CHINESE-AMERICAN

JOINT COMMISSION ON RURAL RECONSTRUCTION

Plant Industry Series No. 21

THE IMPROVEMENT AND PRODUCTION OF IMPORTANT LONG VEGETABLE FIBERS IN TAIWAN

TAIPEI, TAIWAN, CHINA

MAY 1961

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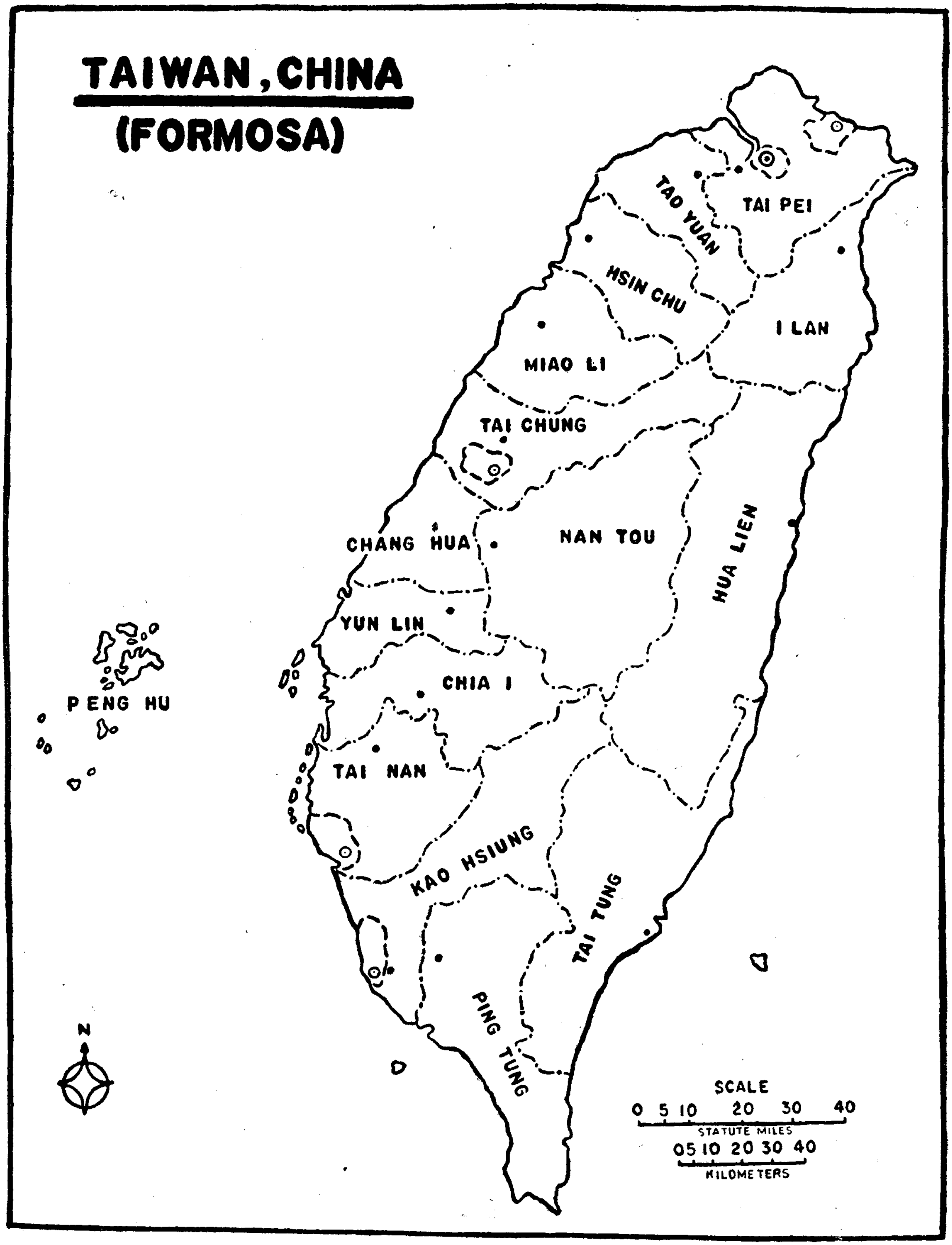
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FOREWORD

Long fiber crops occupy rather small acreages in Taiwan but play vital roles in the nation's major economic activities. The local jute supports an industry which manufactures gunny sacks for all the sugar and rice export at the magnitude of 800,000-900,000 metric tons of sugar and some 150,000 metric tons of rice, respectively, each year. Likewise, the sisal supplies the raw material for most of the ropes and twines consumed by the fishermen and farmers of Taiwan. Ramie and flax have even smaller acreages, but each has its contribution either to the local industries or to the export trade.

Research on long fiber crops started rather late in Taiwan as compared with other crops. Pre-war work was limited in volume. Before 1952, there was only a Fiber Crops Propagation Station which multiplied cotton, jute and kenaf seeds. The Station was transformed into the present Fiber Crops Experiment Station in 1952, becoming a branch station of the Taiwan Agricultural Research Institute. Since then, a systematic research program for long fiber crops began to take shape, including jute, kenaf (*Hibiscus cannabinus* L.), the Paw Keo of Thailand (*Hibiscus sabdariffa* var. *altissima*), ramie, flax, sisal, banana fiber, etc.

It is interesting to note that many experiments on long fiber crops conducted in Taiwan reflect the problems special to the ecological and social environment of this Island. Basically, all problems are stemmed from the density of population, the lack of cultivated land, and subsequently the prevailing multiple crop rotation system. For instance, in order to save land, the method of multiplying jute seed by apical cuttings is developed so that the same jute plants may be used for both maximum fiber yield and seed production. Retting of jute and kenaf is done with peeled bark instead of the whole stalks as is practised in India, Pakistan, Thailand, etc., because large rivers and ponds are not available in Taiwan and the use of the water bodies must be economized for retting jute. Kenaf and Paw Keo are studied for substituting jute on lower grades of land, as the trend is foreseen that jute will be gradually crowded out from its present growing areas by other crops such as rice, hybrid corn, peanut, soybean, etc. Flax is grown as a winter cash crop on paddy fields after two rice crops are harvested. Ramie has long since been pushed to hillsides by other crops of higher economic value. All researches on ramie and flax are, therefore, conditioned by the special requirements of their respective habitat.

The present pamphlet includes progress reports on some of the major research programs on long fiber crops.

H. T. Chang
Chief
Plant Industry Division

May 1961

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THE IMPROVEMENT AND PRODUCTION OF IMPORTANT LONG VEGETABLE FIBERS IN TAIWAN

H. S. Chang

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I. Natural Environment of Taiwan

Taiwan is an island located in the western Pacific Ocean, lying between 22° to 25° latitude N. and 120° to 122° longitude, having a total land area of 35,961 square kilometers. The Tropic of Cancer traversely crosses throught the southern part of the Island, so it lies both in the subtropical and tropical zones.

Within its total land area, about one-third is on the plain on which farming is being practised, while the remainder is occupied by mountain ranges covered mostly by forests.

The island has an annual precipitation of 2,500 milimeters quite unevenly distributed in the year. The average yearly mean temperature is between 22° to 24°C.

Among the three kinds of soils in Taiwan, i. e., the alluvial, the lateritic and the podzolic soils, the former two kinds are directly related to crops either planted on the plain or on the crop/forest marginal land, while the latter is chiefly forest soil.

Because of the warm climate, abundant rainfall and mild winter, it makes possible the planting of a good many varieties of crops in Taiwan. The principal crops now being grown in Taiwan consist of rice, sugarcane, sweet potato, wheat, soybean, peanut, tea, jute, pineapple, citrus fruits, tobacco, etc. Farmers in Taiwan are very sensitive and responsive to the prices of farm produces, so the consistency of crop sequence is difficult to maintain owing to the fluctuation of prices of farm produce from year to year. However, due to the limited arable land in Taiwan and the comparatively small farm holdings, averaging about 1 hectare per each farm household, the farmers have been trying to make the best use of their land by practising a very intensive system of cultivation. Generally speaking, if irrigational facilities are available, two rice crops are planted. In addition, a winter crop is commonly added as a cash earner. In central Taiwan, another summer crop is further planted either in the status of intercropping or in succession with the two rice crops. This highly intensive farming system in Taiwan is called "multiple cropping system". In studying the agriculture of Taiwan, these basic facts should not be overlooked.

II. Important Long Vegetable Fiber Crops in Taiwan

Jute is the most important long vegetable fiber crop in Taiwan. Besides jute, kenaf, sisal, ramie, and flax are also minor important crops good either for weaving, cordage making, or for scutching, into fiber for export.

1. Jute

In Taiwan, jute is mainly used for weaving into gunny bags to pack some 800,000 metric tons of sugar and 1,850,000 metric tons of rice produced annually, and also for making twines for farm use. The annual consumption of retted jute amounts to 18,000,000 kilograms.

In the year of Taiwan's restoration (1946), the acreage of jute dropped to only 2,500 hectares contrasting to the record of 25,000 hectares planted in 1939. Since then, efforts have been made to increase its production in order to meet the domestic needs and also to reduce imports of gunny bags. In the past 13 years, the acreage of jute fluctuated considerably from year to year. However, the general trend of unit yield and total production increased significantly. As a result, a small amount of 150,000 kilograms of scratched jute was exported to Japan in 1959. The acreage, yield and production of jute from 1947 to 1959 are listed below (Table 1).

Table 1.

Jute Acreage and Yield and Production of Retted Jute in Taiwan, 1947-1959

Year	Acreage (hectare)	Retted jute	
		Unit yield (kilogram/hectare)	Production (kilogram)
1947	3,778	685	2,587,583
1948	16,600	685	11,366,337
1949	11,094	797	8,839,784
1950	9,152	766	7,009,306
1951	12,174	890	10,840,628
1952	16,229	1,241	20,144,519
1953	6,791	787	5,342,570
1954	11,230	1,140	12,804,722
1955	14,960	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

Since the end of World War II, both varietal and cultural improvement works have been done in Taiwan. In varietal improvement work, a set of standard procedure for jute breeding was worked out and put into effect in 1953, which has been followed by the jute breeders ever since. Crossings between the existing local varieties and those with Halmaheira No. 5 were made. Systematic selections among the local varieties has been started since 1952. Among the strains selected, Y-6-466 is found less sensitive to day length, resistant to Anthracnose disease and high yielding. It is expected that this variety will be put into general extension in 1961.

To improve the cultural practices of jute, the Joint Commission on Rural Recontruction (JCRR) gave assistance in constructing 417 cement retting ponds, drying racks (total length: 8,694 meters), 64 baling machines and warehouses (total capacity: 15,200 square meters) to facilitate the farmers to ret their green ribbons properly and the related organizations to store the retted fiber in order to prevent possible damages due to improper storage facilities.

Method of interplanting jute with the first rice crop (spring season) was extended to farmers for practice in order to use the farm land more economically. Transplanting of jute seedlings has been proved as successful as the direct sowing method and has been put into demonstration and practice.

For seed increase, th apical portion of the jute plant bearing the flowers may be cut off and then transplanted into the field for developing new roots. The apical cutting method has been found very satisfactory in seed production. Another method derived by the agriculturists is to sow the seeds of the preceeding crop in winter and to collect the seeds in the following spring. This method could multiply jute seeds in a much shorter period in order to compensate the damages caused by typhoon.

With the development of new and promising jute varieties, coupled with the application of improved cultural practices, the unit yield of jute may be further increased to a higher level.

2. Kenaf

Kenaf is planted only in limited acreage in Taiwan. Its fiber has also been used for making gunny bags, so it is regarded as a possible jute substitute. The planting of kenaf before 1951 was quite insignificant, so its acreage and production were included in that of jute. In 1952, its acreage reached its peak of 1,271 hectares. However, due to the infestation of borer and Anthracnose disease, followed by the attack of typhoon, farmers became reluctant to plant kenaf, so its acreage dropped considerably to a low level and dwindled to around 100 hectares annually. The acreage, yield and production of kenaf from 1952 to 1958 are listed in Table 2.

Recent work toward kenaf improvement has concentrated on: (1) varietal improvement through hybridization and introduction of promising varieties from other countries. Among the introduced varieties, Cuba A, Cuba C and BG-52-7 are found very promising due to their high-yielding capacity and resistance to Anthracnose disease; and (2) development of measures to control insect pest, particularly the corn borer. Experimental results revealed that, by applying 1:1,000 time of Endrin spray, the borer could be put under control, Another alternative is to plant a row of corn surrounding the kenaf field as a trap crop. The borer would attack the corn rather than the kenaf so the latter could be saved.

Table 2.
Kenaf Acreage and Yield and Production of Retted Fiber in Taiwan, 1952-1958

Year	Acreage (hectare)	Retted fiber	
		Unit yield (kilogram/hectare)	Production (kilogram)
1952	1,271	1,242	1,579,207
1953	499	878	437,700
1954	282	619	174,667
1955	269	1,345	361,196
1956	155	883	137,233
1957	109	907	98,387
1958	83	657	54,575

It is therefore safe to predict that future acreage of kenaf would be on the increasing side; and it would become more and more important as a jute substitute in Taiwan.

Thai kenaf or Paw Keo as named by the Thai people introduced to Taiwan in 1957 is another promising plant needing to be mentioned here. The preliminary results indicate that the plant could thrive well on less fertile land with poorer irrigation facilities. No sign of attack by rootknot nematode was found on Paw Keo. Intensive experiments on its adaptability, cultural practices and seed production are currently underway. It is possible that Paw Keo would become the third important crop to furnish raw materials for gunny bag making.

3. Ramie

The production of ramie fiber in post war years seldom exceeded 1,000 metric tons annually with the exception of 1954 when 1,024 metric tons of ramie fiber was 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. In Taiwan, ramie is mostly planted on marginal land located between the plain and the mountainous area, so it is generally operated by the aborigines. Usually 3-5 harvests are made in a year. From harvesting to decorticating, manual labor has been used. This makes the ribbon much cleaner but more costly. Recent emphasis has been placed on the mechanical decortication of ramie with the aim of lessening its cost. By modifying the native Ikeda Type Decorticator used for sisal, the machine could be made to serve well also for ramie decorticating. Furthermore, a simple foot-operated decorticator has been invented particularly convenient for growers in the mountainous area where transporting of heavy machinery is difficult. Foreign types of decorticators were also introduced for trial.

These new decorticators have gradually been brought to use in the ramie producing areas. The dried ribbon thus produced is acceptable to the ramie mills in Taiwan. A new ramie plantation established in 1958 by the retired servicemen has adopted the Ikeda type decorticators entirely on its 200 hectares of farm.

Emphasis of varietal improvement has been placed on the introduction of promising varieties from other countries, including the United States, Japan and the Philippines, and also on the application of Colchicine to induce polyploid individuals.

The formulation of a standard ramie breeding program is also underway.

The acreage, yield and production of ramie from 1947 to 1959 are listed in Table 3.

Table 3.
Ramie Acreage and Yield and Production of Clean Ribbon in Taiwan, 1947-1959

Year	Acreage (hectare)	Dried clean ribbon	
		Unit yield (kilograms/hectare)	Production (kilogram)
1947	1,319	576	759,111
1948	1,455	523	761,689
1949	1,578	566	892,762
1950	1,125	612	688,117
1951	1,087	607	659,535
1952	1,044	647	675,555
1953	1,106	726	802,349
1954	1,266	809	1,024,238
1955	1,143	724	827,752
1956	1,122	753	844,969
1957	1,151	740	852,527
1958	1,125	762	857,152
1959	1,152	777	895,210

4. Flax

Although there is not yet a flax mill now in existence in Taiwan, the planting of flax has been chiefly for its fiber. Another interesting fact is that the crop is planted mostly in paddy fields in the central part of Taiwan where flax is planted as a winter crop after the harvest of the second rice crop, contrasting to the situation in other flax-producing countries. The only variety, Taichung Special No. 1, now under extension, is a fast growing one requiring only about 90-100 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 Table 4.

Table 4.

Flax Acreage and Yield and Production of Dried Straw in Taiwan, 1950-1959

Year	Acreage (hectare)	Dried straw	
		Unit yield (kilogram/hectare)	Production (kilogram)
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

The extension and collection of flax is handled by the Taiwan Industrial Development Corporation (TIDC), which has two flax scutching mills located in the Taichung area. Every year, between August and September, an extension meeting is called by TIDC, in which the prices of flax, extension acreage and so forth are decided. Flax seeds are supplied by TIDC to farmers on loan basis and repaid by them in kind in next April with a premium of 50%. During the harvesting time, farmers will bring in their flax straw to the collecting points according to a pre-arranged time table. Prices will be paid to the farmers according to the grades of the flax straw.

Under this extension and collection system, the flax to be produced each year could fit well to the capacity of the scutching mills without being over or under-produced. The processed flax fiber from these two mills are exported to Japan for manufacturing purpose.

Arrangements were made between the local agricultural organizations and USDA that the world collection of 1,200 flax varieties including both fiber and oil flax were introduced to Taiwan in 1960. Observations and selections are being made in order to choose the more desirable varieties suitable to the climatic conditions of Taiwan for future planting.

5. Sisal

Sisal has been planted in Taiwan since 1902. Its fiber is mainly supplied to the cordage industry to make ropes for the fishing vessels. The acreage, yield and production of sisal fiber from 1948 to 1959 are listed in Table 5.

Table 5.

Sisal Acreage and Yield and Production of Fibers in Taiwan, 1948-1959

Year	Harvested acreage (hectare)	Dry fiber	
		Unit yield (kilogram/hectare)	Production (kilogram)
1948	3,440	863	2,969,825
1949	1,706	627	1,069,254
1950	1,588	685	1,087,963
1951	1,722	659	1,134,123
1952	2,012	628	1,263,900
1953	1,998	351	701,300
1954	2,271	440	998,645
1955	2,448	440	1,076,908
1956	2,757	449	1,236,801
1957	5,750	1,201	6,904,420
1958	5,737	1,192	6,837,245
1959	6,088	1,083	6,591,565

In Taiwan, there was notmuch improvement work being done on sisal. However, some fertilizer and harvesting experiments and also trial of cover crops on the sisal plantation are being conducted in ordor to eliminate the damage of soil erosion. Demonstration on the grading of fibers is also being contemplated.

III. Research Organization

The agricultural research programs in Taiwan are primarily undertaken by the Taiwan Agricultural Research Institute under the Provincial Department of Agriculture & Forestry and its six experiment stations, each specialized in its own respective field. The research on fiber crops has been carried out by the Tainan fiber Crops Experiment Station.

The Tainan fiber Crops Experiment Station was founded in 1937 and was first assigned to work solely on cotton. It was reorganized in 1952 and its responsibilities were increased to the present pattern to include all the vegetable fiber crops to its program. The Station is situated in the city of Tainan with a branch station located in Chiayi. It has a total area of 30 hectares in which 16 hectares are for experimental uses. Among its total staff of 33 persons, 25 of them are technical personnel.

The Station has its own greenhouses, dark room, laboratory, equipment, machines and farm implements, so it is capacitated to carry out a great variety of studies ranging from field experiments to physiological and cytological researches.

Besides its research programs, the Station shares the duties with other agricultural organizations in conducting extension work including the setup of demonstration plots, holding of field days and other educational programs.

IV. International Exchange of Planting Materials

To exchange planting materials internationally would enrich the plant breeders with a much more plentiful source of breeding stocks which would help substantially in the crop improvement program. From January 1947 to July 1960, a total of 19 kinds of fiber crops were introduced from 11 countries to Taiwan and 6 kinds of planting materials were sent from Taiwan to 7 countries. Among the introduced materials, the following are the most outstanding ones which are either still under trial or are being put into demonstration ready for extension:

1. Kenaf: Cuba C, BG-52-7
2. Thai kenaf: Paw Keo
3. Ramie: Miyazaki 112, Kawaminami No. 1, Murauchami, P. I. 87521
4. Sansevieria: Florida H13
5. Jute: Solimoes (U.S.A.) (Non-sensitive)

PRODUCTION AND IMPROVEMENT OF JUTE IN TAIWAN

H. S. Chang, C. Y. Chi and C. K. Chen*

I. Introduction

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.

II. 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 1948 to 1957. The acreage, yield and production of jute from 1947 to 1959 are listed in Table 1.

III. Producing Areas

The main jute producing areas is 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.

IV. Organization, Production and Consumption

Jute is produced in Taiwan through well-planned cooperation and coordination among the agricultural and industrial circles, producers and consumers. Hence, a well-

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Senior Specialist and concurrently Chief of Fiber Crops Section, Provincial Department of Agriculture & Forestry.

Table 1.

Year	Acreage	Retted jute	
		Unit yield	Production
	(ha.)	(kg/ha.)	(kg.)
1947	3,778	685	2,587,583
1948	16,600	685	11,366,337
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1957	6,755	1,340	9,052,741
1958	12,644	1,352	17,095,847
1959	17,864	1,344	24,009,216

organized committee, Joint Committee on Jute Extension and Procurement (JCJEP), is organized which comprises of representatives from the following organizations: jute textile mills (manufacturer), local governments in main jute producing areas, Taiwan Sugar Corporation (consumer), Taiwan Food Bureau (consumer), Provincial Department of Agriculture & Forestry (PDAF), Bureau of Commodity Inspection and Quarantine, Chinese-American Joint Commission on Rural Reconstruction (JCRR) and Provincial Supply Bureau. This Committee is responsible for planning of the project on jute production and consumption of the very year. The Jute Purchasing Center (JPC) of the Provincial Supply Bureau is the agency designated to execute the project. The principle functions of JCJEP and the procedures of jute extension and procurement in Taiwan may be briefly stated as follows:

A. Principal functions of JCJEP:

1. Planning the amount of jute to be produced for the year.
2. Deciding the prices of jute and gunny sack.
3. Handling matters with respect to jute procurement and settling disputes, if any.
4. Making available funds for production loans and for the procurement of jute.

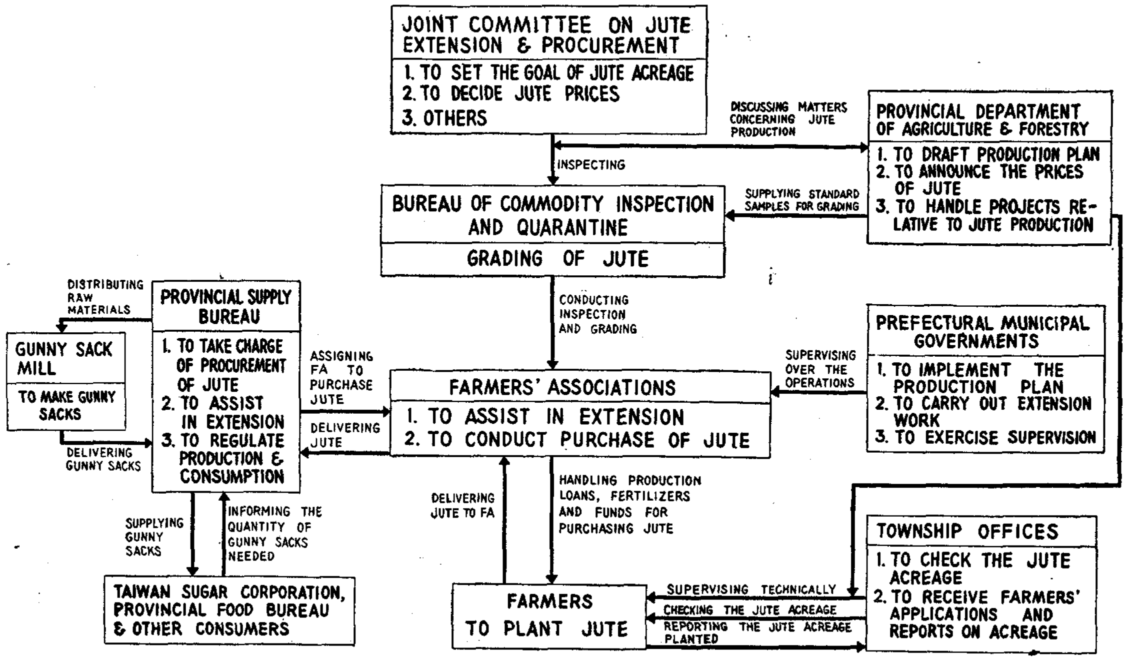
B. Procedures of jute extension and procurement:

1. Guaranteed price for jute is announced in advance of the planting season.
2. For the purpose of encouraging farmers to raise more jute, publicity work is energetically done by JPC in coordination with governmental agricultural agencies.
3. Farmers are required to report to the respective farmers' association their planted acreage of jute.

4. Spot-checks on the acreage of jute actually planted are made by JPC representatives and governmental officials; after that, production loans without interest will be extended to farmers in accordance with the contracts entered between JPC and the local farmers' associations.
5. Improved cultural methods and other technical instructions are made known to farmers by the agricultural agencies.
6. Local farmers' associations provide warehouses for storing purchased jute.
7. Dates for purchasing jute in various townships are set by JPC in consultation with the local farmers' associations.
8. Specialist of the Bureau of Commodity Inspection and Quarantine is responsible for inspecting the grades of jute during the course of procurement.
9. For supervising the purchasing work and settling disputes between JPC and farmers, a supervisory unit is organized by the members appointed by JCJEP.
10. JPC is responsible for conducting the purchasing work.
11. After being purchased, all retted jute is baled and shipped to the designated mills for processing by farmers' assoiations.
12. The amount of retted jute allocated to each mill is based on the production capacity of the mill.
13. Based on the information obtained by JCJEP, the gunny sacks made by the mills are allocated to the Taiwan Sugar Corporation and the Taiwan Food Bureau according to their respective requirement.

C. An organizational chart showing the procedures of jute extension and procurement in Taiwan is shown below:

AN ORGANIZATIONAL CHART OF THE JOINT COMMISSION ON JUTE EXTENSION AND PROCUREMENT



V. Jute Textile Industry

In Taiwan, there are four gunny sack mills with a total capacity of 10,574 spindles and 420 power looms, which could produce annually 20,000,000 gunny sacks on active operation.

VI. Important Measures for Jute Production

A. The establishment of guaranteed price for jute purchasing:

With the purpose of encouraging farmers to plant more jute, the guaranteed price which is competitive with prices of other crops for every years is arranged by the JCJEP in consideration of the following factors, i.e., the cost of jute production, the profit obtained by raising competing crops other than jute and the price of imported gunny sacks. Consequently, farmers are made confident that a reasonable profit will be obtained through growing jute. Meanwhile, the reasonably set price is also beneficial and acceptable to both the producers and consumers.

B. Improvement of farming techniques:

Important advance in jute production is derived from increasing its unit yield and promoting its fiber quality through the improvement of cultural practices. It may be illustrated by the fact that favorable results have been obtained through seed sterilization by using Spergon to prevent the jute seedlings from being attacked by damping-off disease and through applying proper amount of N-P-K fertilizers in company with compost manures. In Addition, by practising the improved techniques of retting and drying, the quality of retted jute has been strikingly elevated. For recommending practices that are applicable to the farms in the jute producing areas, briefing on jute production is regularly held, and pamphlets on seeding methods, proper application of chemical fertilizers, effective control of insects and diseases, improved methods of jute retting and drying, etc., are distributed to the participants. Furthermore, extension workers frequently take field trips to the jute growing areas and give assistance to farmers in putting the practices into effect.

C. Strengthening of research work:

The Tainan Fiber Crops Experiment Station of the Taiwan Agricultural Research Institute is responsible for conducting research work on jute breeding, cultivation, as well as physiological and ecological studies on jute plant. Because of the variation of climate and soils and many kinds of crops grown in Taiwan, it is necessary to set up test plots on farms to determine the adaptability of the recommended practices to a specific region. Hence, intensive research at a experiment station is not enough to support an extension program and must be reinforced by adequate field testing. Therefore the following steps have been adopted in the course of promoting jute production: 1) intensive research at the experiment station to develop new practices, 2) extensive testing of these practices to determine their adaptability under practical conditions; and 3) assistance to farmers in putting the practices into effect.

D. Establishment of the systems of regulating and grading jute fiber:

In order to set reasonable prices for different grades of jute, to encourage farmers to produce fiber of better grades, and to eliminate the possible disputes during the process of purchase, grades and standards for retted jute, crude jute and scratched jute were established and put into effect in 1949 by the local government. The grades and standards are shown in Table 2 and Table 3.

E. Contest for high yield and good quality:

In order to encourage farmers to produce jute of better quality and higher yield, the government had sponsored jute production contest in 1951-1953. There were two kinds of contest, namely, individual and group contests. Farmer who planted over 0.3 ha. of jute was eligible to participate in the individual contest, while, the township in which there was a definite planting acreage was qualified to participate in the group contest. Substantial prizes were awarded to winners for encouragement.

Table 2.

Grades of Retted Jute

Requirement	First	Second	Third	Fourth	Fifth
Length	Over 1.82 m.	Over 1.52 m.	Over 1.21 m.	Over 0.97 m.	Over 0.76 m.
Fiber quality	Fibers excellently loosened, very fine	Fibers excellently loosened, very fine	Fibers well loosened, ordinary fine	Fibers loosened, not very fine	Fibers loosened, coarse
Color	Silvery white or bright brown	Silvery white or bright brown	Silvery white, white or brown	Greenish or dark	Greenish or dark
Texture	Very soft	Soft	Ordinary	Slightly hard	Hard
Degree of retting	Excellent, no mixture	Good, no mixture	Ordinary, no other mixture	Retting less desirable, mixture not over 2%	Retting undesirable, mixture not over 13%
Strength*	Very strong	Strong	Ordinary	Slightly weak	Weak
Drying	Excellent	Good	Fair	Fair	Fair

*Based on the part 40-50 CM. from the tip.

Table 3.

Grades of Crude and Scratched Jute

Requirement	First	Second	Third	Fourth
Length	Over 1.97 m.	Over 1.67 m.	Over 1.36 m.	Over 1.06 m.
Color	Bright red or bright green or bright loquat color	Red, green or loquat color	Red green or loquat color	Slight dull
Degree of processing	Completely of bast layer, no other mixture	Completely of bast layer, no other mixture	Mixture not over 1%	Mixture not over 1%
Thickness	Very thick	Thick	Ordinary	Thin
Drying	Excellent	Good	Fair	Fair

F. Strengthening of physical facilities for jute production:

With the financial and technical assistances from JCRR and JCJEP, retting ponds, drying racks, baling machines and warehouses have been installed in order to facilitate the processing, handling and marketing of jute in the jute-producing areas. Data itemized below show the kinds and quantities of facilities made available through the assistances of the said organizations since 1950.

Jute retting pond	417 sets
Drying rack	8,694 meters
Baling machine	64 sets
Warehouse	15,200 square meters
Grading office	26 places

Among the above-mentioned facilities, retting ponds and drying racks are necessary for producing high quality retted jute, whereas baling machines and warehouses are indispensable to farmers' associations for storing and transporting jute. Funds are required for the maintenance and periodical repair of the facilities in order to lengthen their serviceability. However, it has been experienced that collecting funds from individual farmers is rather inconvenient and long-term subsidizing from the government would also be ineffective. Finally, it was decided that JPC would collect funds from the Farmers' Associations for such purposes. The amounts of funds required for various kinds of facilities are determined based on the reports prepared by the prefectural governments upon approval of PDAF.

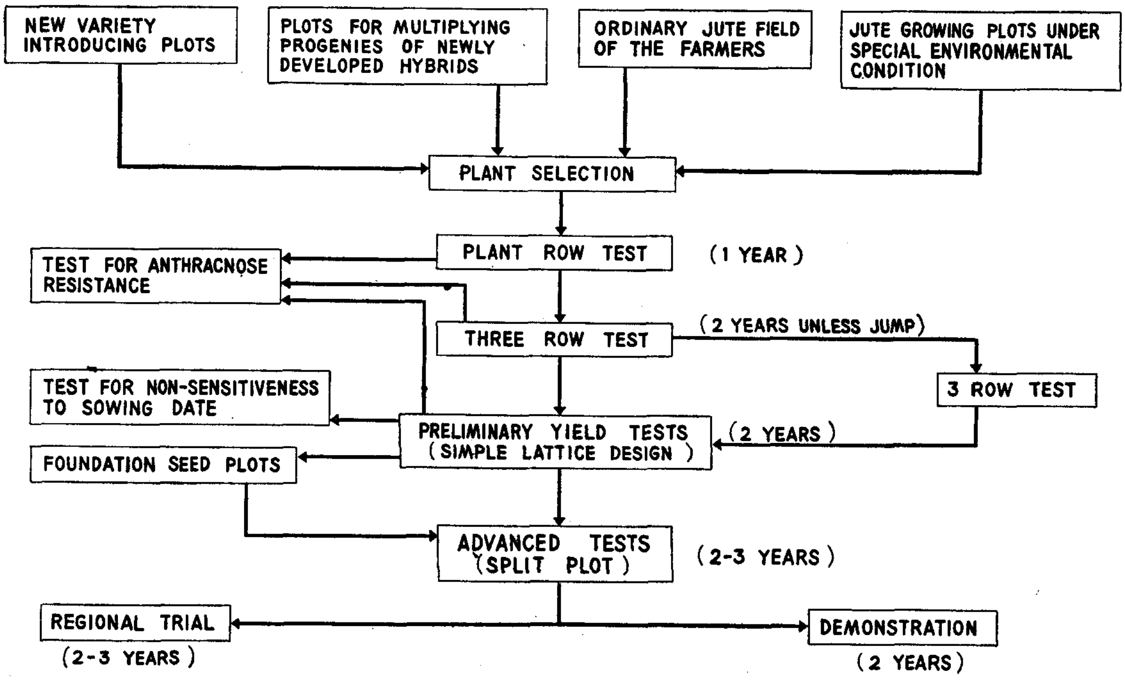
VII. Jute Improvemeut Program

A. Varietal improvement of jute

1. 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:

PROCEDURES OF JUTE BREEDING IN TAIWAN



2. 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 7, 6 and 10 localities respectively. As a result, the varieties "Huwei Green Bark No. 7", "Hsinfeng Green Bark" and "Taichung Special No. 1" 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 the 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 yillages in 83 townships located in 13 prefectures/municipalities. Throgh 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 out-yields 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.

3. 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.

B. Cultural Improvements:

The steady increse 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.

1. 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.

2. 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 into the paddy field under intercropping condition with the rice for 15 days would save a total of 55-65 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 first and the seond 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.

3. 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 on breeding work.

VIII. Conclusion and Summary

Since 1948, much attention has been paid by the government to the increase of jute production. Undoubtedly, the success of this program has depended much on the as sistance given by JCRR and the constant efforts made by the local governments in cooperation with the jute farmers. The following facts justify the results.

A. Increase in production:

During 1946, after the retrocession of Taiwan to China, jute acreage dropped to 2,500 ha. and production of retted jute reduced to 1,279,600 kg. Though the acreage increased to 3,370 ha. in the next year, the production of 2,578,600 kg. of retted jute could only meet the needs of the farmers' own uses but not the jute mills. No substitute for jute for making gunny sacks was available at that time. However, with the efforts made by the government, both acreage and production of jute have been simultaneously increased since 1948. Taking the figures of 1948-1959 as an example, the annually planted acreage almost outstripped 10,000 ha. with a total production of 10,0000,000 kg. of retted jute. With the exception of natural calamities occurred in 1953, the average yield of retted jute throughout the Island has been steadily increased from 700-900 kg/ha. to 1,000 kg/ha. If taking the average yield of 1,350 kg/ha. obtained during recent years as an index, it is evident that the provincial average has doubly increased as compared with that during the Japanese occupation period. As a result of the significant increase in unit yield, the amount of gunny sacks produced has also been strikingly increased as shown in the following list (Table 4).

Table 4.

Production of Gunny Sacks in Taiwan, 1946-1959

Unit: bag

Year	Sugar sack	Rice sack	Other sack	Total
1946	473,175	905,996	227,211	1,606,382
1947	949,152	220,082	142,742	1,311,976
1948	2,123,289	642,305	104,759	2,870,353
1949	4,060,747	291,476	7,352	4,359,575
1950	4,577,562	483,967	191,375	5,252,904
1951	4,298,580	876,568	102,301	5,277,449
1952	5,598,783	841,453	316,639	6,756,875
1953	6,715,298	1,577,118	453,202	8,745,618
1954	7,469,493	1,574,456	471,513	9,515,462
1955	7,327,479	3,124,357	521,733	10,973,569
1956	10,075,351	3,032,611	439,537	13,547,499
1957	8,216,029	3,717,635	816,047	12,749,711
1958	6,468,293	2,404,227	564,330	9,436,850
1959	12,169,657	3,976,002	853,022	16,998,681

B. Promoting the quality of jute and reducing the cost of processing:

From the period of Japanese occupation to V-J Day, Taiwan imported jute annually from India to mix with the locally produced jute for knitting into gunny sacks on account of the inferior quality of the domestic jute. However, after years of improvement since 1949, the quality of jute produced in Taiwan has reached such a standard that, even without mixing of imported jute, the gunny sacks manufactured have been widely recognized as of very fine quality. Meanwhile, the cost of processing has been reduced considerably. According to the estimation made by the jute mill of the Taiwan Industrial Development Corporation, the cost of each gunny sack in terms of raw jute was 4.3 kg. in the early part of 1948, it dropped to 3.6 kg. in the latter part of 1949, and still lesser in the later years. Up to the present, only 2 kg. of raw jute equivalent is needed for making one sack. It is evident that quality of jute is the major factor in determing the cost of processing for mass production.

C. Increasing farmers' income:

JCJEP is formed for the purposes of coordinating between the producers and consumers through the local farmers' associations and of preventing the exploitation by the jute dealers, thus enabling the farmers to gain more cash returns. Jute price is reasonably adjusted year by year in order to compete with other crops. It can, therefore, be logically concluded that jute production has much to do with the development of rural economy.

D. Saving of foreign exchange:

Increase in jute production has not only improved the jute growers' livelihood but has also reduced the volume of importation of jute fiber and gunny sacks. Jute production in Taiwan has reached the stage of self-sufficiency since 1951. It is estimated that Taiwan needs 12,000,000 gunny sacks annually. If each sack costs US$0.3, the annual saving of foreign exchange will amount to US$3,600,000. In other words, a total of US$32,400,000 has been saved during the past 9 years. Moreover, it is certainly possible that Taiwan will be able to supply definite amout of jute to meet the foreign demands, if jute becomes lacking on the international market.

PRODUCTION AND IMPROVEMENT OF KENAF IN TAIWAN

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I. Kenaf Production 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 less fertile soil. Furthermore, it is adaptable to a wide range of dryland soil. For these reasons, there is no competition for land between kenaf and rice, which is otherwise in the case of jute.

When the Second World War 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 Anthracrose infestation was very severe in that year. Followed by strong typhoon, the crop was therefere 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	Unit Yield in Retted Fiber	Production in Retted Fiber
	Ha.	Kg.	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

II. Cultural Practices of Kenaf in Taiwan

Most of the kenaf in Taiwan is cultivated on loam or sandy loam soil with good drainage. It is usually grown in regions without irrigational facilities where upland miscellaneous crops prevail. It is also grown in rain-fed single rice crop field before the transplanting of the second rice crop. Ordinarily when the preceding crop is harvested, compost manure is applied by broadcasting as basal manure at the rate of 10 to 20 metric tons per hectare. The compost is turned under by deep plowing. The soil is stamped, harrowed and levelled. Ditches are made with plow and hoe along the field for drainage. When it begins to rain, the field is drilled with plow and seeds sown immediately. The rate of seeding is 10-15 kg/ha. The distance between rows should be 40-50 cm. apart. The seeding rate or density of seeding in Taiwan is much less than those in other countries. This is because kenaf fiber in Taiwan is extracted by hand, and larger stem and less plants per unit area are more preferable. Secondly, a proper distance between the rows is necessary for drilling, trenching, dressing and hilling operations to be carried out by a water buffalo.

About 14 to 20 days after germination, when seedlings are about 20 cm. high, thinning, intertillage and top dressing should be made. In the 5th and 6th weeks, second thinning should be done, leaving a single plant in each hill spaced 10 cm. apart in row. At the same time, hilling of soil between rows by plowing and banking of soil around the plant by hoeing should be carried out. The third top dressing is made without covering it with soil in order to avoid injuring the dispersed roots between rows. The recommended rate of each fertilizer application is 200 kg. of ammonium sulphate, 100 kg. of calcium superphosphate and 50 kg. of potassium chloride per hectare. A total of 3 applications are deemed desirable. The time for harvesting kenaf is between late July to early September. The stalks are cut with sickle by hand. Ribbons are peeled off and retted in ditch or pond.

III. Improvement Program of Kenaf in Tiawan

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 varieties introduced, Cuba C has been found quite promising. This variety is resistant to Anthracrose and is found to yield 29.78% more than the variety Madras Red under extension, according to the experiments made at 7 localities in a period of three years. In 1957, another 81 new strains were introduced from the United States and Cuba to Taiwan. Among these introductions, BG-52-7 has been selected as one of the best strains. Beginning 1960, together with 42-3112-1, El Salvador, Cuba C and Madras Red, BG-52-7 has been included in the regional test conducted at 7 localities in Taiwan.

In order to transfer the characteristic of rootknot nematode resistance to kenaf, interspecific crosses have been made between kenaf and *Hibiscus acetosella* which is claimed to be very resistant to nematode infestation. The program is still underway.

(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 (Pyransta 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.

IV. Prospect of Kenaf Production in Taiwan

Kenaf serves as a good substitute for jute for making gunny sacks in Taiwan. To meet the local demand alone, a total of 200,000 metric tons of jute fiber is needed annually. To date, the source of fiber for making gunny sacks comes mainly from jute. However, in view of the fluctuation of prices of the competing crops, including rice, soybean, sweet potato, etc., the jute acreage might vary from year to year to a great extent. Particularly in the case of rice, the demand for it to meet the need of the ever increasing population is getting stronger and stronger every year. In the not unforeseeable future, a part of jute acreage is bound to give in and make way for growing rice. Then, the supply of raw materials to the jute mills will eventually become insufficient.

Kenaf can be grown on upland and give excellent yield of fiber, so it would naturally be a good substitute for jute. It is therefore safe to predict that kenaf would become more and more important among the fiber crops in Taiwan. Selection of disease resistant as well as high-yielding varieties and the improvement of fiber processing method will be the most important tasks for future development of kenaf in Taiwan.

PRELIMINARY REPORT ON THE EXPERIMENTS OF PAW KEO (THAI KENAF)

H. S. Chang and C. Y. Chi*

Paw Keo or Thai Kenaf belongs to the family of malvaceae. It is an introduction from Thailand in 1957. At first, a local jute mill introduced some seeds of Paw Keo to Taiwan. When Dr. T. H. Shen, Commissioner of the Chinese-American Joint Commission on Rural Reconstruction (JCRR), completed his attendance at the 3rd Session of the Working Group on Agricultural Development & Planning of ECAFE held in Bangkok, he also brought back seeds of Paw Keo to Taiwan for trial planting by the concerned local agricultural institution. Since then, the new introduction began to attract the attention of the agriculturists in Taiwan. In 1957, with the assistance of the International Cooperation Administration/Mission to China and the United States Operation Mission to Bangkok, JCRR has air lifted 38 kg. of Paw Keo seeds from Thailand to Taiwan and began to make intensive studies on its adaptability and various phases of cultural practices. The following is a brief report covering the results of the experiments conducted between 1957-59.

I. Name and characteristics of the plant:

According to the 1957 Edition "Agriculture in Thailand", Paw Keo is listed under the category of kenaf and bears the name *Hibiscus Pungens.* As the official statistics of the Thai government reveal, its acreage in Thailand was around 37,000 Rai or 5,760 ha. in 1954 and was mainly planted in the provinces of Nakorn Rajsima, Udorn, Ubol, Roi-et, Mahasarakarm and Kon Kan. The seed is usually sown in May and June and harvested in September and October for fiber extraction.

Paw Keo is an annual plant, reaching a height of over 3 meters in Taiwan. Leaves palmately veined, deeply lobed, with grey pubescence, alternately borne on stem. The basal portion of the petiole attached to the stem is deep purplish in color. Stem pubescent, dark geen in color. Flowers bell-shaped with five petals. Seeds brownish, kidney shaped, smaller than seeds of kenaf *(H. cannabinus.)* Capsule cylindrical, pubescent. It thrives well under drought condition.

In 1957, attempts were made to determine the chromosome number of Paw Keo. Mr. S. C. Hsieh of the Taiwan Agricultural Research Institute has found that the chromosome number of Paw Keo is 72 (2 N), which is similar to that of *H. sabdariffa*

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but diffirent from that of kenaf, *Hibiscus cannabinus* (2 n = 36).

In 1959, seeds of Paw Keo were sent to the United States for identification. According to Dr. F. D. Wilson of USDA, the plant belongs to *Hibiscus sabdariffa. var. altissima.*

II. Regional adaptability of Paw Keo in Taiwan:

To determine its regional adaptability in Taiwan, Paw Keo, together with jute and kenaf, was planted at 40 localities distributed in 15 prefectures (1958: 15 localities in 12 prefectures; 1959: 25 localities in 13 prefectures) for observation and comparison. In making the trial, paddy land, dryland and hilly land of different kinds of soils were chosen. The following are some of the important findings:

1. On paddy land, jute seems to give much higher yield than kenaf and Paw Keo, while on dryland the latter two crops yield better than the former one.

2. In some places under the dryland conditions, the germination of Paw Keo was rather uneven, while that of jute and kenaf was quite normal. It seems that the germination of Paw Keo required more water than that of jute and kenaf.

3. Paw Keo is found thriving well on sandy soil, hilly land and gravelly land with good drainage.

4. Paw Keo could stand the drought very well, provided that germination took place normally.

5. During the growing period, leafhoppers and aphis were found infesting both Paw Keo and kenaf, but not the jute. However, it was found that Paw Keo was very resistant to rootknot nematode infestation.

III. Experiments on cultural practices:

Since Paw Keo is a new crop in Taiwan, its cultural practices, i.e., time of sowing, spacing, rate of fertilizer application, method of sowing, period of harvesting and insects pests, should be determined through intensive experimentation. The results of the experiments conducted have provided valuable information for future extension.

1. Time of sowing

In order to determine the suitable time of sowing, seeds of Paw Keo were sown from February 15 to August 16, 1958 (13 sowings) in Tainan, Pingtung, Miaoli and Hualien at 15-day intervals. In 1959, sowing was made from March 1 to August 1 (11 sowings) in Tainan, Pingtung, Miaoli, Hualien and Taitung also at 15-day intervals. The field design was in 8-row plots arranged in randomized blocks with 4 replications. Plants were harvested for fiber extraction 150 days after germination and yield of retted fiber were compared.

It was found that the different time of sowing affected the height, circumference of the stem as well as the fiber yield. However, the blooming periods of the different treatments were very close to one another, varying in less than 7 days. The different blooming periods and fiber yields in Taiwan are shown in Tables 1 and 2.

Table 1.

Blooming Period of Paw Keo with Relation to Time of Sowing in Taiwan (1958)

Time of sowing	Blooming period			
	Tainan	Hualien	Miaoli	Pingtung
2/15	11/19	11/8	—	11/19
3/1	11/19	11/8	11/16	11/19
3/16	11/20	11/8	11/16	11/19
4/1	11/20	11/8	11/16	11/19
4/16	11/19	11/10	11/16	11/19
5/1	11/19	11/10	11/16	11/19
5/16	11/20	11/10	11/12	11/19
6/1	11/17	11/10	11/12	11/19
6/16	11/17	11/10	11/20	11/17
7/1	11/19	11/10	11/20	11/17
7/16	11/22	11/12	11/20	11/17
8/1	11/22	11/14	11/25	11/17
8/16	11/26	11/15	11/25	11/20

Table 2.

Yield of Retted Fiber of Paw Keo in Kilograms per Hectare with Relation to Different Time of Sowing in Taiwan (1958-59)

Location / Year / Date of sowing	Tainan		Pingtung		Hualien		Miaoli		Taitung
	1958	1959	1958	1959	1958	1959	1958	1959	1959
2/16	1138.9	—	2720.4	—	2203.7	—	—	—	—
3/1	1185.2	—	2477.8	—	2277.8	—	2098.2	—	—
3/16	1490.7	1322.5	2463.0	—	2509.3	1870.0	1898.2	2440.0	—
4/1	1120.4	1027.5	2564.8	2512.5	2675.9	1690.0	1764.8	1512.5	3775.0
4/16	1227.8	930.0	2898.2	2415.0	2537.0	1695.0	1737.0	1800.0	3712.5
5/1	1459.3	830.0	2564.8	2242.5	1696.3	1755.0	1879.6	1517.5	1775.0
5/16	1648.2	575.0	3107.4	2337.5	1657.4	825.0	1774.1	1490.0	1287.5
6/1	1777.8	475.0	2481.5	2027.5	1674.1	777.5	1505.6	1390.0	837.5
6/16	1072.2	340.0	2477.8	1770.0	1251.9	582.5	1071.3	907.5	850.0
7/1	1000.0	230.0	1222.2	1325.0	764.8	505.0	650.4	512.5	438.6
7/16	576.1	—	986.7	970.2	351.9	—	—	—	463.1
8/1	333.3	—	888.9	—	425.9	—	—	—	245.0
8/16	300.4	—	689.2	—	76.6	—	—	—	—

From the above table, the optimum dates of sowing Paw Keo in different places in Taiwan may be summarized as follows:

Tainan—Mid-March to Mid-May
Pingtung—Mid-March to Mid-June
Hualien—Mid-March to Mid-May
Miaoli—Mid-March to Mid-May
Taitung—Early April to Mid-May

2. Spacing

In 1958, the experiment on spacing of Paw Keo was conducted at three localities, i.e., Chunan (dryland), Houpi (sandy soil) and Wanluan (sandy soil), with 7.5 cm., 10 cm., and 15 cm. between hills and 24 cm., 36 cm., and 48 cm. between rows, arranged in split-plot design and replicated for 4 times. Each small plot was 6 m. x 2.88 m. in size. The distance between hills was regarded as the main plot.

In 1959, the experiment was repeated at the same localities with only 7.5 cm. and 15 cm. distances between hills (10 cm. distance was omitted) and all the other treatments remained unchanged.

The experimental results have indicated that:

a. In planting Paw Keo, a closer distance of spacing should be recommended. Otherwise, the branching habit will occur and yield will be lower.

b. Paw Keo has a longer growing period than jute (150 days vrs. 130 days); early harvesting would affect its yield.

c. The proper spacing should be 7.5-15 cm. between hills and 24-36 cm. between rows.

3. Rate of fertilization

In 1958, the fertilizer experiment was conducted only at Chiayi and Tainan, while, in 1959, it was expanded to include Taitung in view of the prospects of growing Paw Keo there in the future. Five different levels of fertilizer rates were experimented, which are shown as follows:

	N (kg./ha.)	P_2O_5 (kg./ha.)	K_2O (kg./ha.)
A—standard rate for jute	100	40	78
B—2/3 of standard rate	66.6	26.6	52
C—1/2 of standard rate	50	20	39
D—1/3 of standard rate	33.3	13.3	26
E—no application	—	—	—

Each level of fertilizer was equally divided into 3 applications, the first one being applied as basal manure, the second applied 4-5 weeks after germination and the third 4-5 weeks after the second application. The field design was in 7-row plots, Latin

Square arrangement. Sowings were made between April 2 to May 29 in 1958 and April 30 to May 27 in 1959. Harvesting was done 150 days after germination.

The experimental results obtained may be summarized as follows:

a. In Tainan and Taitung, fertilized plots gave higher yield than those non-fertilized ones. The greater the amount of fertilizer applied, the higher the yield of fiber was obtained.

b. In Chiayi, the effect of fertilizer to fiber yield was not significant. This could be due to the reason that the experimental plot in Chiayi had been heavily applied with compost every year. This cumulative effect of compost might have offset the fertilization during the experimentation.

c. After comparing the increase in fiber yield and the amount of fertilizer applied, it seems advisable to adopt only the fertilizer rate D as itemized above, i.e., 1/3 of the standard rate of fertilizer for jute, on Paw Keo in order to obtain the most economical return.

4. Time of harvesting

Since Paw Keo has a much longer growing period than jute, its proper time of harvesting to obtain maximum yield should be determined. Experiment was conducted in 1958 at Tainan to harvest the crop from 90 days to 210 days after germination at 15-day intervals; and a total of 10 harvests were made. 6-row plots, randomized arrangement with 4 replications, were adopted for the experiment. Sowing was done on March 31, 1958. The fiber yields from different treatments can be summarized in Table 3.

Table 3,

Calculated Retted Fiber Yield with Relation to Days of Growth in Taiwan (1958)

Days of growth	Yield of retted fiber
	(kg./ha.)
120	919.44
135	1327.78
150	1502.78
165	1519.44
180	1708.33
195	1894.67
210	1841.60
225 (blooming time)	1483.30

By analyzing the results, the following conclusions could be reached:

a. Those plots allowed to grow for 195 and 210 days gave the maximum yield over all the other plots.

b. The fiber yield increased with the increase in days of growth until a period of 195 days of growth was reached. Then, the yield dropped down significantly.

c. Under the present situation of economizing the use of farm land in Taiwan, 150-day growth for Paw Keo seems desirable so that enough time could be left for growing the succeeding crop.

5. Observation of disease and insect infestations

During the experimental period, incidence of diseases and insects was observed and their control methods studied. These may be presented hereunder:

a. Diseases

The most common diseases found to infest Paw Keo are: 1) Damping-off disease (Rhizoctonia solani) attacking the young seedlings and infesting as high as 50% at Lotung; 2) Anthracnose disease (Colletotrichum sp.) infesting the stem portion in early and late stages, causing damages from 10-70%; 3) The Powdery mildew (Botrytis sp.) infesting the crop in late stage, causing only slight injury; and 4) Sooty mold found on the leaves of Paw Keo without affecting much of its growth.

b. Insects

There are six kinds of insects found injuring the crop during the period of experimentation. These comprise of: 1) European Corn borer which affected the upper portions of the stem and stopped the terminal growth, thus inducing branching habit; 2) Chafer was found to attack the leaves of Paw Keo causing only slight damage; 3) Stink bug was sometimes found to affect the stem and the capsule; 4) Mealy bug occurred at the terminal portion and stopped its growth, affecting the yield severely particularly during dry season; 5) Aphis were found on Paw Keo leaves causing slight damages; and 6) Leafhopper was a common insect found on the leaves of Paw Keo causing the leaves to curl, and, in severe cases, the leaves would become reddish and drop off from the stem.

IV. Summary and conclusion:

The purposes of conducting these experiments on Paw Keo are: 1) to observe its regional adaptability in Taiwan; 2) to study its cultural practices for successful planting; and 3) to evaluate its prospects for future extension in Taiwan.

In 1958-59, intensive studies were made at various localities in Taiwan. The results may be briefly stated as follows:

1. Paw Keo is found to have a fairly wide adaptability in Taiwan, particularly in places of dryland conditions with good drainage. However, it did not do well in paddy field.

2. It seems advisable to sow Paw Keo seeds from Mid-March to Mid-June in order to get a good harvest of the crop. However, the proper time of sowing varies with the different localities.

3. The spacing of Paw Keo is recommended to be 7.5–15 cm. between hills and 24–36 cm. between rows.

4. The fiber yield of Paw Keo is found to increase with the increase of fertilizer application. However, in practical application, 33.3 kg. of N, 13.3 kg. of P_2O_5, and 26 kg. of K_2O per hectare seems to give the best results.

5. The fiber yield increases with the increase in days of growth until a period of 195 days is reached. If the crop is left to grow over 195 days, the yield will not increase proportionally. In order to cope with the multiple cropping system now being practised in Taiwan, the date of harvesting fiber is recommended not to exceed 150 days of growth of the plant.

During the period of experimentation, the incidence of diseases and insects on Paw Keo were also observed. These include Damping-off, Anthracnose, Powdery mildew, Sooty mold, European corn borer, Chafer, Stink bug, Mealy bug, Aphis and Leafhoppers. So far, Paw Keo was found very resistant to the attack of rootknot nematode which was prevalent on both jute and kenaf.

PRODUCTION AND IMPROVEMENT OF RAMIE IN TAIWAN

H. S. Chang and C. Y. Chi*

I. Historical Background and Production

Ramie has been cultivated in Taiwan for more than 300 years. Most of the ramie farms in Taiwan are scattered over the hillsides and are rather small in size. Only a few farms were recently expanded to an acreage of over hundred hectares. The record year of annual production was 1937 when 1,390 metric tons of dry fiber was produced. The total ramie acreage in that year was 1,890 hectares.

The acreage and production of ramie fiber from 1936 to 1959 are tabulated as follows:

Year	Acreage ha.	Production kg.	Average yield kg./ha.
1936	2,007.27	1,378,025	687
1937	1,889.87	1,390,454	736
1938	1,579.17	776,173	492
1939	1,826.47	770,235	422
1940	1,863.36	654,923	351
1941	1,817.66	813,349	447
1042	2,131.56	986,489	463
1943	2,161.13	1,005,285	465
1944	2,322.30	900,944	388
1945	1,502.87	653,613	435
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

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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 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 manufacturing ramie fabrics, threads and yarns and also for making fishing gear, rope, cordage, braids, etc., or for other uses on the farm.

II. General Practice of Ramie Cultivation

The most desirable soil for ramie is sandy loam, with deep furrow-slice, soft structure and moderate moisture, and rich in organic matter. Next in order of desirability is moderately heavy loam. Sandy and clayey soils are least desirable. The adequate moisture content in soil will be 12-14% with pH value 4-6.

In land preparation, it is important that a field should be deeply ploughed. Ploughing in light soil should be not less than 18-23 cm. deep, and, in heavier and moist soils with a clayey composition, not less than 30 cm. The roots, weeds, stones and other foreign matters should be removed from the field. After ploughing, the soil should be thoroughly worked to break up all the lumps or clods. Then compost and other organic manures are to be used to enrich the soil. The amount of compost required for each hectare is 20 metric tons. Trenches are dug about 20 cm. deep and 10 cm. wide. Well-rotted organic fertilizer is spread in them to a depth of 7 cm. The fertilizer and soil should be well mixed. The pieces of rhizomes are placed against the sides of the trenches in a slightly slanting position. The trenches are then filled with soil. The depth of the soil over the pieces of rhizomes should be sufficient to cover the top ends about 3 to 5 cm. The distances of spacing are 50 cm. between rows and 30-40 cm. between hills. A total of 50,000-60,000 pieces of rhizomes are required for each hectare.

The amounts of fertilizers required are listed in the following table:

Kind of fertilizer	Quantity of fertilizer applied (kg./ha.)		
	Base fertilizing	1st top dressing	2nd top dressing
Green manure	Ploughed under	—	—
Ammonium sulphate	220	110	110
Calcium superphosphate	100	88	—
Potassium chloride	100	78	—

The basal manure is applied in winter before planting, the 1st top-dressing applied three weeks after sprouting and the 2nd top-dressing three weeks later.

Proper management during the 1st and 2nd year is of vital importance. When the stalks of the young plants are 20 to 25 cm. high, they should be cut down in order to maintain uniform growth. During the 1st year of planting, shallow ploughing between the rows is recommended. Weeds and grass should be removed from the field 3 or 4 times a year in the 1st and 2nd year. By the 3rd year, the plants are usually sufficiently well-established to prevent the growth of weeds. Only one or two weedings are needed. This is done at the beginning of the growing season.

In the mountainous regions or the northeastern part of Taiwan, the roots may be damaged by freezing winter, especially during the lst and 2nd year after the planting is established. It is advisable to spread, in late fall or early winter, a mixture of half-rotted compost, decorticated waste, straw, leaves and grass over the field to a depth of 5 or 7.5 cm. as covering. The amount required is 11,000 to 19,000 kg. per hectare. It is suggested that this procedure be continued every winter in cold areas.

During the 3rd and 4th year after planting, the roots throughout the entire field will increase and become quite heavily matted and crowded and the stalks sent up become smaller and shorter with a corresponding decrease in fiber yield. This could be remedied either by cutting off the older parts of the root system or by pruning off the roots appeared on the surface of the soils.

The adequate time of harvesting ramie is indicated by the following criteria:

a. The lower portion of the stalk turns slightly brown.

b. The stalk breaks easily and the bast layer can be separated easily from the woody pith.

c. The leaves on the lower portion turn yellow and begin to drop off.

d. The tips of new sprouts begin to appear just above ground.

However, the number of harvests in a year and the time of each harvest vary with the localities. These can be shown by the following table:

Area	Number of harvests				
	lst crop	2nd crop	3rd crop	4th crop	5th crop
Central Taiwan (Nantou)	May	July	September	November	—
Southern slope area (Nanhua)	Julp	Septemeber	November	—	—
Southern plain (Pingtung)	January	April	June	August	October

In Taiwan, ramie is harvested by hand with a sickle. The harvested stalk, if not decorticated by machine, will be striped of its leaves and then scratched into ribbon. And, it is estimated that about 80% of ramie fiber in Taiwan are scratched by hand. The cost for labor in scratching fiber by hand occupies more than 50% of the total cost of production. Although the Ikeda type ramie decorticators were recommended during World War II, farmers seldom adopted the use of them to decorticate ramie fiber for lack of regular market for such kind of fiber. Since 1958, the improved type of ramie decorticators have been made in Taiwan and extended to ramie growers. There are about 75 sets of such decorticators in use in the ramie producing areas at present time.

The ramie fiber is dried under the sun. To prepare the fiber for drying, it should be hung over bamboo poles or sticks of a convenient length. Proper hanging of fiber is important. It is desirable to hang the strands over the pole in such a manner that the drape of the strands of fiber over the bamboo pole comes at a point a little less than half of the total length of the strands, the shorter part being the butt end. After fiber is properly hung on a pole, the ends of pole are placed in notches located a suitable distance apart on racks of convenient height, placed in a sunny site. After being exposed to the sun for 1 or 2 days, the fiber is ready for storage. The fiber is tied into bundles and stored in a barn or warehouse until it is shipped to the mill.

III. Ramie Improvement Program

a. 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:

(1) 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 outyield 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.

(2) Breeding through mutation induced by Colchicine and radiation:

Colchicine has been used to treat ramie seeds for induced mutation. 52 plants were selected from the offsprings developed from seeds treated with Colchicine. Some of them are found growing vigorously and producing more tillers. Cytological studies to check whether these are actually induced by Colchicine are still under way. 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 seedlings treated have been planted or observation.

(3) Breeding through selfing and crossing:

Some good varieties have been selected for selfing since 1957. 56 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.

(4) 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.

b. Improvement in cultivation:

(1) 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.

(2) 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.

(3) 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.

c. Improvement in fiber processing:

(1) 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 co-operation 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 16-20 kg. of dry fiber in an 10-hour day, with a team of 2 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.

(2) 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 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.

(3) 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. Prospects of Ramie Production in Taiwan

Among the fiber crops now being grown in Taiwan, ramie is of minor importance due to its small acreage as well as inconspicuous production. Since Taiwan has only a limited acreage of arable land and the demand for food crops (paddy and upland food crops) by the ever-increasing population is so strong, the competition for land among the crops will be very acute. Under these circumstances, the better graded land which gives higher yield would naturally be planted to food crops. Only land of inferior grade will be planted to these minor crops including ramie. The present yield of ramie in Taiwan is still much too low as compared with Florida where two tons of fiber is produced per hectare of land. Therefore the expansion of acreage will mainly depend on increased yield, which would serve as an incentive to farmers to plant ramie. Moreover, through the adoption of mechanical decortication, the cost of stripping fiber could be considerably lowered, then, the acreage of ramie could be increased.

Should all these factors be favorable and the world demand be strong, there does exist a good prospect for fast expanding of ramie acreage in Taiwan.

PRODUCTION AND IMPROVEMENT OF FLAX IN TAIWAN

H. S. Chang & C. Y. Chi*

I. Production

Flax was introduced to Taiwan from Japan early in 1920. After repeated trials and tests, it was found that flax could be successfully planted in paddy field in winter after the harvest of the second rice crop. In 1943-1944, the flax acreage was extended rapidly for fiber purpose to a record of 10,933 hectares producing 5,697 metric tons of dried flax straw. There were ten flax scutching plants established to process the flax straw produced at that time. Each plant had a capacity to handle 1,000-1,500 metric tons of dried flax straw and used Moulin type of scutching machine for processing fibers. All processed fibers were exported to Japan as raw material for the textile industry. After World War II, there was almost no commercial cultivation of flax in Taiwan because of the lack of seeds and the dilapidation of scutching plants caused by war. Since then, efforts have been made in varietal selection and cultural improvement; the unit yield of flax was therefore steadily increased. The yield per hectare in 1959 was more than twice as much as that of 1950 (3,303 kg. vs. 1,585 kg.). Among the ten pre-war established flax scutching plants, two have been kept in operation, equipped with turbine type scutching machines to take care of the flax straw produced locally. Each plant has a capacity to process 4,000 kg. of dry straw during an 8-hour day.

The following table shows the flax acreage, unit yield and production of dried straw in Taiwan during the period of 1950-1959:

Flax Acreage, Unit Yield and Production of Dried Straw in Taiwan, 1950-1959

Year	Acreage (hectare)	Dried straw	
		Unit yield (kilogram/hectare)	Production (kilogram)
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

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II Cultural Practices of Flax

As flax is planted in Taiwan in paddy field as a winter crop, earliness becomes a very important factor. The proper time of broadcasting is around November 20 of each year at a seeding rate of 70 kg./ha. The land is either carefully prepared before sowing, or roughly prepared after the harvest of the second rice crop, or, in some cases, not prepared at all. The finely prepared bed gives best growth of flax. Flax requires rainfall in its early growing stage but not in the later stage. The optimum amount of fertilizer required for flax is 30 kg. of N, 30 kg. of P_2O_5 and 7.5 kg. of K_2O per hectare.

In the central part of Taiwan, it falls in the dry season of the year when flax is planted; therefore irrigation is necessary to attain a good stand of the plant.

With the existing variety now under extension, harvesting is done 90 days to 100 days after sowing. When two-thirds of the stalk and one fifth of the capsule turn yellow it is the right time for harvesting. The flax plant is usually pulled out by hand with its roots attached and then arranged on the ground for sun-drying. After 2-3 days when the straw is 70-80% dry, the straw should be stacked up on a platform about 2.5 ft. above the ground for a period of three weeks for further drying.

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.

III. 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	4,772	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 cut with four seed-flax varieties as testing materials. The results are presented as follows:

Year	Sowing date \ Variety / Yield	Punjab 47		Punjab 53		Argentine C. 1463		Red Wood	
		Seed (kg./ha.)	Straw (kg./ha.)	Seed (kg./ha.)	Straw (kg./ha.)	Seed (kg./ha.)	Straw (kg./ha.)	Seed (kg./ha.)	Straw (kg./ha.)
56/57	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
57/58	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.

IV. Prospects of Flax Production in Taiwan

Flax is planted as a winter crop in the central part of Taiwan. The present acreage seldom exceeds 2,000 ha. This is because that the production is limited by the capacity of the two scutching plants. If the acreage further expands, it would be impossible for the two scutching plants to handle such a large production.

As far as the land availability and the many uses of flax fiber and linseeds are concerned, there is plenty of room for acreage expansion. In planting the crop, both flax straw and seeds will be obtained. However, the rate of seeding as well as other cultural practices for fiber flax and that for linseed are different from each other. Emphasis should be placed either on fiber or on linseed but not on both. For fiber production, uniform stem and less branching are preferred; thus, seed production will be affected. On the other hand, if linseed is the expected product, wider spacing and more branching are preferred, which may be obtained only at the expense of the quality of the straw.

In conclusion, it is of prime importance that new flax varieties either of fiber or seed varieties should be early maturing in order to fit into the present cropping system. Then, the yield of flax straw and that of seeds and the prices are also important factors in determining which variety is to receive the best attention. Lastly but not the least, the return from the competing crop is another deciding factor in the future extension of flax in Taiwan.

SISAL PRODUCTION IN TAIWAN

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I. Historical Background and Production

Sisal is one of the several important fiber crops in Taiwan. Its fiber is chiefly used for making marine cordage to meet the immense requirement of the navy and the fishery industry, with a rather small percentage left to be used on the farms as tying and wrapping twines. Sisal enterprise in Taiwan was founded some sixty years ago. Early in 1901, Mr. James W. Davidson, then an American consul on this Island, brought in some pieces of planting materials and gave them to the Japanese agricultural experts for trial planting. These materials were first planted in Taipei. Next year, six pieces of their young plants were sent down to Hengchun, the southernmost tip of the Island, for trial planting. After the possibility of successful growing of sisal was assured by its good stand there, more planting materials were introduced for its initial culture. in order to extend this new crop successfully, a sisal multiplication farm was then established in 1905, and a Priedo Type of decorticating machine was imported in 1913. By 1919, 516 hectares of sisal were planted. Though the Japanese Colonial Government exerted much effort in developing this new enterprise, the sisal acreage had never increased as fast as what was planned. It was not until 1939 when the acreage reached 2,000 hectares. The highest yield occurred in 1941 which was resulted by severe cutting in order to meet the demand of War. This caused a sharp drop in fiber yield in the ensuing years. During 1944-46, both the planting acreage and fiber yield slipped down drastically due to the replacement of sisal by food crops in the sisal fields. After the restoration of Taiwan to China, as a result of the recovery of the fishery and rope manufacturing industries, fiber requirement increased. The rise in price of fiber offered incentive to sisal growers to re-establish their sisal plantations and to pay more attention to their crop management. Thus both the acreage and yield have been put back on the upward track year after year. By 1958, the planting acreage hiked up to a record high of 7,300 ha. with an annual fiber production of 6,800 metric tons. A statistical table given below indicates the trend of sisal production in Taiwan from 1936 to 1959.

Year	Planted acreage (ha.)	Harvested acreage (ha.)	Production (in kg. of dry fiber)	Average Yield (in kg. of dry fiber per ha.)
1936	—	—	—	—
1937	1,052.50	—	594,091	—
1938	1,388.21	—	792,776	—
1939	2,345.32	1,173.58	1,251,450	1,066
1940	2,708.20	1,155.64	983,978	851
1941	2,933.10	1,578.06	2,311,684	1,461
1942	2,973.06	1,966.28	1,990,772	1,012
1943	2,919.24	2,370.36	653,385	276
1944	489.80	122.62	21,000	171
1945	331.71	331.71	30,078	91
1946	536.30	334.18	52,899	158
1947	1,404.48	—	1,698,575	—
1948	3,955.00	3,439.50	2,969,825	863
1949	3,274.25	1,705.50	1,096,254	627
1950	2,906.85	1,587.70	1,087,963	685
1951	3,060.42	1,721.73	1,134,123	659
1952	3,488.75	2,012.00	1,263,900	628
1953	3,733.14	1,998.00	701,300	351
1954	4,427.06	2,271.12	998,645	440
1955	5,123.40	2,447.72	1,076,908	440
1956	5,483.34	2,756.50	1,236,801	449
1957	7,574.39	5,750.30	6,904,420	1,201
1658	7,310.92	5,736.91	6,837,245	1,192
1959	7,028.30	6,087.80	6,591,565	1,083

Among the 15 prefectures and 5 cities in Taiwan, over 80% of the total sisal acreage is concentrated in Pingtung Prefecture of southern Taiwan. Taitung, a southern prefecture on the East Coast, with about 15% of the total sisal acreage, is regarded as the second principal sisal-producing region on the Island. The distribution of acreage, yield and production of sisal in Taiwan in 1958 is shown in the following table:

Distribution of Sisal in Taiwan in 1958

Prefecture (Hsien)	Planted acreage (ha.)	Harvested acreage (ha.)	Production (kg.)	Yield (kg./ha.)
Pintung	5,997.70	5,184.50	6,254,520	1,206
Taitung	1,140.75	521.91	560,305	1,073
Hwalien	137.47	30.50	22,420	735
Ilan	20.00	—	—	—
Kaohsiung	15.00	—	—	—

Most of the sisal are planted on sub-marginal hillsides of sandy soils overlying coral limestone in the southern part of the Island along both the East and West Coasts. Due to the single-grain structure of the soil, its richness in calcium and the relatively constant annual high temperature, Hengchun—a rural area of Pingtung Prefecture—has been assured to be the most suitable area for sisal cultivation. Better fibers and higher yield are usually obtained from plants grown in this area. About half of the populace in this area live on the outcome of this undertaking. Although the annual rainfall and temperature in Taiwan seem very favorable to sisal growth, the uneven distribution of rainfall has become a principal limiting factor that makes the sisal yield of Taiwan the lowest among other sisal-producing countries in the world. More than 80% of the total annual rainfall precipitate in summer and fall. The long drought period, lasting more than half a year from late October to mid-May, retards the normal growth of sisal plants. A fatal natural calamity, typhoon, also severely affects the sisal yield and its fiber quality. The sisal leaves are liable to be broken by the strong wind and injured by the salty drops from the sea under typhoon condition. More than 20% of sisal plants were heavily destroyed by typhoon in 1958 as well as in 1959.

II. Current Cultural Practices and Problems

All sisal plants grown for commercial purpose in Taiwan are of the species *Agava sisalana.* Its cultural practices have been handed down from the early growers and have undergone very little changes. The current cultural practices may be described as follows:

1. Soils and soil preparations prior to planting:

Most of the commercial sisal plantations in Taiwan are located on sandy soils overlying coral limestone. Despite their low fertility, a satisfactory crop could be normally produced, provided that adequate attention is given to its management. In the older producing area of Hengchun, sisal has been under cultivation continuously for the past 50 years. The soils have been rendered effete, as practically no fertilizers were applied. There is an erroneous belief that fertilizers are not required in so far as the plants make satisfactory growth. The soils are not being given a rest; and new plants are usually set between rows on the old plantation of the fifth year after its first planting. The prevailing practice is shown in the following diagram:

	Planting			First harvest commences				
Age of plants in years, 1st planting	1	2	3	4	5	6	(7)	(8)
					Planting			First harvest commences
Age of plants in years, 2nd planting					1	2	3	4
								Planting
Age of plants in years, 3rd planting								1

This process of continuous cropping on the same piece of land year after year without replenishing it with fertilizers accounts chiefly for the shortened life span of the sisal plants grown in Taiwan. On certain plantations, the suckers springing out from the root system are often allowed to remain there without setting them in the nursery beds. This taxes the land fertility to the extremity; and, as a result, each plant produces on the average only 105 leaves in three years and dies after the sixth year. With improved cultural methods, each plant could be enabled to live for 10 to 15 years and produce approximately 200 leaves in its life time, as is the case in Java and East Africa. In reclaiming the hillsides for planting sisal plants, no adequate land preparation of the plantation sites is practised. As sisal plants are shallow-rooted, bushes and grass should be thoroughly cleared or burned so as to check their revival which would otherwise outgrow the sisal plants. Holes are opened up with a hoe and young plants are stuck in there with soil lightly packed around them.

2. Plant materials:

Both bulbils and suckers are being used as planting materials. Being too flexible to be grown in ordinary fields, they are first cultivated in nurseries for 1 to 2 years under careful management. Transplanting of them is ready to be done when they reach 35-45 cm. in height. In fact, most of the growers collect the young plants from suckers right beside the mother plants for planting.

3. Planting time and planting distance:

March to May and September, i.e., the beginning and end of the rainy season, are considered the most appropriate time for setting up new plantations in southern and eastern Taiwan. Practically, planting can be done almost all the year round, as the plants are so stiff that they could be well established even in arid season. As to the number of plants per hectare, there is considerable variation in practice. Nevertheless, a standard planting space of 1.0×2.5 m. is recommended. Most of the young sisal plants are placed in straight rows along the slopes, with distances between rows and plants spaced at 1.5 m. and 90 cm., respectively. Closer distance of planting can usually be observed on farms on gentle slopes and plains where the leaves would often be injured by the terminal sharp spines of one another amidst a strong wind. The quality of fibers from such injured leaves would thus be degraded. For the convenience of harvesting and carrying the reaped leaves down the hills, plant rows on the old plantations and even on the newly-developed ones are usually kept in a vertical direction running up and down the slopes, thus rendering the change to contour planting impossible. Consequently, it leaves the soil conservation in raining season very serious a problem.

4. Weeding and fertilizer application:

Clean cultivation to keep down the weeds especially important during the first three years after planting so as to allow the young plants to have sufficient sun light as a better start. However, weeding is often neglected on most of the sisal plantations in Taiwan due to the extensive method of production adopted. After three years' of clean cultivation, weeding once a year in the fall after harvesting would be sufficient; and the materials are usually used for mulching purposes. Only long grasses such as rushes should be cut above the ground for 2-3 times each year. Intercropping with sweet potatoes, peanuts, and several kinds of beans is often made on newly-established plantations. On such plantations, the earth is well cleaned. The old practice of using 10 to 15 metric tons of compost as basic application in the spring is seldom followed nowadays. However, a handful of model farmers in the Hengchun area have adopted the use of calcium cyanamide at the rate of 25 kg./0.01 ha.; and significant results have been obtained therefrom. Only leaf trashes, after decorticating, are usually applied directly by the farmers at the present time. Past experiment proved that, next to nitrogen, calcium, potassium and phosphate were also important in the order given. In prewar days when beancakes were cheap and plentiful, they were used for basic application; nevertheless the rate of application had become rather obscure.

5. Harvesting:

Harvesting starts from the 3rd or 4th year after planting. The lower and outer old leaves are cut off first. Usually 12-15 upper leaves are left uncut on the plant. Generally, 5-7 harvestings can be made from each plant before it grows old and throws up a pole-flowering stem. The highest yield is obtained from the 3rd or 4th harvesting. Usually, harvesting is done once a year. When the leaves commence to droop down to an almost horizontal position, at least to an angle greater than 45° measured from the center of the plant, it is the proper time for harvesting. Excessive harvesting is very common. Instead of leaving 12-15 immature leaves, only 6-7 are left after harvesting. In more serious cases, only 3-4 leaves were left on each plant. Such plants grow old fast and cannot yield fibers of good quality. Severe cutting is closely related with the price of fibers. The rise of price stimulates farmers to collect more fresh leaves than usual for more cash returns.

6. Extracting of fiber:

In Taiwan, the bulk of sisal fiber is processed by the Ikeda Type decorticators, which are powered by 3-5 H.P. diesel engines and moved around from farm to farm. There were formerly about 500 units of this type of decorticators, which were originally designed and used for ramie but were later modified and used for sisal. Unfortunately, only a few sisal farmers have their own machines, while most of the decorticators are possessed by the fiber dealers. These dealers, with their machines and working teams, move from farm to farm to extract fiber for farmers. They share the dry fibers with farmers as a compensation for the processing cost. The amount of dry fibers charged by the fiber dealers is determined by the location of the farms. Ordinarily, a ratio of 3:7 is adopted for farms with easy accessibility. For farms located in hilly regions, a ratio as high as 5:5 is followed. In extracting practices, one decorticator is operated by a working team of 6-7 persons. One of them acts as the mechanic to keep the machine in order, with 4 persons divided into 2 sub-teams extracting fiber from fresh leaves in alternate turns. The remaining two are to carry the newly-extracted fiber to the drying place and the leave trashes or pulpy wastes away from the machine. The individual leaves have to be fed one by one and be held by hands in reversible positions of both ends for complete scrapping away of the pulpy matters. Usually, about 200 kg. of dry fibers can be produced during a 10-hour work-day. The leaves shoule be stripped within 48 hours after being cut; otherwise, the plant juice would become gummy, thus rendering the extraction of fiber more difficult and the resultant strands unclean. Fibers, after being extracted, are spread out on the ground for drying. They are usually kept overnight to be wetted with dew that makes fiber white and more glossy. Washed fiber has the brighter color with less trashes. But on most sisal plantations, particularly those in hilly regions, clean water is hard to obtain. This explains why that a lot of the fiber on market is of unwashed product. With the assistance of the Chinese-American Joint Commission on Rural Reconstruction (JCRR), the Fiber Crops Experiment Station of the Taiwan Agricultural Research Institute has modified the old typed decorticator into a more efficient extracting machine which is called the FCES Motor Operated Decorticator. An extension program on this improved type of machine will be carried out soon. In relation to the above program, the government is also planning to help farmers buy their own machines so that they could get along without the fiber dealers and enjoy more returns from their own efforts.

III. Prospects of Sisal Production in Taiwan

Sisal has been considered as the best substitute for abaca in the manufacture of marine cordages. In Taiwan, a small percentage of sisal is used in the rural area as tying and wrapping twines. Besides, it is also used as raw material for making mats.

In Taiwan, there are at present some twenty rope factories which consume a portion of the sisal fiber produced, while the remainder is exported to other countries for manufacturing uses.

In recent years, the demand for sisal as well as for ropes in Taiwan has been very strong, although the world supply has been increasing considerably. In view of these facts, the policy of the relevant authority towards sisal production in Taiwan will be to place emphasis on increased unit yield rather than expanded acreage. To increase the unit yield, study and application of improved cultural practices, the extension of contour planting to prevent soil erosion, the extensive use of improved decorticators for extracting sisal fiber and the enforcement of grading of fiber will be the principal points to be attended to. Furthermore the elimination of sisal dealers and the stoppage of overcutting of leaves by farmers will help immensely in increasing the unit yield of sisal in Taiwan.

ENGINEERING PHASE OF THE IMPROVEMENT OF LONG VEGETABLE FIBER PRODUCTION IN TAIWAN

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For the efficient production of long vegetable fiber crops in Taiwan, there has been some work along the agricultural engineering phase conducted jointly by the Joint Commission on Rural Reconstruction, the Tainan Fiber Crops Experiment Station (FCES) and the Agricultural Engineering Department of the National Taiwan University (NTU), in addition to the work done along the non-engineering phases of agricultural technology. Such work may be briefly stated hereunder.

A. Sprinkler Irrigation of Ramie

Ramie yield in the U. S. and Japan is around 1,700-2,000 kg. of dry fiber per hectare per year, but it is only about 800-1,000 kg. in Taiwan. Among all the possible reasons for such difference, timely and ample application of irrigation water appears to be the most decisive one. In Taiwan, because of the existence of the significant dry season, application of irrigation water in this period would make possible the harvesting of one or two more ramie crops in addition to the three harvests usually obtainable. Since ramie is usually planted on hilly lands, no other method of irrigation is practical except sprinkler irrigation. Upon request of the JCRR & FCES, Prof. C. King of NTU has suggested a sprinkler irrigation set for experimental use. This set is designed on the condition that water is available within 6 meters from the field. It uses a 9 HP engine capable of pumping the water up to the field of 5-20% slope through 3" main line and 2" lateral lines to supply 4-5 sprinkler heads, each having a sprinkling radius of approximately 10 meters. This unit can cover an area of 0.15-0.20 hectare each time, and the water sprinkled will penetrate into the soil for 2-3 inches after irrigated for two hours. It takes about 36 hours to irrigate one hectare of ramie field consuming about 12 gallons of gasoline. If water source is farther than 6 meters from the field, an additional pump is needed to deliver the water to the sprinkler unit. Mr. M. L. Lai of the FCES experimented to irrigate ramie fields for two hours each time at 15-day intervals throughout the dry season; and two more harvests were then realized during the dry season bringing an increase in the total yield of dry fiber per hectare per year from 800 kg. to 1,380 kg. Water soluble fertilizers can also be applied through this system with a fertilizer injection tank attached to the pipe line. Using of this device is considered the most effective way of applying fertilizers to ramie fields.

B. Improvement of Power Long Vegetable Fiber Decorticator

During the Japanese occupation years, a model of power decorticator was introduced to Taiwan from France through Japan. The original maker's name cannot be traced, therefore, it is called the Ikeda type decorticator as it was duplicated by the Ikeda Iron Works of Japan. After the restoration of Taiwan to China, this type of decorticator was found not used in ramie fields but used by custom decorticating teams on sisal plantations in the southernmost part of Taiwan. The reasons for this machine's not being popular with ramie are mainly:

1. It uses plain bearing, thus resulting in low efficiency.

2. The decorticating blades on the rotary drum are liable to break. This accounts for the fact that the decorticator works satisfactorily on sisal leaves but not on ramie stems.

3. For ramie, a hand decorticating method has been in practice, while no other method than machine decorticating has ever been derived for sisal.

In view of the above, Messrs. M. N. Shih and T. C. Chen of the FCES have improved this machine by the following points:

Part of machine	Original design	Improved design	Advantage of improved parts
Rotary decorticating drum	Two cast iron rotor plates on the ends of the drum	1) Solid wooden rotor plate added on the middle of the rotary drum.	1) Clearance between the drum and edge of feeding mouth being maintained even.
		2) Wooden cushion shim added between decorticating blade and the rotor plates.	2) Decorticating blades not easy to break.
Bearings	Plain bearings	Ball bearings	1) More suitable for medium speed operation. 2) Easy to maintain and less wearing.
Frame support	Cast iron	Steel U-bar	1) Lighter in weight. 2) More durable.

The improved model is named the Tainan FCES Improved Power Decorticator (see Fig. 1). The decorticating efficiency of this newly-improved power decorticator is 120 kg/hr of ramie fiber when powered by a 5—6 HP prime mover is about 20% higher than that of the old Ideka model which is about three times faster than hand decorticating. And it produces much better fibers of ramie and sisal than the old model machine would do. Also it becomes possible to extract fibers from pineapple leaves, Sansevieria leaves, banana pseudo stems, etc. In connection with decorticating of banana pseudo stems, a disk type splitting machine is designed by Mr. T. C. Chen of the FCES to split the stems into thin pieces so that they can be fed into the decorticator easily.

C. Development of Pedal Ramie Decorticator

In view of the fact that a substantial portion of ramie is grown in mountainous regions, a light weight portable unit becomes desirable. Prof. T. Takasaka of the Agricultural Engineering Department of NTU took up this work. A small decorticator propelled by the power mechanism of an ordinary bicycle is successfully developed (see Fig. 2). This new machine needs two men to operate on shift basis; and approximately 16-20 kg. of dry fiber can be produced in a 10 hour day, i.e., about 8-10 kg. per man per day. This is not considered much improvement in efficiency. Besides, this machine has to work at a speed of 300 rpm., i.e., the operator has to pedal 60 strokes per minute; and this, in fact, is very toilsome a work. Therefore, Mr. T. C. Chen of the FCES has tried to propel it with an air cooling gasoline engine that Taiwan farmers used to have on their power tillers. The preliminary test reveals that the same decorticator, when propelled by engine and rotates at 500 rpm., can produce almost twice as much of dry fiber than hand decorticating at the same fiber yield rate while costing 30% less. However, as this machine is originally designed for operating at lower speed, to meet the engine powered high speed, some additional modification on this machine is necessary for better efficiency.

D. Test Use of Jute Washing Machine

Mr. C. Y. Chi, Director of FCES, brought back a pamphlet on jute and kenaf washing machine from his last trip to Cuba. This machine was developed by Mr. Virgil C. Pettit of ICA/Washington while he was working with the USDA assigned to Cuba, together with Ing. José A. Pérez Montnegro, Director Asistente, and Ing. José Cascudo Pérez, Tecnico del Departamento de Ingeniería, both being with the Comisíon Cooperativa de Fibras of Cuba. Since the retting and washing of jute fiber in Taiwan is a part of the processes to be improved, Mr. C. S. Chang of the Agricultural Engineering Department of NTU was asked to reproduce a such washing machine. Mr. Chang made some minor modifications on the machine, as, during the course of reproduction, he found some parts not practical for efficient operation. A workable model was finally produced in the Experimental Farm Shop of NTU. This Taiwan reproduced machine is mounted on four wheels and is to be towed by a power tiller (see Fig. 3). This machine was shipped to the jute-producing area for trial use under the supervision of Messrs. M. N. Shih and T. C. Chen of the FCES in 1960. Some modifications and improvements were again made during the trials. It is felt that it is now not the time to make any conclusive comments on this revised model of machine, because more studies have to be made on its efficiency, its economic value, and the quality of fiber so produced. However, by gathering the farmers' opinions, we are confident that it is an acceptable model.

E. Developing of Electric Jute Baling Machine

The manual operated jute baling machine now used in baling jute fibers needs about 6 men to operate and it can bale about 60-70 bales in a day. Not only is it too slow to meet the requirement in the busy jute purchasing season, but is also too hard a work for human beings to perform. With JCRR support, a new jute baling machine is designed by Mr. T. Liang of the Agricultural Engineering Department of NTU (see Fig. 4). This newly developed machine is powered by a 5 HP motor equipped with automatic on-and-off switch. The preliminary result obtained from trial use in the past jute baling season was that, with a crew of three men and two women, 110 bales can be easily made in a day. Before this electric jute baling machine was brought into being, the farmers' associations (FA) in the jute-producing area used to pay higher wages to the laborers. For example, the Hsinkang FA and Minghsiung FA used to pay the labor crew NT$2.40 and NT$2.50 per bale, respectively, when the manual operated machines were in use. Now they pay NT$1.80 in Hsinkang and NT$2.00 in Minghsiung per bale, as the labor crew are provided with more efficient and labor-consuming baling machines. Meanwhile, the laborers can also gain more because there are less persons in a crew and much more bales can be made in a day. In addition to these economic considerations, the work is much easier to perform than with the old machines, and has won the laborers preference. However, it is believed that there are still some improvements pending to be made toward this new type of machine, and, of equal importance, division of labor for efficient operating of this machine is also to be rearranged.

F. Introduction of Fiber Processing Equipment

A number of fiber processing equipment were introduced to Taiwan for trial use in the FCES, they are:

1. Diamond rotary decorticator
2. Tosen type ramie decorticator
3. Tosen type ramie brushing machine
4. Plantec junior decorticator model 100
5. Plantec ribbon cleaner model 100
6. Abaca decorticating machine

Each one of these machines has its merits, but has also its demerits mechanically or unfitness to our scale of operation. Therefore direct adoption is considered not advisable at the present time.

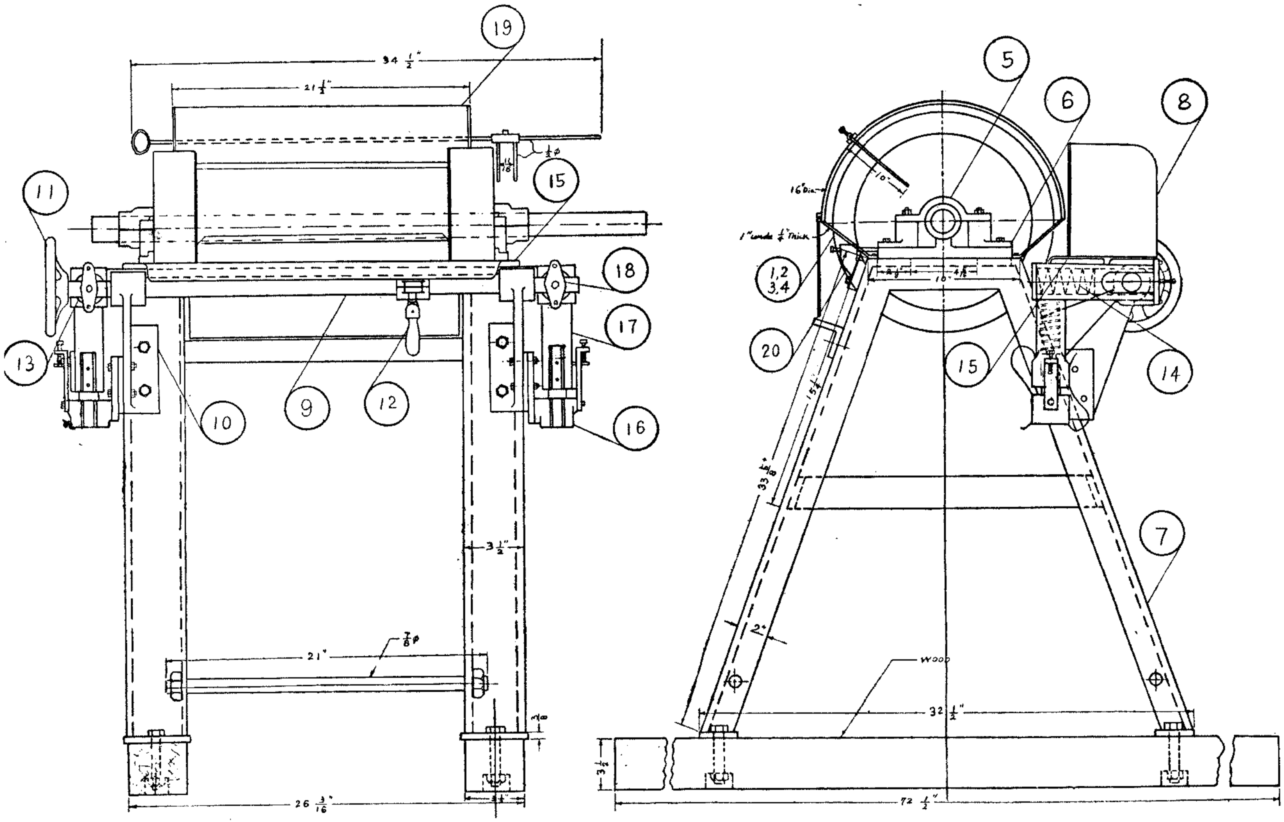


Figure 1. Tainan FCES Improved Power Decorticator

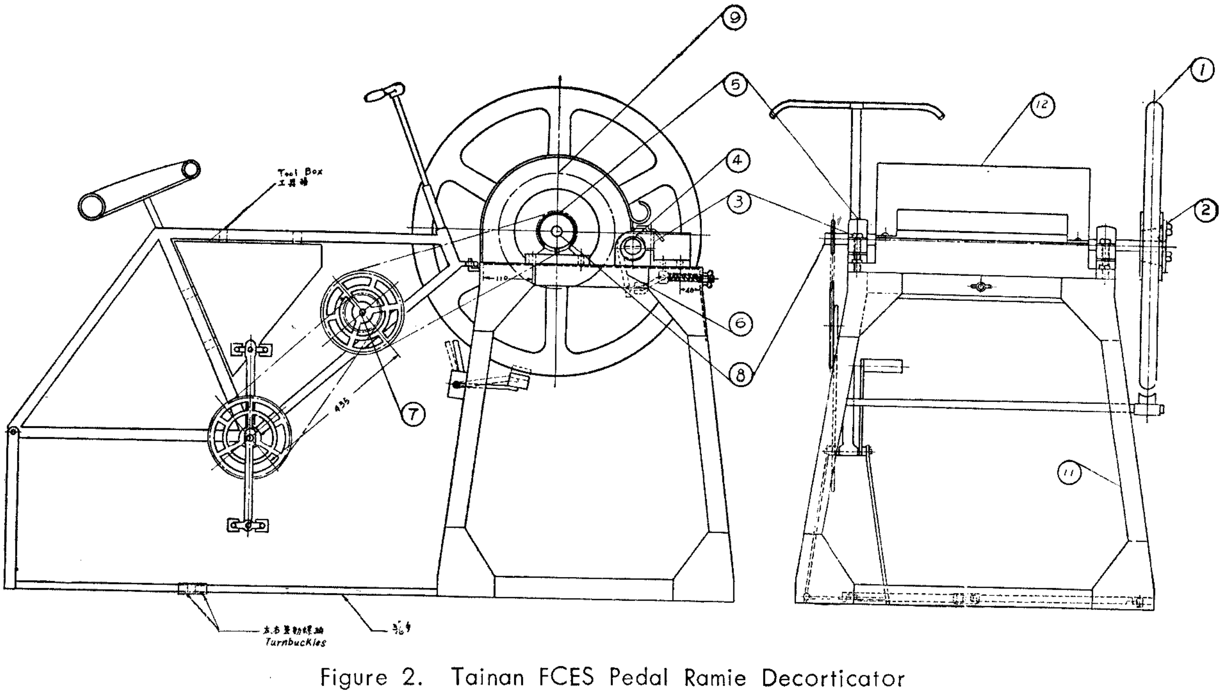


Figure 2. Tainan FCES Pedal Ramie Decorticator

Figure 3. Jute and Kenaf Washing Machine

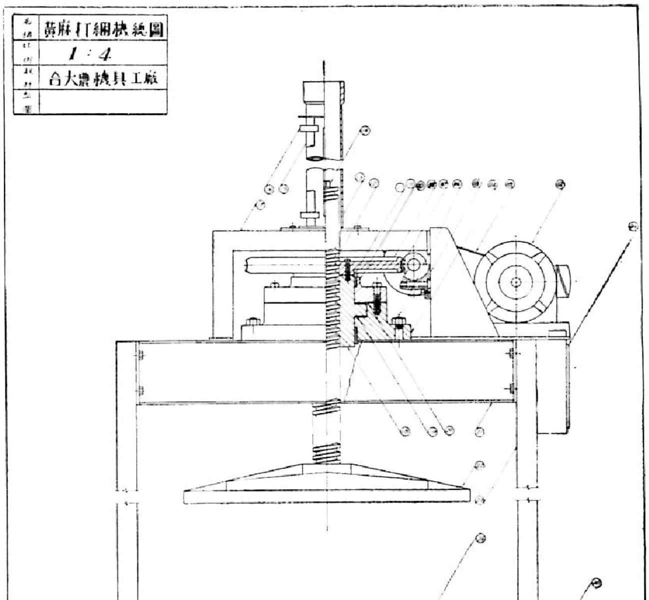


Figure 4. Electric Jute Baling Machine

APPENDIX

Plate 1 Transplanting of jute seedling into the field.

Plate 2 Jute field under harvesting in Chiayi, Taiwan.

Plate 3 A team of women laborers stripping the best layer from jute plant for retting.

Plate 4 Laborers treading on jute fiber immersed in retting pond to hasten the retting process.

Plate 5 Retted jute fiber seen hung on rack for drying.

Plate 6 Inspectors shown inspecting and grading the jute at the purchasing center.

Plate 7 A patch of kenaf in bloom.

Plate 8 Mr. H. S. Chang examining a young plant of Paw Keo (*Hibiscus sabdariffa* var. *altissima*).

Plate 9 Mr. James M. Dempsey, ICA fiber Consultant to Vietnam, visiting a ramie field in Kaohsiung, Taiwan.

Plate 10 A ramie field being irrigated with the sprinkler irrigation setup.

Plate 11 Messrs. C. Y. Chi and H. S. Chang inspecting an experimental flax plor.

Plate 12 Sisal leaves being hauled to the center for decortication.

Plate 13 Decorticating of sisal leaves with an lkedo type decorticator.

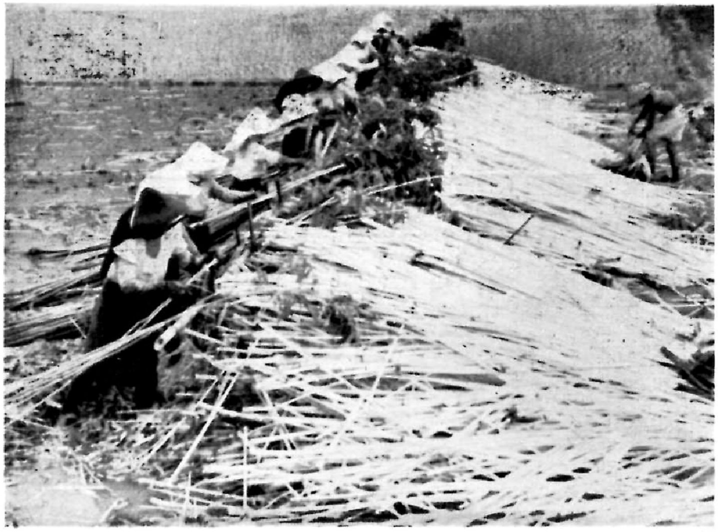
Plate 14 Drying of sisal fiber at Pingtung, Taiwan.

Transplanting of jute seedlings into the field.

(Plate 1)

Jute field under harvesting in Chiayi, Taiwan.

(Plate 2)



A team of women laborers stripping the bast layer from jute plant for retting.

(Plate 3)

Laborers treading on jute fiber immersed in retting pond to hasten the retting process.

(Plate 4)

Retted jute fiber seen hung on rack for drying.

(Plate 5)

Inspectors shown inspecting and grading the jute at the purchasing center.

(Plate 6)

A patch of kenaf in bloom.
(Plate 7)

Mr. H. S. Chang examining a young plant of Paw Keo (*Hibiscus sabdariffa* var. *altissima*).
(Plate 8)

Mr. James M. Dempsey, ICA Fiber Consultant to Vietnam, visiting a ramie field in Kaohsiung, Taiwan.
(Plate 9)

A ramie field being irrigated with the sprinkler irrigation setup.
(Plate 10)

Messrs. C. Y. Chi and H. S. Chang inspecting an experimental flax plot.
(Plate 11)

Sisal leaves being hauled to the center for decortication.
(Plate 12)

Decorticating of sisal leaves with an Ikeda type decorticator.
(Plate 13)

Drying of sisal fiber at Pingtung, Taiwan.
(Plate 14)