inspector deems it necessary. While doing his inspection work, the inspector checks the field for such items as varietal purity, freedom from undesirable weeds, isolation of the field from other varieties, as well as other factors that would affect the production of high quality seeds. The seed processing facilities and cement drying ground existing on the farms are also inspected. After the seed farms are duly approved upon field inspections, the seeds must be handled carefully by the growers after harvest.

4. **Sampling for laboratory testing:** When the seed farms have passed the field inspection, the seeds are harvested at the right time and sun-dried on cement drying grounds. Caution is given to the mixing of different varieties on the drying ground, in the winnower and in the gunny bags. A printed postcard is distributed to the seed grower for him to fill in the date he desires for sampling (after being thoroughly dried and cleaned) and mail it to the Provincial Seed Testing Laboratory. The field inspector then proceeds to collect the samples on that particular date set by the grower himself. In sampling, attention is given to the problem of representation of the samples to the bulk lot of seeds. Double-tube sampler is used for taking the samples. The samples are then sent either through mail or carried by the inspector himself to the Provincial Seed Testing Laboratory.

5. **Laboratory analysis, certification and distribution of certified seeds:** The seed samples are analysed as soon as they reach the Provincial Seed Testing Laboratory at Taichung. Laboratory analysis of seeds includes such items as determination of seed moisture contents, seed purity and germination percentage. The results of testing, be it acceptable or unacceptable, are sent in triplicate to the PDAF, the concerned township office and producers. The seed producers get 15% premium in kind in addition to the same amount of the seeds turned in by themselves, if their seeds were found up to the minimum standards set by the

government. The certified seeds are all stored in the warehouse of the township Farmers' Association. No certification tags are used for rice seeds. Any farmer who wants to get the certified seeds may draw it from the local FA by bartering with his own seeds for certified seeds at a 1:1 ratio, no extra expenses are involved in obtaining the certified seeds.

6. **Distribution of rice seeds**: Prior to the second rice crop of 1959, all the extension seeds multiplied were distributed or rather disposed of by the seed producers themselves to the rice farmers. The majority of the farmers obtained their seeds through a barter system under which the farmers offered their paddy for seeds at a ratio varying from 1:1 to 1.0:1.2. Some offered cash to buy the seeds. The barter usually took place at the homes of the contract seed growers.

Since the second rice crop of 1959, the Provincial Food Bureau has taken charge of the seed distribution work. The contract seed growers are required to turn in their seed lots to the local FAs right after drying. For seed lots meeting the certification requirements, the growers get a 15% preminm from the PFB disbursed through the FAs. Those farmers who need pure seeds may turn in their paddy to the FAs and get the extension seeds (certified) there at the exchange rate of 1:1.

III. Seed Multiplication System for Other Crops

The seed multiplication program for such miscellaneous crops as sweet potato, peanut, wheat, soybean and sorghum was first launched in 1949. The same three-level multiplication system as applied to rice was adopted. The foundation seed farms were managed with utmost care only by the District Agricultural Improvement Stations. The following is a brief account of the seed multiplication system for sweet potato and other crops propagated by seeds and vines:

A. Seed Multiplicaton System for Sweet Potato:

Like the system for rice seed multiplication, there is a Provincial Upland Food Crops Improvement Conference called at the mid-year by the PDAF to review and finalize the recommendations made on the varieties to be multiplied for the next year. At this conference, attended by all cropmen from the PDAF, research/experiment stations, DAISs and JCRR. Series of reviews are thoroughly made on the performances of the different crop varieties tested at different districts. The best ones and those most favored by the farmers are recommended for seed multiplication and extension. A complete list showing the schemes of seed multiplication, including the names of varieties, acreages to be planted and amounts of seed material to be multiplied at each district, is prepared by PDAF after the conference and then announced at the Provincial Food Production Conference.*

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*The Provincial Food Production Conference which is jointly sponsored by the Provincial Food Bureau and the Provincial Department of Agriculture and Forestry, is codvened at the beginning of each year. This Conference lasts one day and is attended by about 200 representatives from all the agencies related to the food production. During the meeting, the production goals, from provincial level down to prefectural/city level, of rice, sweet potato, peanut, soybean and wheat are announced and subjected for discussion. The proposals aimed at achieving the goals are also brought up for discussion and finalized during the meeting. The food production plan thus stipulated are to be implemented accordingly by various responsible agencies.

1. **Foundation seed farms:** This level of seed farms is only managed by the DAIS. Seed potatoes for the foundation seed farms are usually supplied by the breeding stations; but, in most cases, the DAISs preserve their own foundation seeds. In every five years, the breeding stations supply the various stations with the breeders' stocks for renewal of their seed stocks. Each foundation seed farm is established in a field where the same variety of sweet potato has been planted in preceding crop season. The foundation seed farms are ordinarily planted in August or September with the seed potatoes produced ready for distribution in February or early March of the following year. Distribution of foundation seed potatoes to the stock seed farms is free of charge.

2. **Stock seed farms:** The stock seed farms are established in different prefectures, forming the second level of the seed multiplication system. They differ from the foundation seed farms, however, in that the vine cuttings produced from the stock seed farms are used for distribution instead of seed potatoes. The stock seed farms are operated by the prefectural FAs or by contract farmers under their supervision. To facilitate the supervision and distribution work, these seed farms are established only at 1—3 carefully selected sites in a prefecture in a season. Roguing of off-types and doubtful plants is strictly practised. At the average production of 1,050,000 vine cuttings per hectare, one hectare of stock seed farms will be enough for planting 17.5 hectares of the extension seed farms on the basis of 60,000 vine cuttings per hectare. The distribution of vine cuttings from the stock seed farms to extension seed farms is made free charge sometime in May or June. The prefectural FAs or contract farmers who operate the stock seed farms are given some cash subsidy by the PDAF as a compensation.

3. **Extension seed farms:** These seed farms planted with vine cuttings from the stock seed farms are established at different townships. From these farms, again vine cuttings are used for distribution. The extension seed farms are operated by contract farmers under the supervision of the township FAs. Planting is made in May and June, and the distribution of vine cuttings in August or September. To each hectare of the extension seed farms, 60,000 vine cuttings are planted, which, in turn, produce about 900,000 vine cuttings per hectare. This will be enough for planting 30 ha. of farmers' fields at the rate of 30,000 cutting per hectare. The extension seed growers will sell their vine cuttings at a price approved by the PDAF.

The whole system as described above may be illustrated by Table 2.

Table 2.

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

From the above, it may be seen that the whole system starting from the time of planting foundation seed farms to the time of distributing the vine cuttings from the extension seed farms to the farmers may be completed within a period of about one year. This system is an improved one, while the old system which used seed potatoes for distribution from all the three levels of seed farms was adopted before the war until 1955.

B. Seed Multiplication For Other Crops

1. Soybean, peanut and wheat: The soybean seed multiplication system was established in 1956 after the soybean variety Sankuo was newly introduced and released for commercial planting. For peanut and wheat, the system was started in 1950. The same 3—level seed multiplication system as used for rice was adopted for peanut, wheat and soybean.

2. Corn: The production of corn seeds through a government-supported seed multiplication program was started only in 1960 when the first double-cross hybrid corn variety Tainan No. 5 was officially released to the farmers. The work of multiplying inbred lines is assigned to the Corn Research Center at Putze; and the Center also produces single-cross seeds. Due to the insufficiency of land and technical personnel, the work of single-cross seed production is also entrusted to Taiwan Seed Service. At the present time, the Taiwan Seed Service (TSS) of the PDAF is producing the major part of the single-cross seeds needed for the whole program. The production of double-cross seeds of corn is also done by the TSS. In 1964. a

total of 113,378 kg. of double-cross seeds was harvested. Because of its excellent quality, the new hybrid corn variety Tainan No. 5 has marked a great success as evidenced by its rapid acreage expansion (Please see Table 3 on page 12).

Producation of corn seeds in Taiwan deserves particular attention. Corn is a minor crop in Taiwan; but it is gaining increasing importance in recent years owing to the general improvement in the hog-raising techniques requiring corn as the main ingredient for feedstuff. The successful development of hybrid corn has further aroused the interest of the farmers in growing this crop. The new hybrid corn variety Tainan No. 5 yields about 50% higher than the local farmers' own varieties; and is so far the only variety of its kind ever extended to the farmers. For the production of double-cross hybrid corn seeds, the following procedures are followed:

a) Inbred lines: The production of inbred line seeds are done exclusively by the Corn Research Center at Putze, an affiliated institution of the Tainan DAIS; and no other agencies are engaged in this line of work.
b) Single-cross seeds: The production of single-cross seeds are done by two agencies; the Corn Research Center and the Taiwan Seed Service.
c) Double-cross seeds: The production of double-cross seeds are done by the Taiwan Seed Service and contract seed growers.

Table 3 shows the acreages and amounts of seeds produced since 1960:

Table 3.

Year	Inbred lines		Single cross		Double cross	
	Acreage (ha.)	Production (kg.)	Acreage (ha.)	Production (kg.)	Acreage (ha.)	Production (kg.)
1960					38.67	58,805
1961	0.38	78	2.10	562	29.60	51.049
1962	3.00	320	5.50	2,800	77.71	180,528
1963			5.50	3,910	64.36	164,920
1964	1.15	265	5.50	1,537	156.32	113,378

In order to foot the seed business on a healthy basis and to create a good example of developing a seed enterprise in a sound manner, a Corn Improvement Fund was established by PDAF, JCRR and the concerned agencies. Of the sales proceeds derived from selling the double-cross corn seeds to the farmers, 26.6% of it are contributed to the Foundation which amounts to over one million New Taiwan dollars a year at the present time. The Fund is used for financing research projects on corn upon authorization by a small group of executive members.

In the production of corn seeds, field inspection and laboratory analysis are strictly applied and only the certified seeds are packed (in polyethlene bags of 2.5-kg. and 5-kg. capacity) with certification marks printed on the bags. The seeds are carefully dried with artificial devices to a moisture content of about 11-12% and are treated with fungicides to a reddish color before packing. A small pamphlet on how to best cultivate the seeds is enclosed in the bags.

3. Jute and kenaf: The jute and kenaf seed multiplication/certification program was started in 1961 when the first improved variety of jute, Tainung No. 1, was released for commercial planting. Since then, seeds of these fiber crops have been produced by the 3-level multiplication system. Both the foundation and stock seed farms are operated by the agricultural stations of PDAF and the extension seed farms by the contract jute growers, The extension seeds, after being certified by the Provincial Seed Testing Laboratory, are sold by the growers at their own discretion. Certified extension seeds of jute are packed in 2-kg. cloth bags, each affixed with a certifying tag issued by the PDAF Laboratory. The seeds thus produced have enjoyed a good market in the jute-producing areas. Table 4 shows the amounts of jute seeds certified during the period since its debut in 1961 to 1964.

Table 4.

Year	Foundation seeds (kg.)	Stock seeds (kg.)	Extension seeds (kg.)
1961	8.5	24	723.45
1962	3.5	180	2,156.90
1963	41.0	398	15,874.00
1964	22.0	213	13,671.00

IV. Characteristics of the Seed Multiplication Systems

The seed multiplication systems for rice, wheat, peanut, soybean, corn, sweet potato and sorghum as mentioned above bear different functions as compared with those in other countries. Such exclusive functions may be summarized as follows:

A. Seed Multiplication Program Being Strictly a Government-Operated Program

Since the first improved variety of rice was released for general adoption about 43 years ago, it has been the government's responsibility to provide the farmers with either certified seeds of improved varieties or fresh quality seeds for renewal of their old seed stocks. The private seed industry in Taiwan is still underdeveloped and is not sound enough to take over from government the task of producing and distributing qnality seeds in sufficient quantity to the farmers. The government has been financing and operating the progarm of seed multiplication and distribution; however, the program is limited to food and miscellaneous crops only, with no vegetable seeds provided by the government as yet. Besides seed multiplication, the program is also educational. Numerous supervision trips are taken by concerned government personnel and technicians aiming at training the seed producers.

B. Different Purposes for Different Kinds of Crops

For rice, the seed multiplication system is for renewal of the old seed stocks as well as for the extension of new and improved varieties. Although the rate of natural cross among different varieties of rice is rather low (0.9-1.45% according to Szuzuda and Tomouka), it still cannot be completely avoided. Besides, the planting of two or more varieties on the same farm or in the same seedbed as commonly practised in Taiwan provides frequent chances for mechanical mixture of seeds of different varieties during the processes of sowing, transplanting, harvesting, drying, threshing, packaging and storaging. Eventually, segregation of the rice varieties under cultivation also results in the increase of off-types in the field. All such factors account for the necessity for timely renewal of the seed stocks for maintaining the purity of rice varieties. There is no definite time limit as to the validity of the rice seeds harvested from the farmers' fields. In other words, the length of time for maintaining reasonable degree of genetical purity of rice varieties is depending upon mostly the extent of carefulness in preserving and handling of such seed stocks, management of planted fields and other respects of harvesting,

drying and processing of seeds. Since it is rather difficult for the ordinary farmers to determine howm any generations their seed stocks can be used for seeding with respect to the management of how their planted fields so as to maintain reasonable degree of genetical purity of that particular variety of rice, the government has acted upon the recommendations made by the rice experts to set arbitrarily a 6-generation (In Taiwan, it is equivalent to a 3 year period) seed renewal system; and the entire rice seed multiplication program is planned upon this basis.

But, for other crops such as peanut, soybean and sweet potato, the main purpose of the seed multiplication program is to extend the newly-released improved varieties; while for still other kinds of crops such as wheat, cotton, jute, corn and rape the program is aimed at supplying the farmers with quality seeds of the improved varieties only.

C. Very Large Number of Contract Seed Producers

Since it is the government who is rendering services to the farmers in the production and distribution of good seeds, it is only logical to set up small seed farms as widely as possible to meet the wide-spread need of the farmers who are living in the scattered rural areas. Table 5 shows the number of seed farms set up by the government for rice since 1950.

Table 5.

Year	Foundation seed farm	Stock seed farm	Extension seed farm
1950	16	377	11,176
1951	14	261	12,520
1952	14	160	13,594
1953	14	173	12,522
1954	14	189	13,507
1955	14	167	13,826
1956	6	—	—
1957	12	—	6,273
1958	13	147	5,353
1959	13	136	5,078
1960	13	157	4,774
1961	12	128	3,657
1962	12	105	2,792
1963	10	83	1,960
1964	10	76	1,875

For other crops, Table 6 gives a general picture of the numerous small seed farms which were established and supervised by the relevant government agencies for the production of seeds for use of the ordinary farmers.

Table 6.

Year	Wheat	Peanut	Soybean	Sweet potato	Cotton	Jute	Corn	Rape-seed	Total
1959	2,071	561	1,527	490	489	—	3	14	5,155
1960	2,240	475	1,481	453	637	—	7	16	5,309
1961	1,589	462	1,579	427	457	73	6	13	4,606
1962	1,390	518	795	407	859	57	79	14	4,119
1963	431	853	599	428	—	98	41	15	2,465
1964	422	347	647	279	—	64	14	16	1,789

The average size of the seed farms for rice may be indicated as follows:

1957	0.53 ha.
1958	0.51 „
1959	0.53 „
1960	0.53 „
1961	0.62 „
1962	0.66 „
1963	0.84 „
1964	0.89 „

D. The Barter System for Seed Distribuion

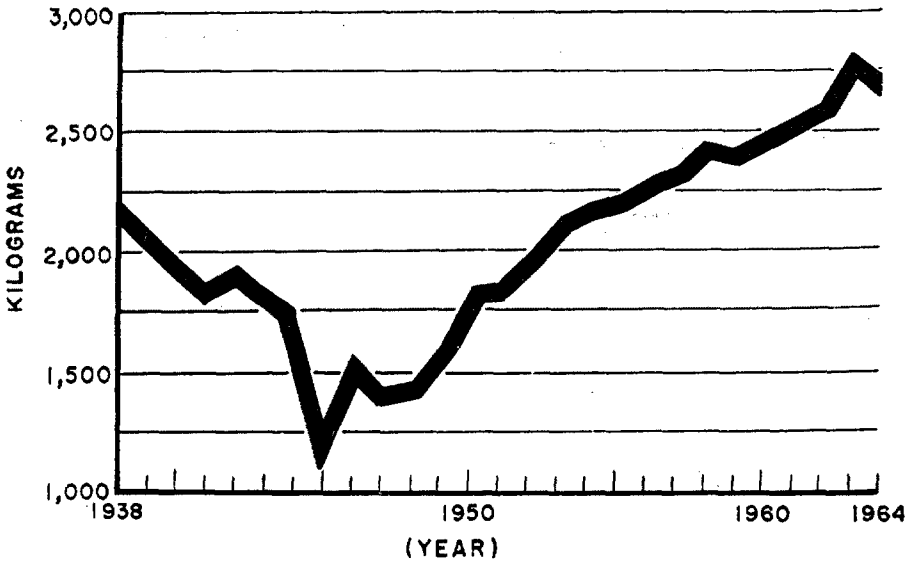
Completely fair distribution of certified seeds by the government is always a difficult job owing to the large number of farmers involved, the cumbersome government procedures and the ignorance of this government-sponsored program on the majority part of the farmers. In order to avoid the undesirable situation whereby the limited amounts of certified seeds would be taken and used by only small groups of farmers who are better educated, experienced or informed, a rotational system of seed renewal was tried in certain districts. However, the trial proved to be a failure due to the following reasons: a) too heavy financial requirement for its efficient operation; b) excessive supervision, persuasion and paper work involved; and c) less enthusiasm and cooperation shown by large portion of farmers. Due to the difficulties mentioned above, the distribution of certified seeds by the township farmers' associations is done in following manner: farmers within the

township are allowed to take the certified seeds on first-come-first-served basis by surrendering a same amount of seeds of their own to the association. No limitation is imposed on the amount of seeds to be exchanged, except that the amount should not exceed the farmers' own needs.

E. Incentives to Seed Producers

The stock seed growers are given the foundation seeds free of charge and also a certain amount of cash subsidy. The seeds thus produced and certified are then purchased by the local prefectural governments at a premium price. The extension seed growers are also given their stock seeds free of charge with no cash subsidy offered. The seeds produced and certified are bartered by government with 15% premium in kind. Besides the physical incentives, the contract seed growers are also accorded an honorary status indicating the government's recognition of their esteemed position and experience in the rural communities.

The seed multiplication program for rice is the backbone of the development of seed technology in Taiwan. The new and improved varieties are all successively channeled to the hands of the ordinary farmers through this program. During the Japanese occupation, all the efforts then exerted by the Japanese government authorities were concentrated on the multiplication of rice seeds and its extension to the farmers. Seed certification was limited to only field inspections by government officials whose primary functions were planning, supervision, reporting and making statistics on agricultural production. No professional field inspectors were ever employed. To those government officials, field inspection of seed farms was an additional activity. When they were busy with other activities, the field inspection was neglected at all. The World War II interrupted the smooth operation of the program; and, as the war dragged on, the program was seriously affected and was eventually paralyzed totally at the end of the war. The rehabilitation work after the War by the Chinese Government was very complicated and tremendous a task. Almost all of the factors related to the high yields of crops had to be restored, improved and extended. The true story of the serious effects of war upon agricultural production in Taiwan may be illustrated by the following figure showing the fluctuation in the per hectare yield of rice during the war and post-war years:



Right after the War, the Chinese Government tried with all-out assistance from JCRR to restore and improve the seed multiplication and distribution program in Taiwan. Many measures and actions then taken by the government as important and indispensable steps to the program have long been ended or in some cases are still in effect at a much lesser degree at the present time, e.g., a) cash subsidies to both foundation and stock seed farm operators are no longer in practice; b) JCRR financial assistance for supervision of seed farms by prefectural/city government and township offices are greatly reduced to a negligible amount; c) various types of contests sponsored by the government to elevate the interest of the farmers in increasing the crop yields no longer bear any significance as before; d) government subsidies for the construction of cement drying grounds, compost houses, seed granaries, and for provision of aluminum barrels for seed storage, bicycles, etc. are generally terminated.

V. Accelerated Development of Seed Technology in Taiwan

A. Milestone of the Development of Seed Technology in Taiwan

The development of modern seed technology in Taiwan first took place only some nine years ago when the First Far East Seed Improvement Workshop sponsored by the former International Cooperation Agency of the United States Government was held in Taipei, Taiwan, in 1956. This workshop was the first of its kind ever held in this part of the world to discuss on the ways and means of speeding up the development af seed technology in the participating countries, solving the existing and possible difficulties and problems, and achieving regional development through strengthened international cooperation. The warkshop did bear great importance and far-reaching effects to the development of modern agricultural techniques, particularly to the seed technology of Taiwan. The highlights brought about by this Workshop may be briefly stated as follows: a) The importance of "quality seeds" to the increase of agricultural production was emphatically stressed and realised by the responsible government quarters as well as the general public. In the previous years, better varieties were always the prime objective of the government efforts in promoting agricultural production as well as the chief interest of the ordinary farmers; the improved cultural methods came next in importance. What the farmers were interested was seeds of better varieties, with less importance attached to the quality of the seeds; b) It was then generally recognized that the availability of good seeds through a well planned and executed program of seed multiplication, certification and distribution is indispensable to a modern agriculture; c) The training of seed inspectors, seed analysts, seed administrators and seed technologists was emphatically urged; and d) The setting up of seed testing laboratories, stipulation of minimum seed certification standards for various levels and kinds of seeds and other measures to safeguard the seed quality were also stressed.

B. Government Policies Towards the Development of Seed Technology

After the conclusion of the said workshop, the responsible officials of the Provincial Department of Agriculture & Forestry (PDAF) and specialists of the Joint Commission on Rural Reconstruction (JCRR) made thorough studies and discussions on the situations and problems of developing the seed technology in Taiwan with the concerned personnel of the local governments, rural extension workers, seed pro-

ducers and seedsmen. Ideas and suggestions were freely exchanged, and problems and difficulties candidly evaluated. Through such meetings and discussions among seed workers of both the government and private quarters, policies governing the development of seed technology in Taiwan were successively formulated as may be summarized as follows:

1. Commercialization of the local seed industry, supplements with government assistance in the production and distribution of certified seeds of important food, feed and oil crops: Commercialization of the seed industry is a world trend which is aimed at relieve the government of the overwhelming burden of supplying the individual farmers with seeds of numerous kinds of crops. However, owing to the following reasons, government assistance in operating seed multiplication program for the various food, upland feed and oil crops in Taiwan could hardly be terminated totally in the foreseeable future: a) The difference in seed quality of the various food and feed crops between the certified seeds and the farmers' own seeds, which are mostly self-pollinated are not sufficient enough to warrant a profitable seed business. On the average, the certified seeds of rice yield 7.9% higher than the farmers' own seeds as revealed by a survey of some 600 farm families conducted in 1952. As the cultural techniques improved, and the farmers are generally better educated, informed and experienced, the superiority of the certified seeds of those kinds of crops over farmers' own carefully preserved seed become insignificant; b) the farmers' small land holding which is averaged at only 1.06 ha. for each farm household requiring only small quantities of seeds (e. g., 50kg. for rice, wheat or soybean), Farmers are not willing to pay higher prices for the seeds which they could obtain from their own fields and those demonstrate no significant increase in yield; c) The government subsidy program, once initiated, could hardly be terminated without meeting the strong objections by the farmers.

The commercialization of seed industry should start with vegetables, high-yielding hybrid corn and sorghum and other cash crops.

2. Streamlining of seed research, control and administration agencies: A top seed administration agency under the PDAF has been established to assume overall responsibility of planning, controlling, promoting and supervising the various aspects of the seed development program in Taiwan. An authoritative seed testing laboratory and a seed technology research laboratory have been established under the PDAF and the National Taiwan University, respectively. Field inspection of the

numerous seed farms has also been made into a specialized operation with full-time inspectors of adequate training and experience.

3. Promotion of export of seeds of vegetables, flowers and other exportable crops: Taiwan has a ready market for fresh vegetables in the Far East Asian countries. The export of seeds of vegetables, flowers and other high-priced crop seeds to those countries will have a very promising future provided with adequate promotive measures.

4. Strengthening the education of farmers on the use of quality seeds: A sound seed industry can be developed only when the farmers are fully aware of the value and importance of quality seeds to ensure increased crop yields and quality crop products. The reasons for the farmers' not using certified seeds are many, but the lack of adequate educational measures and inefficient agricultural extension work pose as the major ones.

5. Certification of superior mother-trees of fruit crops and mushroom spawns for quality products: It takes many years of toilsome and hard work to establish a fruit orchard. But improper selection of young planting material or the kinds of mother-trees would render the efforts and capital investments fruitless. Truly, it is rather difficult for a less experienced orcharder to distinguish between the superior and inferior young trees or between the healthy and diseased ones. Therefore, a certification program will provide reliable information to enable the growers to recognize the right kinds and the real conditions of the plants they intend to buy. A certification program will do the same to mushroom spawns for the benefit of the mushroom growers. Both programs are now under active consideration by respective governmental agencies for its implementation in nearest future.

6. Promulgation of a seed law to safeguard the interest of the seed producers and consumers in Taiwan: The purposes of a seed law are to ensure the availability of quality seed to the growers and to prevent the possible misrepresentation by seeds with respects to the kinds, varieties, quality and other characteristics of various food, feed, vegetable, oil, flower, industrial and ornamental crops. But a seed law would also produce an undesirable situation if other related factors are not mature enough for its implementation. So far, Taiwan is still without a seed law to ensure the minimum quality of the crop seeds on the market; and it seems that the general public, farmers and the seed dealers are not yet prepared for it.

VI. A Historical Account of the Important Events in the Development of Seed Technology in Taiwan Since 1957

1957

1. Establishment of a Seed Technology Research Laboratory at the National Taiwan University: This research laboratory is equipped with delicate apparatus for determining the seed respiration, various types of seed germinators, cold storage, fumigation room, etc. The function of the laboratory are three-fold a) to undertake basic research on seed physiology, morphology, and taxonomy; b) to serve as a training site for local seed technicians; and c) to provide the agricultural students of the National Taiwan University with the needed laboratory facilities for practices on agronomic courses. Up to the present, this seed technology research laboratory had completed a three-year seed storage experiment, a testing on seed moisture content under the various conditions of seed moisture/humidity equilibriums, and researches on the problems of pure rice seeds.

2. Promulgation of the rules and minimum standards for seed certification of rice, sweet potato, peanut, soybean, wheat and sorghum by the Provincial Department of Agriculture & Forestry.

3. Actual inspection of seeds of Ponlai rice in accordance with the procedures and standards began in the fall of 1957. This was the first attempt to obtain completely certified rice seeds for use by the farmers.

4. Minimum equipments for seed laboratory testing were provided the seven District Agricultural Improvement Stations.

5. A three-day training course on laboratory analysis of seeds was held at the Seed Technology Research Laboratory of NTU for the local seed analysts.

1958

1. Field and laboratory inspection of seed farms and seeds of peanut, wheat, sorghum, soybean and sweet potato began in the fall of 1958. The newly-promulgated procedures and standards for seed certification were followed.

2. Three local seed workers were sent to the United States for advanced training on seed technology under the Technical Assistance Program sponsored by the then ICA/Washington.

1959

1. The Provincial Seed Testing Laboratory designed to have a capacity of testing over 20,000 seed samples a year was established under PDAF in the fall of 1959. This laboratory was fully equipped with all the necessary instruments for determining the seed moisture content, making seed purity analysis, and determining seed germinability. A specially designed sand-bed germinating room was accommodated in this laboratory. A low-temperature germination room and a seed health testing room were also added. The laboratory is also installed with a 600-sample germination room which maintain temperatures at 20°C or 30°C by manual adjustment. The laboratory is staffed with four seed analysts, one pathologist and a few casual helpers. Located within the compound of the Taichung DAIS in Taichung City, the laboratory has a total floor space of 384 square meters.

2. Seeds produced from the Hsinchu, Taichung and Tainan districts were all channeled to the Provincial Seed Testing Laboratory for testing which was formerly performed by the DAISs. For the time being, needs of the first rice crop produced in eastern Taiwan and the Taipei and Kaohsiung districts are still tested by the local DAISs. Table 7 shows the kinds and number of seed samples tested by the laboratory during the past years.

Table 7.

Crop	Number of samples tested					
	1959	1960	1961	1962	1963	1964
Rice	333	2,910	3,147	2,377	1,809	1,938
Peanut	—	406	359	556	123	435
Soybean	147	371	328	356	291	154
Wheat	170	1,417	1,409	1,249	4,675	605
Sweet potato	—	18	18	—	—	—
Corn	—	3	45	53	23	47
Rapeseed	—	30	20	28	31	30
Sorghum	—	3	3	3	1	3
Barley	—	3	8	5	3	—
Cotton	—	—	5	6	7	6
Jute	—	—	61	128	193	105
Castor bean	—	—	17	5	3	—
Vegetables	—	—	129	21	273	146
Kenaf	—	—	—	—	—	26
Flax	—	—	—	—	—	9
Total:	650	5,161	5,540	4,788	3,222	3,503

3. Dr. Don Grabe, a noted Seed Physiologist of the Iowa State University, and Mr. C. Hunter Andrews of the Mississippi State University were invited to Taiwan for a 3-month consultation tour to study the problems concerning the development of seed technology to make recommedation for their improvement. During their sojourn here in Taiwan, they also conducted a 2-week training course by offering lectures on seed testing for 12 selected local technicians, marking the first complete training course for seed analysts ever held on the Island. The international rules for seed testing were introduced to Taiwan during the training course. The main recommendations included in Dr. Grabe's report after completion of his visit may be summarized as follows:

a) The certification systems be combined into one, with field inspection and sampling of all crops consolidated under one man, and laboratory testing of all crops under another man;

b) Uniform procedures of seed testing be adpoted as taught in the short training course;

c) Emphasis be placed on the use of locally available materials;

d) The sand tests be instituted where practicables;

e) Research on standards be continued.

4. The Second Far East Seed Improvement Workshop was held in Tokyo this year. The Republic of China sent a 6-man delegation to participate in this Workshop headed by the late Dr. C. F. Cheng, then Sr. Specialist of Plant Industry Division of JCRR.

1960

1. The First Far East Seed Technology Training Course was held in Taiwan, with the attendance of 18 participants from Korea, Japan, the Philippines, Vietnam, Thailand and the Republic of China. Dr. James Delouche and Mr. C. Hunter Andrews from the Mississippi State University were invited to lecture at the Course on the techniques of laboratory seed testing. Four selected local technicians served as assistant lecturers at the Course. This training course embodied three weeks of class lectures and laboratory practices, and one week of field observation trip covering the major crop-producing districts in western Taiwan.

2. An International Seed Exchange Center was established under the Taiwan

Agricultural Research Institute. The establishment of such an institution was in conformity with the resolutions reached at the Second Far East Seed Improvement Workshop held in Tokyo in 1959. The functions of the Center are as follows:

a) Centralizing and simplifying the introduction of breeding stocks of various kinds of crops from foreign sources to the various local agricultural institutions so as to avoid duplication;

b) Representing Taiwan in the international exchange of seed stocks with foreign countries;

c) Keeping complete records of the introduced and exported seed stocks; and

d) Handling the follow-up work on the seed stocks introduced for trial planting and other purposes.

Table 8 shows briefly the status of seed exchange handled by the Center during the past years since its inauguration.

Table 8.

	Incoming number of			Outgoing number of		
	Crops	Varieties	Countries	Crops	Varieties	Countries
FY1961	36	4,584	19	32	359	31
FY1962	23	878	25	38	1,875	46
FY1963	12	381	17	32	647	55
FY1964	18	638	19	36	761	54

3. Revision and publication of the "Rules and Regulations Governing Seed Certification In Taiwan" and the minimum standards for various levels of seed. Vegetables of 10 groups were also included. The rules and standards include the following kinds of crops and items:

a) Regulations governing the certification of crop seeds.

b) Regulations governing the implementation of seed certification.

c) Standards for seed certification of various kinds of field crops (rice, sweet potato, peanuts, soybean, wheat, hybrid corn and sroghum, barley, cotton, rapeseed, jute, kenaf, flax, etc.)

d) Standards for seed certification of vegetables (groups of cabbages, Pai-tsai,

mustard, radish, lettuce, onion, melon, bean and solanum).

4. Setting up of Seed Technology Committees under the Rice Improvement Conference and Upland Crops Improvement Conference. These standing conferences were organized by the PDAF to take up the technological research and improvement of rice and other upland crops in Taiwan. The Conferences are composed of various committees on breeding, cultural improvement, soils and fertilizers, irrigation, and seed technology. The committee members meet several times a year to study and discuss the difficulties and problems encountered and to formulate their remedial measures for consideration and action by the PDAF.

5. Release of the first hybrid variety of corn (Tainan No. 5) making the use of modern seed packaging with polyethylene bags and seed certification tags a reality. The seeds were packed in 2.5- and 5-kg. bags just good for sowing 0.1 and 0.2 ha. of corn field to suit the needs of corn growers.

1961

1. A research laboratory for tree seeds was established by the Taiwan Forestry Research Institute to meet the mounting need for testing the quality of tree seeds. The determination of the germination ability of tree seeds usually takes much longer time than what is required for crop seeds. Biochemical methods for determining the seed viability, particularly for tree seeds, are frequently used. The main function of this laboratory is to conduct research on the proper methods of determining the germinability of various kinds of tree seeds. The laboratory also renders service in testing seed samples for other public agencies.

2. A specialized field inspection system was instituted to replace the previous practice of performing the field inspections by local government personnel in an "amateur" manner. Such personnel were mostly not well trained, nor were they well experienced. They were just to do the inspection work casually within a short length of time during each cropping season. This on-and-off operation was likely to affect the working efficiency of the inspecting personnel. Besides, the field inspection work only constituted a minor share in their regular duties and there were hardly people in the local governments who are fully aware of the importance of the field inspection operation. In order to improve this situation, a new system of specialized field inspection was carried out on a trial basis. For the first year, only three agricultural college graduates were employed as professional inspectors with each of

them provided with a motorcycle to facilitate their field operations. Intensive training on the inspection techniques, knowledge of crop cultivation, and the varietal characteristics of different crops were given to these inspectors. The three men were assigned to the Taichung district to work exclusively on field inspection of various types of seed farms. The results of the first-year performance by these three inspectors were very encouraging with the following achieved: a) establishing a confidence among the government personnel, seed producers and farmers in general in the effectiveness and usefulness of the new system under the overall seed multiplication and certification program; b) urging the farmers to become more aware of the quality of crop seeds, and the seed producers to pay more attention to the management of their farm; c) saving a great deal of time and energy of the research workers at the various DAISs by supplying them with the needed information on crops and field situation, imparting agricultural know-how to the farmers and serving as a liaison between the local government and the farmers. After the first-year trial of the new system, the coverage of the system was enlarged to cover the entire farm lands in western Taiwan with a total of seven specialized inspectors employed.

1962

1. The Republic of China became a member of the International Seed Testing Association (ISTA). A three-man delegation headed by Mr. H. S. Chang of JCRR was sent to attend the 13th Congress of the ISTA at Lisbon marking the first participation by China in such an international activity aiming at the improvement and unification of seed testing techniques. The Provincial Seed Testing Laboratory of the PDAF was designated by Chinese Government to represent this country in the Association, thus becoming the only ISTA-accredited seed laboratory in China.

2. A seed processing plant equipped with modern seed processing machineries was established at the Taiwan Seed Service of the PDAF. The plant is so far the only one of its kind ever established on the Island for the following three purposes: a) to process the seeds produced by the Station itself at an estimated value of around 8-10 million New Taiwan dollars a year at the present time; b) to serve as a training site for the local seed processing technicians; and c) to serve as a model plant for improving the crude equipment for seed processing now used by the ordinary farmers in Taiwan. The Station is also installed with two units of Aerovent dryers, three cold storage rooms, a small-scale seed testing laboratory, and a series of seed packaging equipment. A Swedish made laboratory seed processing plant con-

sisting of scourer, air separator, shaking sieves, table separator, indented cylinder, etc. are also installed in the plant for research and training purposes.

3. Vegetable seed farms producing vegetable seeds for export began to be subject to field inspection and laboratory analysis. This measure was aimed at elevating the quality of the vegetable seeds for export. For the time being, it was applied only to the main kinds of vegetables, such as radish, edible rape, Chinese kale, and cauliflower. The exporters of vegetable seeds were required by the government to enter into contracts with the seed growers and to apply for field inspection of the seed farms. Usually two field inspections were made, one at the flowering stage and the other at the seed-setting stage. Emphases of the inspection were laid on the doubtful plants, off-types, other varieties, and the condition of isolation of the seed farms. Seed samples were taken from the seed farms with the sample bags sealed by the inspectors. For laboratory testing, two kinds of tests were adopted: a) regular laboratory analysis of purity and germination; b) field plot examination for varietal genuineness.. When all the tests were completed, the test results were transmitted to the Provincial Bureau of Commodity Inspection & Quarantine (BCIQ) for reference, an agency officially responsible for the inspection of imported and exported commodities. No seeds were allowed to be exported without passing through this procedure and having proper reference at the BCIQ. Table 9 shows the status of vegetable seed production and inspection during the past three years.

Table 9.

				No. of seed Farms		No. of seed samples		No. of seedlings	
Year	Crop	Planted acreage (ha.)	No. of seed growers	In-spected	Passing field inspection	Analyzed	Passing lab. analysis	Examined	Passing examination
1962-63	Radish	170.53	242	242	206	185	162	162	162
	Edible rape	18.21	32	32	14	13	13	13	13
	Chinese kale	29.90	88	88	73	72	72	72	71
1963-64	Radish	135.91	234	234	180	97	97	97	86
	Edible rape	31.38	48	48	41	17	16	—	—
	Chinese kale	39.83	50	50	39	24	24	24	23

1963

1. In order to accelerate the progress of seed technology development in Taiwan, it was generally felt that some sort of an organization should be established to combine and strengthen the efforts of all the seed workers on this Island. In 1963, JCRR initiated the establishment of a "Seed Technology Research Conference" with the purposes of a) providing education and training to the fellow seed workers, b) exchanging ideas and discussing problems regarding the development of the seed multiplication and certification programs, and c) providing incentives to the handful of seed workers to improve their learnings on seed technology through mutual help and encouragement. The Conference is composed of about 35 regular members, and holds four seminars in a year, in which lectures are given by invited specialists on various topics such as seed administration, multiplication, certification, processing, storaging, treating, packaging, and the problem of seed law.

2. A new section of seed health testing was added to the Provincial Seed Testing Laboratory. But, so far the testing for seed health is not included in the regular seed certification program. Instead, research on health condition of seed of various kinds of crops and vegetables sampled from different sources is being conducted separately by one pathologist at the Laboratory.

3. Seed processing constitutes one of the important phases of the modern seed technology. However, due to the small farm-holding (averaged at 1.06 ha. per each farm household) in Taiwan and the rather limited harvests therefrom, farmers are generally negligent of the quality and grade of their farm products for marketing, and consequently only quite primitive implements for seed processing are used. The most common seed cleaning implement used in Taiwan is the winnower which is hand-operated and performs the cleaning operations by the difference in weights of the grains and other matters. Rough screens are also used operated by hand shaking. In order to improve this backward situation and to adopt the use of modern seed processing machineries as existing in the advanced countries, Messrs. Charles Vaughan and George Dougherty, Seed Processing Specialists of the Mississippi State University, were invited to make a 2-month observation trip to Taiwan to provide the needed counsel on the improvement of the seed processing equipment and operation. With the availability of their consultative service, a 1-week short training course on seed processing was held for some 40 participants at the seed processing plant of the Taiwan Seed Service. This training course was the first

of its kind ever held in Taiwan to acquaint the local seed workers on the basic principles of modern seed processing. Although the number of partcipants was limited, its impact on the local seed industry was immensely great. Before their departure from Taiwan, the two named seed processing experts from the U. S. submitted two reports to the JCRR and AID/Washington presenting in details their observations, suggestions and recommendation on the improvement of seed processing in Taiwan.

4. The national standards for minimum seed qualities and the standardized methods for seed testing were drafted by the concerned agencies and adopted by the Legislative Yuan of the Chinese Government. The new standards and methods were formulated to include the international rules for testing seeds. It was officially promulgated by the Ministry of Economic Affairs to govern the import and export of seeds since then.

1964

1. A new measure for the improvement of the rice seed multiplication system was conceived and initiated, which, if proved successful, will serve to pave the way for the commercialization of rice seed production in Taiwan. The gists of the new measure were as follows: a) seed growers should be urged to undertake the production of certified rice seeds in a voluntary manner instead of the appointed seed growers; b) seed growers should have the free choice to select the varieties they wanted to plant and produce; c) collective production of seeds was encouraged; and d) the number of seed growers was to be reduced to a minimum. This new approach was tried out in Taoyuan Prefecture for the first year and will be expanded to cover other districts in the future, if proved successful.

2. Four 1-week training courses were conducted, one on seed processing and three on seed testing, with a total attendance of 94 local technicians participating in the trainings. The courses were all taught by local specialists on seed processing and testing.

3. A Chinese version of the 1959 edition of the International Rules for Testing Seeds was published. The translation was rendered by the writer. It is the seventh language of the Rules ever published.

4. A new section named "Seed Technology Section" was established and added

to the organizational chart of the PDAF. The newly-created section was to assume the responsibility of overall planning and implementation of the development of seed technology in Taiwan. It will supervise over the progress of field inspection and laboratory testing of various kinds of seeds under the seed multiplication and certification programs. It will also administer the seed trade of Taiwan according to the government regulation, and exert its efforts in promoting the seed export. The feasibility of launching a provincial seed law for Taiwan is also being intensively studied by this new section of PDAF.

VII. Review and Discussions

The general pattern of agricultural development in any place usually takes the following steps:

1. Setting up of agricultural experiment stations to introduce and select pure lines, and to cross-breed superior varieties for extension to the farmers.

2. After the superior varieties are ready for extension, the small amounts of breeder's seeds are multiplied through a system sound enough to safeguard the genetic identity and varietal purity. There are two ways to achieve these objectives: a) to distribute the breeder's seeds to a selected number of reliable seed firms or seed growers for multiplication; b) to multiply the seeds through a government-sponsored seed multiplication, certification and distribution programs. For most of the densely populated agricultural countries, the second way is almost the only way to follow.

With the small farm-holding per each farm household and the limited amounts of seeds needed by the farmers for their own fields, it is evident why the second way as mentioned above appears to be the only way out. In such countries, no large scale seed firms are existent and the government has no other alternative but to take up the responsibility of seed multiplication, certification and distribution of the superior varieties.

For the past 40 years or so, Taiwan has experienced all the possible problems, hardships and almost insurmountable difficulties in the development of the seed program. The institutional and sociological problems and the deep-rooted conservativeness and lack of adequate eductation on the part of the farmers all accounted for slow-paced progress of the seed development program and the development of a healthy seed industry in Taiwan. In order to step up the extension of the improved varieties released by the agricultural improvement stations, the Taiwan Provincial Government instituted a three-level seed multiplication system to increase the availability of seeds to meet farmer's mounting demand for better varieties for planting. The government agencies contracted numerous small seed growers for the production of the extension seeds; and large number of government personnel were dispatched to supervise over the seed farms and to inspect the seeds to maintain desired qualities. The distribution of certified seeds is also a tremendous task for

the government. How to persuade the farmers at all localities to come to take delivery of the certified seeds or, in another way, how to mobilize all the facilities under government control to ship and distribute the certified seeds to the individual farmers is always the biggest challenge in the entire program.

The problems frequently encountered and the means of their solution as adopted in Taiwan are summarized as follows:

Too many small seed growers

In order to facilitate the distribution of seeds, the government tends to set up seed farms as evenly distributed as possible in every township and village. This measure is, in fact, taken at the expense of the quality of seeds. Because of the limited budget, technical personnel and other facilities under government disposal, it is rather difficult to ensure that all the farms are properly managed, genetic identity is maintained and the seeds thus produced are up to the minimum certification standards. To tackle this problem, the concept that only the government has the responsibility to provide the farmers with seeds of improved varieties has been gradually changing among concerned govermental officials. A new concept in increasing the farmers' share in seed production for their own benefit is being emphasized. The farmers are told that good seeds of improved varieties will be produced by the government, but they will get their seeds only at certain places (township FAs in Taiwan). The days of seed farms in every village are over. As stated above, the number of rice seed farms in Taiwan has been drastically reduced from over 10,000 to around 1,500 in the past 15 years. Even so, the number is still considered too large for efficient management and will be further reduced. In reducing the number of seed farms, the following steps are taken:

1. Seed farms should be concentrated in one or two villages in each township;
2. Seed growers with a record of two failures in passing the inspection and certification will be dropped;
3. A minimum area for each seed farm is enforced; and
4. By raising of per hectare yield of the crops, the total planted acreages of seed farm can be reduced, thus reducing also the number of seed growers.

Limited coverage of crops and varieties in the program

Rice is the staple food for the people of Taiwan. Therefore, it was the first kind of crop with its seeds multiplied by the government-sponsored seed multiplication and certification system. It was not until some 20 years later when other major feed and oil crops such as sweet potato and peanut were included under the system. The system now contains 13 kinds of food and feed crops and 4 kinds of vegetables. These crops are mostly naturally self-pollinated or multiplied vegetatively; and the maintenance of their genetic identity and varietal purity are much simpler than those cross-pollinated crops. Due to the same reason of limited budget and technical personnel on the part of the government, only very limited number of major crops can be accommodated into the seed multiplication and certification system administered by the concerned agencies.

In present Taiwan, the whole system now tends to limit its function to the multiplication of only those newly-released improved varieties, while the job of increasing the seed supply of the old varieties is left to the farmers. By so doing, the number of varieties of each crop to be multiplied will be a very small one, and the seeds thus produced and certified will find a very popular market and a strong demand by the ordinary farmers.

Difficulty in selecting most popular varieties to be multiplited

What varieties should be included in the government-sponsored seed multiplication and certification program is always a difficult question to answer. There are often different opinions between the ordinary farmers and the agricultural workers (breeders and agronomists) in regards to the best varieties to be multiplied. Since the whole program is operated by the government, usually the opinions of the government workers prevail. But it is the farmers who are to use the seeds so produced, and they would not use such seeds unless they are convinced of the desirability of the respective varieties. So there have been instances that the certified seeds of certain varieties produced under the government-sponsored seed multiplication and certification system lay idle in the warehouses of the FAs, thus posing a difficult problem for the government agencies to handle. This controversial problem subject exists very often between the agricultural workers and the farmers. The breeders are apt to base their view on the results of field experiments and regional varietal

tests which are conducted at well-selected localities and field conditions more favorable than the farmers' fields. It is only natural that there exist some discrepancies between breeders and the ordinary farmers in the adaptability of some of the varieties. The problem is now remedied by modifying the seed multiplication system on the following points: a) instead of the appointed seed growers, farmers with good reputation and competancy in seed production are urged to register with the respective government agencies for authorization to take up the seed production work; and b) the seed growers are vested with the freedom to decide on the varieties they intend to grow instead of the designated varieties as was the practice in the past. These remedial measures have been put under a trial in one prefecture in last year, and will be extended to cover the entire Island, if the results of the trial turn out to be satisfactory.

Shortage of government funds and technicians for efficient implementation of the program

For efficient planning and implementation of the current seed multiplication and certification program, the government agencies will need 10 technicians to spend 250 days each in a year just to make field inspections of the seed farms (totalling over 10,000) planted to various kinds of crops, leaving all the other operations related to the seed multiplication and certification program to others which are requring even more man-days. The fund required for carrying out the seed program is imposing a tremendous burden on the stringent budget of the government agencies. The regular budget of the government for carrying out the seed program is usually far from being adequate to cover all the expenses needed for the responsible personnel to make contacts with the contract seed growers, to supervise over their farms, to make field inspections and to take samples for testing by the Provincial Seed Testing Laboratory. Since it appears rather impossible for the government to explore additional fund sources for the program for the time being, the efficiency of all the operations in implementing the program as mentioned above will continue to be affected for some time to come, thus resulting in lowered quality of the seed produced. The ultimate solution to this serious problem seems to lie in the complete commercialization of the entire system of seed production and marketing.

Difficulties encountered in promoting the commercialization of the seed production and marketing system

It is generally realized that the production of seeds can be made a profitable undertaking and its commercialization will help modernize the production techniques, relieve the government of its burden to supply seeds to the farmers, and stimulate the prosperity of rural economy.

The basic principle for the commercialization of seed production is to bring increased returns to the seed growers and the concerned seedsmen; and the steps taken by the government towards the attainment of this objective are mainly as follows:

1. To select the regions most suitable for the production of certain kinds of crop seeds and to render financial and technical assistance to the growers, making the criteria for the selection known to the farmers;
2. To make available seeds of the new and improved varieties to the seed growers in selected regions for multiplication and extension;
3. To conduct short training courses on the techniques of seed production for the seed growers in those selected regions;
4. To maintain the government's authority of certifying the seeds produced;
5. To urge the ordinary farmers to purchase their seeds from those seed producing regions and use only certified seeds;
6. A **"Newsletter of Seed"** is published to serve as an information medium on the supply and demand for seeds to introduce the new and improved farming techniques, and to announce the wholesale and retail prices of the important crop and vegetable seeds in various districts of the Island. The existing and newly-created seed firms are also introduced in the periodical.

Althongh preat effort rendered by the concerned government ageneies in promoting the commercialization of the seed industry in Taiwan, the progress is slow paced due to numerous difficulties, such as the ignorance and money-consciousness of farmers, the small quantities of seeds needed by individual farmers, the deep rooted traditions and customs of seed transaction system, and the low profits of seed production.

Shortage of seed administrators, researchers and technicians

The overall planning and execution of the seed development program in Taiwan is handicapped by the fact that well trained and experienced seed workers are so short that they can be counted by one's fingers. Even the handful of seed workers are drained away from time to time due to one reason or another. So far, eight agricultural technicians have received advanced training on various phases of seed technology in the U.S. for different periods lasting from three months to one year under Technical Assistance Program sponsored by the former ICA and current AID of the United States Government. About 80 technicians have received 1-week training on seed testing techniques, and over 1,000 received 1- to 3-day training on the techniques of seed production, field inspection and seed administration. Even so, the shortage of capable and competent seed workers in Taiwan is keenly felt; and unfortunately, many of the trained technicians have been transferred to other jobs and are no longer devoted to the seed program. Practically, no research is being undertaken on seed physiology; and in recent years there has been a strong tendency that capable young technicians are being tempted to work for other private enterprises for higher salary and better chances to get promoted.

As a matter of fact, this serious problem is not only challenging the authority responsible for the development of seed technology, but is also taxing great difficulties on other branches of agriculture. As we are all aware, as long as the government workers are ill-paid as is the present situation, this difficult problem will remain unsolved. However, regular on-the-job trainings in the form of short training courses on seed testing, processing, field inspection and other related subjects are conducted form time to time for the seed workers of various government agencies. Short training courses for seed growers are also held from time to time.

The problem of seed law

Up to the present, there is no seed law enforced in Taiwan. The government is exerting major efforts in the production of certified seeds to meet the farmers' needs and in educating them on the use of certified seeds. The feasibility of a seed law in present Taiwan is still under study and discussion. There are quite few considerations regarding the problem of a seed law for Taiwan. For instances, there are over 360 small seed dealers mostly on vegetable seeds existing on the Island,

with most of them owning no seed farms and not producing seeds by themselves. They just buy the seeds directly from the seed growers and then sell it to the farmers. No information concerning the quality of the seeds they sell is available to the buyers. Of course, there is a limited number of seed dealers who own their seed farms, and do have their seeds duly tested before marketing. A seed law which requires proper labelling of the seeds will only cause more confusion and will not likely improve the situation. Furthermore, under the present circumstances in Taiwan, the enforcement of such a seed law would be a tremendous job for the concerned law-enforcing agencies. Numerous inspectors will have to be employed, and great numbers of seed samples must be taken regularly for checking the trueness to the labels. Before a seed law can be effectively enforced, education of the seed dealers should first be strengthened. Although there is no seed law in Taiwan as yet, measures have been taken towards that end:

1. Seed samples are collected from the market for proof-planting at the government stations, with field days held to enable the respective seed dealers to witness by themselves the field performance and quality of their own commodity and with prizes given to the best performers.

2. A general survey of the 330-odd seed dealers was conducted in early 1965 to acquire information as follows:
   a) Does he have his own seed farm? If not, what are the sources of his seeds?
   b) The kinds and quantities of seeds he deals usually.
   c) Does he keep a record of amounts of seeds he has sold?
   d) Does he own and seed testing, processing equipment?
   e) How does he store his seeds?
   f) Does he ever pack his seeds before sale?

The results of the survey will be of some reference value to those interested in studying the status of seed industry in Taiwan and to the government quarters making policies on the commercialization of the seed industry at home.

VIII. SUMMARY AND PROSPECTS

The development of seed technology is a time-consuming task, especially in conntries where small farms prevail and farming is for self-sufficiency of the farm households rather than a commercial undertaking. In Taiwan, the development of seed technology is centered upon the rice seed multiplication program. It had not even been mentioned by the public until the year of 1956 when the First Far East Seed Improvement Workshop sponsored by the former ICA/Washington was held in Taipei. Plans and actions to speed up the development since 1956 are presented in this paper which can be summarized in the following:

1. **Seed administration:** A Seed Technology Section was established under the Provincial Department of Agriculture and Forestry to assume the overall responsibility of planning and executing the government policies and programs on the development of seed technology. Rule and regulations governing seed certification were promulgated. Minimum certification standards for 37 kinds of crops and vegetables were officially announced. Measures towards the commercialization of seed production and marketing were formulated and put into practise.

2. **Seed production:** There are 13 kinds of crops and 4 kinds of vegetables now included in the government-operated seed multiplication and certification program. More kinds of crops and vegetables will be included when a) new and improved varieties are ready for commercial extension; and b) technical problems of seed production, selection of contract seed growers, and other related problems on certain kinds of crops are solved. The export of vegetable seeds to foreign countries is being promoted with all-out efforts by both the government and private circles.

3. **Seed testing:** Provincial Seed Testing Laboratory was established. The Chinese version of the International Rules for Testing Seeds was published for reference of all the seed analysts and seed workers. Seed analysts and field inspectors were given adequate training. The national standards governing minimum qualities of seeds for import and export were promulgated and training courses for both foreign and local technicians were also held.

4. **Seed processing:** A seed processing plant equipped with modern processing machineries, such as gravity separator, air and screen cleaner, seed treater, automatic bagger, cylinder separator, screw separator, dryer, etc., was established in central Taiwan. Training courses on seed processing were held for local technicians. A

simple and low-cost type of seed drying bin was extended and well accepted by the local rice farmers in the humid areas.

5. **Seed research:** A Seed Technology Research Laboratory was established at the National Taiwan University to undertake researches on storage, taxonomy and physiology of seeds. Another seed research laboratory for tree seeds was also established at the Taiwan Forestry Research Institute for exclusive studies on the problems of tree-seed germination. Experiments and research projects on seed storage, moisture equilibrium of seeds under different levels of relative humidity, varietal identification for various kinds of seeds, etc. were also undertaken. Both laboratories also serve as training sites for the local seed technicians.

After some 40 years since the release of the first improved rice variety in Taiwan, seeds of the main kinds of food, feed and oil crops have been supplied by the government agencies. Nevertheless, the quantities of the seeds supplied by the government agencies are rather limited; and the farmers have to rely on other sources for the seeds they need, such as their own farms, their neighbors, the model farmers and the petty seedsmen. So far the production and marketing of vegetable seeds are operated by private seed growers and seed merchants. The experience accumulated by Taiwan through the past years has revealed that there are many difficulties for the government to maintain a satisfactory seed multiplication program to supply quality seeds to the farmers: a) maintaining of an efficient seed multiplication program requires too big a budget which is in most cases beyond the capability of the government agencies; b) government personnel working on this program are usually not well trained and experienced; c) the opinions regarding the varieties to be multiplied, locations of the contract seed farms, the amounts of seeds to be multiplied at different localities are usually different between responsible government personnel and the farmers, thus rendering the whole program less effective; and d) government subsidy is, in most cases, a prerequisite to any government-initiated agricultural program; and, once established, it is hard to eliminate such subsidy. After careful studies of the whole situation, it is felt that the government agencies should shift gradually their main efforts from supplying seeds of food and feed crops to the farmers to promoting the production of hybrid seeds of corn, sorghum and vegetables of higher economic value. The development of a commercialized seed industry should be encouraged and the government should retain the sole responsibility of seed certification. Region and collective production of seeds in most suitable

areas through organization and cooperation among the small seed growers is encouraged in recent years. Cash subsidy from the govenment to the seed growers is reduced and in most cases terminated to stimulate the seed growers' self-reliance and initiativeness in solving their problems. Assigned to the various DAISs and the Taiwan Seed Service are the responsibilities of improving the seed processing, packaging and storaging. The export of vegetable seeds is also very promising and is being promoted by the government through the selection of most suitable varieties and producing seeds by the multiplication and certification program to ensure the quality of the seeds produced for export. Field inspection and loboratory testing of seeds must be specialized and technicians trained. In conclusion, it may be said that the development of seed technology in Taiwan is marching along the right track at accelerated paces, and strengthened cooperation and coordination between the government workers and the ordinary farmers are to be desired for further advancement of the program.