CHINESE-AMERICAN

JOINT COMMISSION ON RURAL RECONSTRUCTION

Plant Industry Series : No. 2

# PROBLEMS OF TEA PRODUCTION IN TAIWAN

By

Hsien-tsiu Chang

TAIPEI, TAIWAN, CHINA

JULY 1953

CHINESE-AMERICAN

JOINT COMMISSION ON RURAL RECONSTRUCTION

Plant Industry Series : No. 2

# PROBLEMS OF TEA PRODUCTION IN TAIWAN

By

Hsien-tsiu Chang

TAIPEI, TAIWAN, CHINA

JULY 1953

# Foreword

The tea industry in Taiwan, being one of long standing and an important element of foreign trade, has many deep-rooted economical problems of its own. Requests received by government and other organizations from the tea manufacturers and exporters, and problems pertaining to tea discussed in the financial or trade board meetings sponsored by the government often include items such as the following:

(A) More favorable exchange rate for foreign exchange realized from tea export.

(B) Provision of long-term and low-interest production loan and packing credit to the tea industry.

(C) Reduction of taxes levied on the tea manufacturers and tea exporters.

(D) Floor prices for tea export and problems arising from the evasion of surrendering foreign exchange to the government due to low official floor prices.

(E) Desirability of standardization of tea for export.

While fully aware of the importance and intricate relations of these problems to the tea industry, this report places its emphasis on a less discussed subject, namely, the improvement of tea plantation management as a basic means to reduce the production cost of the Formosan tea.

Chiang Monlin

Taipei, Taiwan
July 1953

# CONTENTS

# Problems of Tea Production in Taiwan

## Introduction

There are 42,500 ha. of tea in Taiwan. 94.7 percent of them are in the four northern prefectures: Taipei, Taoyuan, Hsinchu and Miaoli (Map 1). Topographically, 80 percent of the tea plantations are on the hillsides, only 20 percent are on the level land (Table 1.) (3). The soil on most of these hills are strongly acid in reaction, with a pH of less than 5, and usually bright red in color (4). These hillside soils, whereon tea thrives, are not suitable for growing rice or sugarcane. Not even sweet potatoes and peanuts would grow well on them.

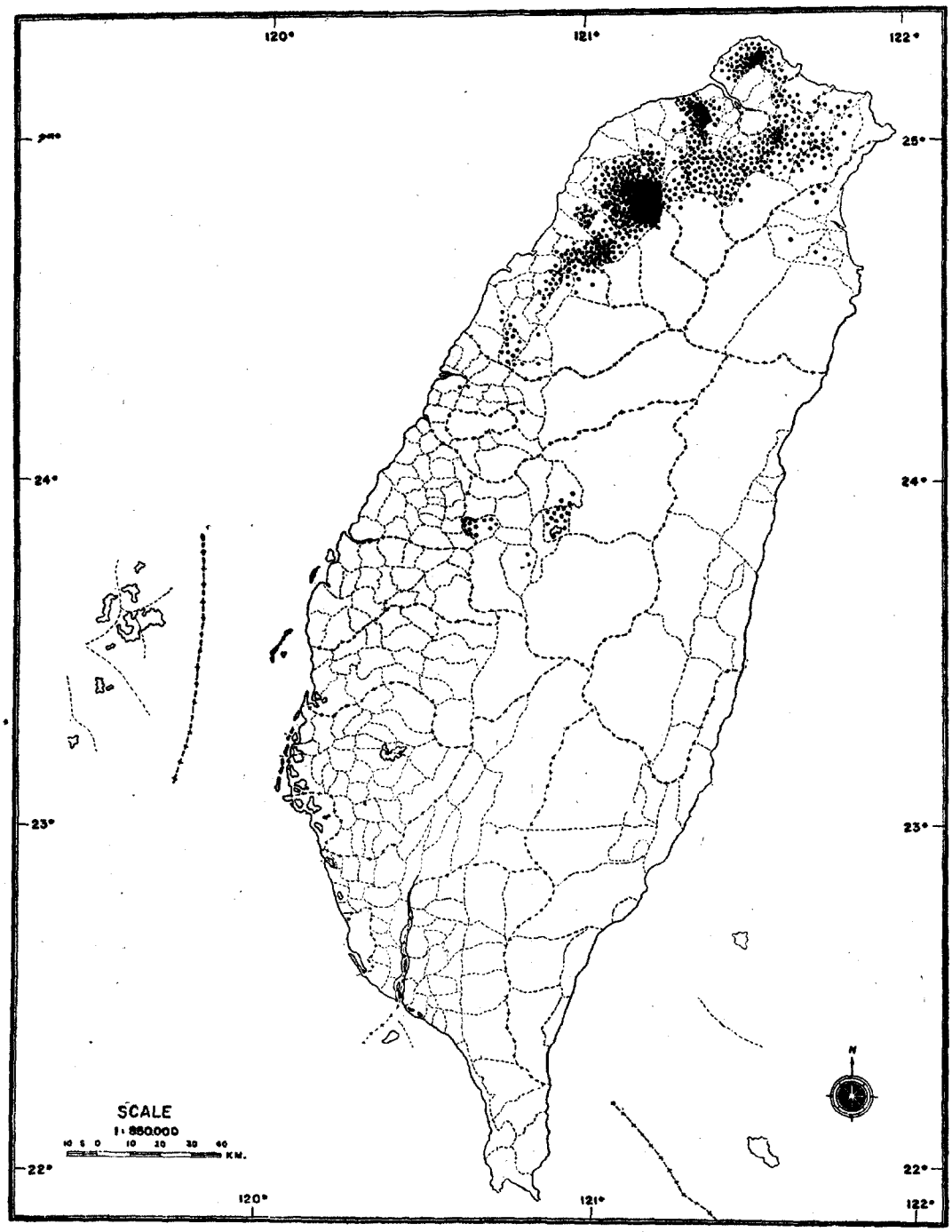
Table 1. Area of Tea in Taiwan [1/]

| Prefecture and Municipality | Area of tea on level land | Area of tea on hillside | Total area of tea | Area of tea under plucking | Plucking area as % of total area |
|---|---|---|---|---|---|
| | ha. | ha. | ha. | ha. | % |
| Taipei Prefecture | 2,371 [2/] | 13,838 [2/] | 16,209 | 12,238 | 75.5 |
| Taoyuen Prefecture | 4,318 | 4,178 | 8,496 | 7,750 | 91.2 |
| Hsinchu Prefecture | 1,104 | 10,907 | 12,011 | 10,620 | 88.4 |
| Miaoli Prefecture | 268 | 3,167 | 3,435 | 3,090 | 90.0 |
| Taichung Prefecture | 47 | 85 | 132 | 109 | 82.6 |
| Nantou Prefecture | 795 | 668 | 1,463 | 952 | 65.1 |
| Ilan Prefecture | - - | 314 | 314 | 280 | 89.2 |
| Taipei Municipality | - - | 21 | 21 | 10 | 47.6 |
| Keelung Municipality | - - | 324 | 324 | 277 | 85.5 |
| Total | 8,903 | 33,502 | 42,405 | 35,326 | 83.3 |

[1/] Data based on Report on a Survey of Tea Production Capacity of Taiwan, Provincial Department of Agriculture and Forestry (PDAF), May, 1952 (JCRR Project TW-M-14)

[2/] Estimated.

Map 1.
Distribution of Tea Acreage In Taiwan
(Each dot = 50 ha.)




Data based on Report on a Survey oi Tea Production Capacity of Taiwan, Provincial Department of Agriculture and Forestry, May, 1952 (JCRR Project TW-M-14)

The economic significance of tea may be illustrated by a few facts. Over 90 percent of the tea produced in Taiwan are for export. In the past two years tea brought to Taiwan yearly around 6 million U. S. Dollars worth of foreign exchange. (The 6 million US Dollars represent the amount registered with the Bank of Taiwan at floor prices of tea export. Since the floor prices were always lower than the actual transaction price, the actual amount of foreign exchange realized from tea export was more than 6 million dollars.) In the 8 tea producing prefectures and municipalities, tea plantations occupy 20 percent of the total cultivated land area; and the tea growing farm families make up 19 percent of the total farm families (Table 2.). Finally, tea production supports an industry of 430 tea factories on the Island (Table 3, Map 2), not including the smaller ones which make tea with hand labor (3).

Table 2. Area of Tea and Tea Growing Families as Percentage of Total Cultivated Land and Total Farm Families

| Prefecture and Municipality | Total area of tea | Total cultivated land area | Area of tea as % of total cultivated land area | Total tea growing family | Total farm family | Tea family as % of total farm family |
|---|---|---|---|---|---|---|
| | | ha. | % | | | % |
| Taipei Prefecture | 16,209 | 49,758 | 32.6 | 10,179 | 32,696 | 31.1 |
| Taoyuen Prefecture | 8,496 | 37,351 | 22.8 | 4,065 | 18,301 | 22.2 |
| Hsinchu Prefecture | 12,011 | 39,865 | 30.1 | 7,518 | 22,924 | 35.8 |
| Miaoli Prefecture | 3,435 | 34,455 | 9.9 | 2,788 | 20,480 | 13.6 |
| Taichung Prefecture | 132 | 10,858 | 1.2 | 115 | 12,040 | 0.9 |
| Nantou Prefecture | 1,463 | 23,843 | 6.1 | 1,402 | 21,734 | 6.5 |
| Ilan Prefecture | 314 | 11,239 | 2.8 | 332 | 7,381 | 3.9 |
| Taipei Municipality | 21 | 1,428 | 1.5 | 17 | 1,782 | 0.9 |
| Keelung Municipality | 324 | 2,132 | 15.2 | 348 | 1,842 | 18.9 |
| Total | 42,405 | 210,929 | 20.1 | 26,764 | 139,180 | 19.2 |

Data based on Report on a Survey of Tea Production Capacity of Taiwan, Provincial Department of Agriculture and Forestry (PDAF), May, 1952 (JCRR Project TW-M-14)

Table 3. Distribution of Tea Factories in Taiwan

| Prefecture and Municipality | Number of tea factories | | | |
|---|---|---|---|---|
| | Crude tea factory | Both crude and refined | Refined tea factory | Total |
| Taipei Prefecture | 105 | 6 | 3 | 114 |
| Taoyuen Prefecture | 78 | 7 | 3 | 88 |
| Hsinchu Prefecture | 107 | 5 | 8 | 120 |
| Miaoli Prefecture | 29 | - | 1 | 30 |
| Taichung Prefecture | 1 | - | 1 | 2 |
| Nantou Prefecture | 8 | 1 | - | 9 |
| Ilan Prefecture | 3 | - | - | 3 |
| Taipei Municipality | - | - | 63 | 63 |
| Keelung Municipality | 1 | - | - | 1 |
| Total | 332 | 19 | 79 | 430 |

Data based on Report on a Survey of Tea Production Capacity of Taiwan, Provincial Department of Agriculture and Forestry ( PDAF ), May, 1952 (JCRR Project TW-M-14)

Tea, therefore, is an important economic crop of Taiwan that occupies mainly the northern hills where it is not in competition for land with any other major crop.

## Characteristics of the Tea Industry of Taiwan

The most important characteristic of the tea industry of Taiwan is its lack of individuality.

Before the First World War, the Formosan Oolong did have a world fame. The main market for the Oolong then was in the United States. From 1896 to 1918, the export of Oolong from Taiwan had been maintained at from 7 to 9 million kg. yearly. After the First World War, Oolong was gradually replaced by the Indian, Ceylon and Java black tea on the American market. Ever since then, Taiwan's tea industry has lost its initiative and has dwindled to the making of fluctuating proportions of Oolong, Paochung and black teas. Since 1949, Taiwan has also started to

make green tea. The same factories, using tea leaves from the same plantations, may produce paochung in one season, black tea in another and green tea in still another, whichever seems to offer a better chance for sale.

Today, only an insignificant amount of Oolong is made yearly because of the ever shrinking market. Paochung is mainly consumed by the overseas Chinese and formerly by people of Manchuria and North China and, therefore, has a market of limited flexibility. The teas of world-wide importance are the black tea and the green tea.

Like tobacco, appraisal of tea is a matter of personal taste and preference. There is as little ground to say that the Indian black tea is "better" than the Formosan black as to say that the British type of cigarettes is better than the American type of cigarettes. But since the palate of the black tea drinkers in most places of the world today has become accustomed to the taste of the India type of black tea (including those from Ceylon and Java), the Formosan black tea, which is made from leaves of tea varieties with Chinese origin and has a distinguished flavor of its own, is considered a lower grade. The quality of the Formosan green tea, again, is considered lower than that of the choice mainland China green tea. Perhaps because of the warm climate of Taiwan and the more mechanized and extensive way of manufacturing, when the local factories started to make green tea in 1949 and 1950, they found it difficult to impart to their product the crystal clear green liquor color and the natural fragrance of the choice mainland green tea made in the precommunist days. Remarkable improvement, however, was made in the processing technic by the local tea makers in 1951 and 1952. In a short period of 4 years the Taiwan green tea has gained a definite name and place on the North African market.

## The Future Prospect of Tea Export from Taiwan

Since the end of the Second World War, when tea production in India, Ceylon, Java and Japan was gradually being revived, the trend of the international tea price is downward. The dump was especially sharp for black tea. In 1951 and before, the Indian and Ceylon black tea were

quoted at from US$ 0.55 to 0.60 per pound respectively ; while the Formosan black was only selling at around US$ 0.35 per pound. At such wide price difference, Taiwan was able to export 4,200 M. T. of black tea in 1950 and 4,800 M. T. in 1951 respectively (1). In 1952, the price of the Indian black tea suddenly dropped to below US$ 0.35 per pound; and the price offered by foreign buyer for the Formosan black was lowered to US$ 0.25 or less per pound.

During the past 3 years, however, the cost of production of tea in Taiwan, like that of most other commodites, was on a steady climb. This can be illustrated by the average cost of production of green tea made by the factories of the Taiwan Tea Corporation (Table 4).

Table 4. Average Production Cost of Green Tea of Taiwan Tea Corporation

| Item | Year | Production Cost Items (NT$/Kg.) | | | | |
|---|---|---|---|---|---|---|
| | | Raw material* | Labor for processing | Management and others | Packing | Total |
| Crude tea | 1950 | 3.38 | 0.30 | 2.96 | - - | 6.64 |
| | 1951 | 5.33 | 0.20 | 1.83 | - - | 7.36 |
| | 1952 | 8.06 | 0.32 | 2.54 | - - | 10.92 |
| Refined tea | 1950 | 6.80 | 0.35 | 0.72 | 0.23 | 8.10 |
| | 1951 | 7.65 | 0.29 | 0.49 | 0.87 | 9.30 |
| | 1952 | 11.50 | 0.30 | 1.53 | 0.71 | 14.04 |

Source of data : Taiwan Tea Corporation, Taipei.
Raw material for crude tea, is fresh tea leaves ; for refined tea, crude tea.

Although the production cost of the Government owned Taiwan Tea Corporation may not be totally representative of that of the private factories in general, the tendency and proportion of increase is unmistakable. From table 4, it is apparent at a glance that the sharp increase of product in cost of the tea in the past three years was due mainly to the steady rise of price of the fresh tea leaves.

At NT$ 14.04 per kg., the cost of production of the refined green tea of 1952 was US$ 0.41 per lb. when converted according to the 15.50

exchange rate. Since the fresh tea leaves can be made either into green tea or black tea, the manufacturers of the black tea had to pay as much for the fresh tea leaves as the manufacturers of green tea; and the production cost of the refined black tea under ordinary conditions would also be about equal to that of the refined green tea, i.e., US$ 0.41 per pound. An offered price of US$ 0.25 per pound against a production cost of US$ 0.41 per pound explained why the black tea export dwindled to 400 M. T. in 1952.

Fortunately, the price of the green tea was fairly good in 1952. The average price offered by the North African buyers was above US$ 0.40 a pound. This change of cost/price relationship basically prompted the change of the Formosan tea export from an emphasis on black tea in 1951 to a preponderance of green tea in 1952 (Table 5) (1).

Table 5. Tea Export from Taiwan, 1946-1952 (M. T.)

| Year | Paochung | Oolong | Black | Green | Miscellaneous | Total |
|---|---|---|---|---|---|---|
| 1946 | 1,115 | 382 | 1,929 | --- | 72 | 3,498 |
| 1947 | 2,208 | 706 | 2,325 | --- | 412 | 5,651 |
| 1948 | 2,965 | 220 | 4,003 | --- | 1,408 | 8,596 |
| 1949 | 2,721 | 1,070 | 7,602 | 1,197 | 2,121 | 14,711 |
| 1950 | 772 | 241 | 4,207 | 640 | 996 | 6,856 |
| 1951 | 1,432 | 225 | 4,796 | 2,882 | 1,799 | 11,134 |
| 1952 | 1,441 | 73 | 406 | 6,150 | 1,409 | 9,479 |

Source of data - The above data represent the amount of teas approved for export by the Bureau of Inspection & Quarantine, Provincial Department of Agriculture and Forestry.

This breathing spell, however, is neither dependable nor certain in even the nearest future. The major green tea market, outside of the producing countries, is in North Africa; and that market has always been largely monopolized by the mainland green tea in the pre-communist days. Taiwan has never made green tea until 1949 when the communists overran the mainland and the export of tea from there was for some time interrupted. The price of green tea and the demand from the Formosan green tea is

affected by the amount and the price of the mainland green tea that reaches the North African ports. Last year apparently that amount was small. Tea exporters, however, speculated that an increasing amount of the mainland green tea would go to North Africa this year. Japan has also started a vigorous sales campaign for her green tea in North Africa as soon as she signed the peace act with Allied Nations. Reports received in early June indicated that Formosan green tea has already felt much stronger competition there this year and the price has dropped.

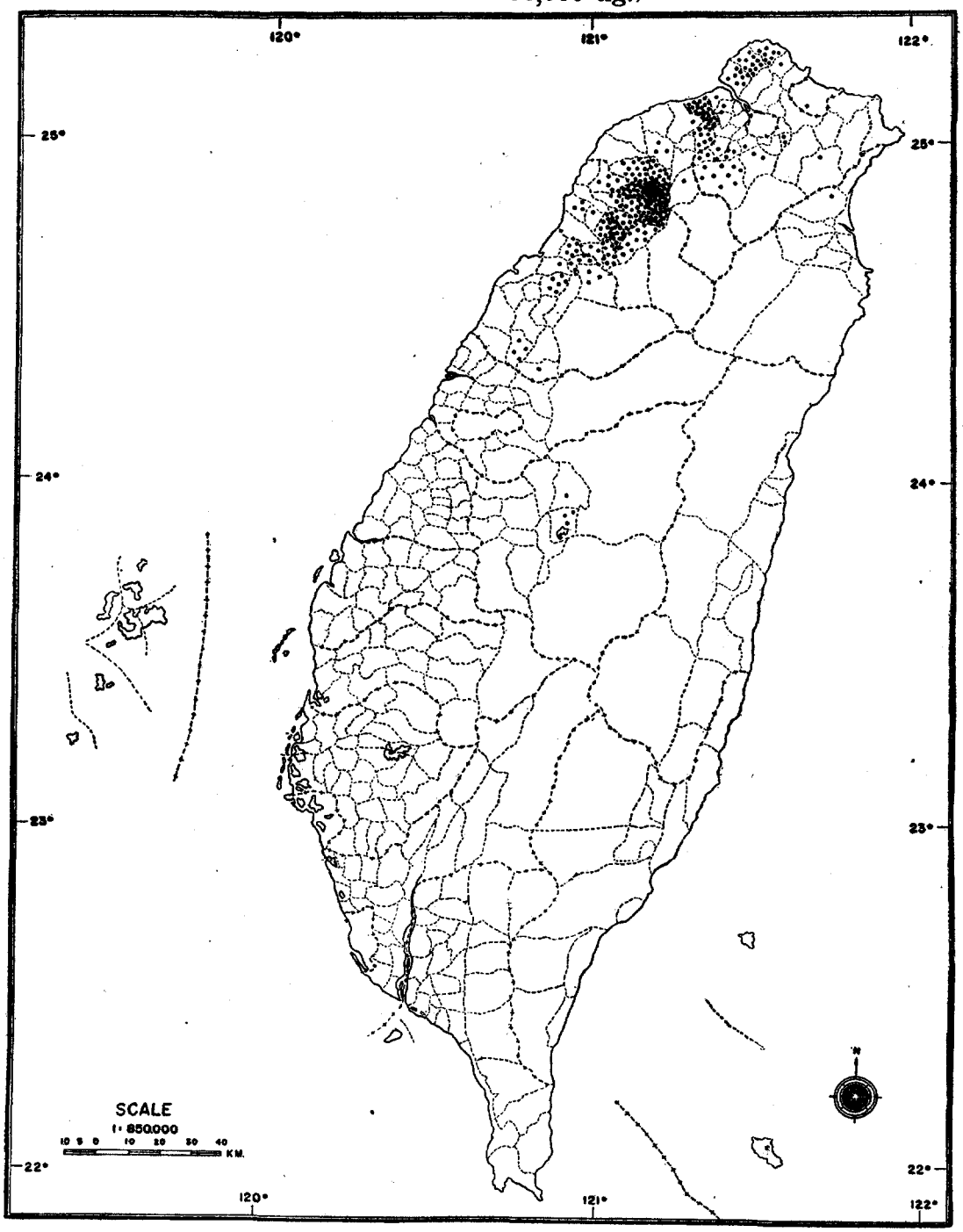
Latest news (June, 1953) also reported a rising trend of black tea price on the world market (2). According to Taiwan Tea Corporation This is due to the controlled production in India and Ceylon this year. The prospect of our tea this year is, therefore, most likely going to be a hard battle for green tea fought over the North African market and an uncertain degree of revival of black tea.

The prospect of Taiwan's tea export is therefore by no means optimistic. Oolong is dying. Paochung has a limited market. The market for Black tea was almost entirely closed in 1952. And danger is being keenly felt for the export of green tea, the last straw of our tea industry. This extremely grave picture brings us back to the cold fact that, if Taiwan's tea industry is to survive at all, every means most be employed to cut down its production cost and, meanwhile, improve its quality, so that it may continue to undersell the tea from other countries.

## Why the Production Cost is High?

In the past two years, Provincial Department of Agriculture and Forestry (PDAF) carried out two important surveys on tea, both financed by funds from the Joint Commission on Rural Reconstruction (JCRR). One was on the cost of production of the fresh tea leaves, the crude tea and the refined tea; the other on the production capacity of all the tea factories equipped with machineries against supply of fresh tea leaves. From these two surveys and also from information gathered elsewhere the following may be summarized:

Map 2.
Capacity of Crude Tea Factories In Taiwan
(Each dot = 50,000 kg.)




Data based on Report on a Survey of Tea Production Capacity of Taiwan, Provincial Department of Agriculture and Forestry, May, 1952 (JCRR Project TW-M-14)

1. In 1952, when the factories were buying fresh tea leaves at NT$ 1.50 or more per catty (NT$ 2.50 per kg.) the production cost of the fresh leaves was only NT$ 0.80 per catty (NT$ 1.33 per kg.) (9). There were not enough fresh tea leaves to meet the demand of all the factories. The price soared as the factories competed over the leaves. There were only 337 tea factories in Taiwan before the Second World War. As of 1951, the number increased to 430; and the total production capacity of the factories exceeded the supply of fresh leaves by some 6 million kg. in terms of crude tea. (Table 6) (3)

Table 6. Production Capacity of Crude Tea Factories vs. Supply of Fresh Tea Leaves in Taiwan

| Prefecture and Municipality | Supply of fresh leaves | | Normal crude tea production capacity of crude tea factories | Crude tea Production capacity vs. Supply of fresh tea leaves | |
|---|---|---|---|---|---|
| | Annual production | Crude tea equivalent | | Capacity deficit* | Capacity Surplus* |
| | kg. | kg. | kg. | kg. | kg. |
| Taipei Prefecture | 11,705,374 | 2,926,344 | 3,866,611 | ... | 940,267 |
| Taoyuen Prefecture | 11,279,520 | 2,819,880 | 4,537,670 | ... | 1,717,790 |
| Hsinchu Prefecture | 13,297,589 | 3,324,397 | 6,466,230 | ... | 3,141,833 |
| Miaoli Prefecture | 3,014,261 | 753,565 | 1,226,620 | ... | 473,055 |
| Taichung Prefecture | 139,190 | 34,798 | 8,000 | 26,797 | .. |
| Nantou Prefecture | 1,471,819 | 367,955 | 194,900 | 173,055 | ... |
| Ilan Prefecture | 243,705 | 60,926 | 71,000 | ... | 10,074 |
| Taipei Municipality | 9,948 | 2,487 | ... | 2,487 | ... |
| Keelung Municipality | 234,844 | 58,711 | 32,000 | 26,711 | ... |
| Total | 41,396,250 | 10,349,063 | 16,403,031 | ... | 6,053,968 |

Data based on Report on a Survey of Tea Production Capacity of Taiwan, Provincial Department of Agriculture and Forestry, May, 1952 (JCRR project TW-M-14)

* In terms of crude tea

It takes approximately 4 kg. of fresh leaves to make 1 kg. of crude tea. In other words, Taiwan needs 24 million kg. more of fresh leaves to meet the capacity of the existing factories. When Taiwan produced 41.4

million kg. of fresh tea leaves in 1952, its factory capacity could actually accomodate 65.6 million kg.

The tea factories do know that the high cost of fresh leaves underlies the high production cost of the crude and the refined tea. In the spring of 1952, a resolution was passed by the members of the Taiwan Tea Guild that the price of the fresh tea leaves was to be maintained at NT$ 1.0 per catty (NT$ 1.67 per kg.) and no one factory should raise the price above that. But later on, they broke their own agreement by each thinking that if he would raise the price just a little bit while the rest of the factories stuck to the price under agreement, he would be able to get more leaves and make more tea. The price was soon built up to above NT$ 1.5 per catty (NT$ 2.50 per kg.) or more. This year again a new agreement on price of fresh tea leaves was reached among the members of the Tea Guild. But the agreed price was again exceeded during the first two months of the 1953 tea season. Tea merchants now found that, at such production cost, they could no longer export tea to North Africa as freely as last year. The price of fresh leaves came down to below NT$ 1.50 per catty toward late May as a result of the sluggish export of the new spring crop of green tea. Apparently, the price of the fresh leaves cannot be successfully controlled by words and agreements. It is controlled by the law of supply and demand.

2. The price of fresh leaves was so high that for private tea makers it made up some 80 percent of the total production cost of the crude tea. The high cost of production of crude tea and consequently that of the refined tea narrowed down the margin of difference between the cost of production of the Formosan tea and the price of tea of other countries. In the case of black tea, a negative margin has actually developed.

3. Although the price of the fresh tea leaves was so high, the farmers were not enjoying prosperity, becuase the yield of their plantations was so poor. The average yield of fresh tea leaves per hectare, according to the estimate of the Tea Section of the Provincial Department of Agriculture and Forestry in a survey made in the spring of 1952 (3), was only 1,172 kg. (Table 7). Even at NT$ 2.50 per kg. (1.50 per catty), the gross average

income per ha. was only NT$ 2,960. This average yield is only about 1/2 of that of Java, 1/3 of that of India/Ceylon, and 1/4 of that of Japan.

Table 7. Yield of Tea per Hectare in Taiwan (1951)

| Prefecture and municipality | Area of tea under plucking | Production of fresh tea leaves | Yield of fresh tea leaves per ha. |
|---|---|---|---|
| | ha. | kg. | kg. |
| Taipei Prefecture | 12,238 | 11,705,374 | 956 |
| Taoyuen Prefecture | 7,750 | 11,279,520 | 1,455 |
| Hsinchu Prefecture | 10,620 | 13,297,589 | 1,252 |
| Miaoli Prefecture | 3,090 | 3,014,261 | 975 |
| Taichung Prefecture | 109 | 139,190 | 1,277 |
| Nantou Prefecture | 952 | 1,471,819 | 1,546 |
| Ilan Prefecture | 280 | 243,705 | 870 |
| Taipei Municipality | 10 | 9,948 | 995 |
| Keelung Municipality | 277 | 234,844 | 848 |
| Provincial | 35,326 | 41,396,250 | 1,172 |

Data based on "Report on a Survey of Tea Production Capacity of Taiwan," Provincial Department of Agriculture and Forestry, May, 1952 (JCRR Project TW-M-14)

4. The low yield of the tea plantations in Taiwan is not so much due to the natural limiting factors, as due to the prevailing malpractices in the plantation management. It could and should be significantly raised. The possibility of raising the yield of Taiwan's tea plantations can be positively illustrated by the improvements made by the Assam tea plantations at Yutze, Nantou. By applying calcium cyanamide at 200 kg. per ha. and by the adoption of scientific management methods, the Yutze Station was able to raise its yield of fresh leaves from an average of 1,204 kg. in 1949 to 2,380 kg. per hectare in 1952. The provincial average in 1952 was only around 1,200 kg. per hectare (8). At 1,200 kg. of fresh leaves per ha and NT$ 2.5 per kg., the gross income from each ha. is NT$ 3,000. At Yutze where the average yield was 2,380 kg., the farmers could get NT$ 3,570 per hectare even if the price of the fresh leaves should be reduced to NT$ 1.5 per kg.

Snmming up the above, we believe that the course of improving the tea

industry should be (A) to halt the expansion of, or better still, to reduce the total capacity of the tea factories; (B) to raise the yield per hectare of the fresh leaves by all means; and (C) to reduce the price of the fresh leaves gradually to a level at which the production cost of the Formosan tea can be sufficiently lowered to enable it to continue to undersell the tea from other countries.

## Why the Yield is Low?

After review of literature, discussion with experienced tea research and extension workers, and extensive field observations, the following are thought to be the major factors limiting the yield of the tea plantations in Taiwan:

1. The high percentage of missing plants on the tea plantations: It is estimated by the Tea Section of the Provincial Department of Agriculture and Forestry that the existing tea plantations have an average of about 20 percent of missing plants. This high percentage of missing plants is the result of a government order during the Second World War to remove alternate rows of tea on some of the plantations for increasing the production of food crops, i.e., sweet potato; the ngligence in management of tea plantations toward the later stage of the War when the export of tea was greatly reduced; and the failure of rehabilitation during the early postwar years.

2. The low natural fertility and the low organic matter content of the red earth on which most of the tea is grown. The poor natural productivity of the soil was aggravated by the application of an extremely low amount of fertilizer and manure by farmers on tea plantations. In postwar years most of the tea growers did not use any fertilizers at all until 1952 when ammonium sulfate was allocated to tea farmers at 100 kg. per hectare.

3. The prevailing cultural practice of deep plowing in winter and cultivation and weeding 3 to 4 times a year, though quite necessary to the immediate well being of the tea shrubs, are very inducive to soil erosion and harmful to the soil productivity in the long run.

4. The tea shrubs are being seriously over-plucked on most of the tea plantations. The poorer the plantation is, the less flushes are produced by the tea shrubs, the greater would be the tendency for farmers to pluck older leaves in order to obtain a bigger weight of harvest. The over-plucking not only results in producing tea of poorer quality, but also impairs the vigor and stunts the growth of the tea shrubs, keeping the yield perpetually low.

5. Negligence of pruning and topping; and poor technic of pruning and layering of seedlings. Most tea growers do not prune their shrubs at all. The shrubs, therefore, do not have an even crown. The plucking girls usually pluck not only the flushes at the tips of the branches, but also reach down and pluck the new leaves on the lower parts of the branches.

If a smooth and dense crown could be established for the tea shrubs by proper pruning at the end of each year, not only would the shrubs flush more profusely and give higher yield of fresh leaves, but also the plucking can be done more efficiently, as the girls can stand erect and pluck off the leaves from the surface of the crown at the height of their waist. Most tea growers do not know how to multiply tea seedlings by layering, Market price of the tea seedlings is expensive. This is one of the reasons why the farmers are slow in filling up the missing plants on their plantations in the postwar years.

## JCRR Tea Program

JCRR tea program is designed to solve the five problems mentioned above. By overcoming these handicaps, it is hoped that the yield per hectare of tea in Taiwan may be substantially increased without expansion of acreage, and the production cost of Formosan tea may eventually be lowered to facilitate the export.

1. To fill up the missing plants on tea plantations:

Multiplication and extension of tea seedlings for filling up the missing plants on tea plantations formed a major part of the JCRR tea program.

Three lines of approach have been persued for achieving this objective

A. Province-wide program for multiplication and supply of tea seedlings:

JCRR started to assist PDAF to multiply and distribute tea seedlings to needy farmers since 1951. A plan was laid out for multiplying a total of 16 million tea seedlings of improved varieties in 3 years. The plan proceeded according to the following schedule:

| Year | JCRR project No. | No. of tea seedlings multiplied | Estimated area of tea plantations missing plants to be fiilled |
|---|---|---|---|
| | | | ha. |
| 1951 | TW-A-122 | 3,000,000 | 1,500 |
| 1952 | TW-A-236 | 5,000,000 | 2,500 |
| 1953 | TW-A-326 | 8,000,000 | 4,000 |
| Total | | 16,000,000 | 8,000 |

The 3 million seedlings multiplied in 1951 were distributed to 3,237 farmers in 63 townships. A sample survey conducted by PDAF in October, 1952, indicated a survival of 84.4 percent of the seedlings after transplanted to the farmers' tea plantations. The 5 million seedlings multiplied in 1952 were distributed to farmers in February and March, 1953. The 8 million multiplied in the spring of 1953 will be distributed in 1954.

From 8,000 to 10,000 tea shrubs are customarily planted on each hectare. On an average basis of 20 percent missing plants, 2,000 seedlings were allocated to each hectare of tea plantations selected to receive the seedlings. The applicants for the seedlings were screened by the township offices and prefectural governments. Poorer farmers were given priority in receiving the seedlings. Farmers who paid less household tax were considered as poorer. The seedlings were given to them on a 5-year loan basis. After 5 years, the farmers are to return the same amount of tea seedlings they each received to the PDAF. The latter will use these returned seedlings for further distribution in the future, e. g., for replacement of indigenous tea varieties with improved varieties.

The distribution of a total of 16 million seedlings are expected to cumulatively fill up the missing plants on 8,000 hectare of tea plantations belonging to poorer farmers, roughly equivalent to one-fifth of the total tea acreage and about one-third of the acreage of tea of improved varieties. The better-to-do farmers are encouraged to multiply their own seedlings and fill up the missing plants by their own efforts. The presence of numerous private tea seedling nurseries indicates that quite a number of farmers are also making that effort, though a complete rehabilitation of the existing tea plantations would be a slow process.

B. Subsidy to Taiwan Tea Corporation for multiplication of tea seedlings:

The government owned Taiwan Tea Corporation inherited about 3,700 hectare of tea plantations from the Prewar Japanese Corporations, of which about 2,000 hectare are in pluckable condition, the rest being too far dilapidated to be productive. Even over the 2,000 hectares of better plantations, the missing plants were as numerous as farmers' plantations elsewhere. These plantations are mostly leased by the Corporation to farmers at an average rental of less than twenty percent of the harvest in kind. JCRR subsidied the Corporation for multiplying 1.5 million and 2 million tea seedlings in 1951 and 1952 respectively (JCRR projects TW-A-142 and TW-A-236). These seedlings are estimated to be sufficient for filling up most of the missing plants on the Corporation's plantations under plucking. Under the tea seedling multiplication program sponsored by PDAF as mentioned in the above section JCRR provided almost the entire necessary fund. For the seedlings multiplied by the Taiwan Tea Corporation, the Corporation, the farmers themselves and JCRR share the expenses on a basis of approximately one-third each.

C. Rehabilitation of Assam Tea Plantation of the Taiwan Tea Corporation:

Prior to the Secend world war, the Japanese made a great effort to develop the black tea industry in Taiwan. One of the pioneer work they did was to introduce the Indian type of tea varieties to Taiwan. About

300 hectare of Assam tea were planted at the Yutze area of Nantou Prefecture near the Sun-Moon Lake. Due to wartime negligece, most of these plantations were abandoned by the end of the War. In 1949, only 252.5 hectares of the Assam tea plantations were left in full stand. From 1950 to 1952, JCRR gave financial assistance to tenant farmers to rehabilitate the dilapidated Assam tea plantations (JCRR project TW-A-28,-119,-198). The Taiwan Tea Corporation which owns these plantations provided Assam tea seedlings to them free of charge. Wild bushes and weeds were removed, soil plowed up, terraces built, contour and vertical drainage ditches laid out, calcium cyanamide applied, new seedlings planted and old remnant tea shrubs pruned back to shape. By 1952, the acreage of the fullstand Assam tea plantations was built up back to 756 hectares, only slightly short of the prewar acreage. The progress made on these plantations is shown in Table 8:

Table 8. Record of Rehabilitation of Assam Tea Plantations at Yutze, Nantou Prefecture.

| Year | Area of full-stand plantation | Area under plucking | Annual production of fresh leaves | Yield of fresh leaves per ha. | Annual production of crude tea |
|---|---|---|---|---|---|
| | ha. | ha. | kg. | kg. | kg. |
| 1949 | 252.5 | 242.9 | 292,468 | 1,204 | 67,192 |
| 1950 | 349.7 | 242.9 | 333,667 | 1,374 | 76,061 |
| 1951 | 456.0 | 242.9 | 515,163 | 2,122 | 116,590 |
| 1952 (planned) | 756.0 | 247.6 | 624,000 | 2,520 | 140,400 |
| 1952 (actual) | 756.0 | 247.6 | 589,170 | 2,380 | 138,067 |

Source of Data: Report of Yutze Tea Plantation on JCRR Subsidized Projects of Rebabilitation of Assam Tea Phlantations at Yutze.

The project of rehabilitation of Assam tea plantation is a small one, but is a good case in point to indicate the destiny of Taiwan's tea industry. In three year's time, the yield of fresh leaves per hectare of the Assam tea plantations has nearly doubled. This remarkable progress is no easy break but the result of steady improvement made in the plantation management and the application of fertilizer. Taking the region as a whole, the Assam

tea plantations at Yutze is by far the highest yielding area in Taiwan. It can be taken as a good example to illustrate the potential productiveness of the tea plantations elsewhere on the Island if the management methods should be likewisely improved.

*2. To increase the fertility and organic matter content of the tea soils :*

A. Advocation of the use of calcium cyanamide on tea plantations :

As tea is known to be adaptable to acid soil and the optimum soil acidity for tea growth is known to lie between pH 5 and 5.5, alkaline fertilizers are ordinarily not recommended for tea. However, since the red earth on which most of the tea is grown in Taiwan is so acid that its pH is usually less than 5, theoretically, application of calcium cyanamide would tend to moderately neutralize the soil and bring its acidity closer to the range optimum for tea growth. The neutralization of soil acidity would also help to liberate more $P_2O_5$ and $K_2O$ for the absorption by the tea plants. These beneficial effects of the Calcium cyanamide to tea under the condition of Taiwan seems to have been borne out by the results of both the prewar experimentation and the postwar fertilizer demonstrations. The result of a 5-year fertilizer experiment (1928-1933) at Pinching Tea Experiment Station in prewar time showed that, when applied at the same level of nitrogen, calcium cyanamide was more effective in increasing the yield of tea than other three kinds of nitrogenous fertilizers ; i.e., ammonium sulfate, sodium nitrate and urea (5). Calcium cyanamide was also shown to be a better fertilizer for tea than ammonium sulfate in field demonstrations sponsored by JCRR in 1951 (JCRR project TW-A-144). By the aplication of calcium cyanamide at a rate of 450 kg. per hectare, the yield per hectare of the fresh leaves on 25 demonstration plots at different places increasel by an average of 25.3 per cent in the first year.

As a measure to supplement the rehabilitation of the Assam tea plantations at Yutze, JCRR granted calcium cyanamide to the renewed plantations under two projects, TW-A-180 and TW-A-199. After having eye-witnessed the significant improvements made on their plantations, as the result of both the application of calcium cyanamide and the rehabilitation projects, the farmers in the Yutze area quickly accepted the use of

this fertilizer, and bechme a progressive group of tea farmers who regularly apply this fertilizer to their plantations.

B. Extension of Lupine:

Green manure crops are especially important to the tea plantations for replenishing soil nutrients and organic matter, because of the lack of other convenient source of organic fertilizers in the tea growing area. Little compost manure is used on tea plantations in Taiwan because of the lack of material to compost with and the labor involved in carrying the manure up the hills. Prewar experiments showed that Lupine was the best adapted green manure for the tea plantations. JCRR started to assist PDAF in extension of Lupine in 1950 by providing funds for purchasing seed (JCRR projects TW-A-39, -98, -243). In 1949, there were about 800 hectares of Lupine on tea plantations. By 1952, PDAF has supplied Lupine seeds to a total of 3,624 hectare of Lupine. It is roughly estimated that the total acreage of Lupine in 1952 has reached around 5,000 hectare including the acreage which has spread of farmers' own accord. PDAF also estimated that there are about 13,000 ha. of tea plantation suitable for planting Lupine, which include the 8,903 hectares of tea plantations on the level land and a part of the plantations on broad terraces and gentle slopes (Table 1). It would be desirable that the extension of Lupine be continued till its area reaches the neighborhood of 13,000 hectare.

C. Introduction and experimentation of other green manure crops for tea plantations:

Although Lupine is a good green manure crop for tea, it has failed to grow well on hill-side plantations. The narrow terraces on steep slopes make both the planting and the turn-under of Lupine difficult. Even On level land, the growing season of Lupine is from September / October to February / March, leaving blank a long stretch of the year during which the soil is exposed to rain and summer heat.

Experiments have been started since 1952 by the Taiwan Agricultural Research Lnshtutr and the Yutze Tea Research Institute on the adaptation of the Korean Lespedeza (*L. stipulacea*), Kobe Lespedeza (*L. striata*), *Lespedeza sericea*, white clover, and white Lupine to the local conditions.

The seeds of these crops were introduced by JCRR. The aim of the experiment is twofold; firstly, to find another adaptable green manure crop to fill in between the tea rows during summer and fall and, secondly, to find a low and dense growing soil cover cover crop for the hill-side plantations. White Lupine is found to be growing more vigorously than the common yellow Lupine in the experimental plots at Taipei and therefore promising as a better yielder of organic matter to the tea soil. It may be used to replace the yellan Lupine in some areas in the future.

Though these experiments are yet in the preliminary stage, they provide future hopes and new ways of approach for improving the fertility of the tea soils of Taiwan.

3. To reduce the soil erosion on tea plantations:

The weakest link in the present tea program seem to lie in finding practical and feasible means to prevent soil erosion on the hill-side tea plantations. The standard tea cultural practice in Taiwan is to deep plow the soil between the tea rows and around the tea bushes in the winter and to cultivate and weed four times a year. These practices are claimed by the tea farmers and most of the tea extension people to be necessary for the immediate well being of the tea plants. It is thought that after the soil is packed by the natural seetling and stamping of pluckers through ont the year, it should be loosened in the winter; and that weeds should be removed as far as possible so they will not take nutrients away from the tea bushes. Such practices, on the other hand, are doubtlessly very inducive to soil erosion and harmful to the tea plantations in the long run. It is hence not unusual for one to find root stumps of the tea bushes exposed from several inches to half a foot above the soil on a number of hill-side plantations, giving proof to the seriousness of soil erosion which has robbed the tea plantations of surface soil through all these years.

Weeding on tea plantations is a problem the world over. Even for the modern tea estates in India and Ceylon, weeding is still a controversy between actual necessity and liability to soil erosion. After experimenting unsuccessfully with weed killing chemicals and taking all factors into consideration, Mr. G. B. Portsmouth, the Acting Director of Tea Research

Institute of Ceylon, advised the Ceylon tea growers in 1951 that "the best cover for tea is tea", and urged them to do all they can to increase the spread of their bushes and so crowd out the weeds, while at the same time protecting their soil from erosion and deterioration (7).

Orthodox soil conservation measures, such as contour terracing, laying out contour drainage ditches, strip cropping, etc., are difficult to implement on the tea plantations under the present circumstances, for the local tea farmers are unable to do the surveying work, neither are there technicians in the townships and prefectures qualified to advice them on the soil conservation methods. The Soil Conservation Training Class sponsored by the Taichung Agricultural College and financed by JCRR marks a valuable start, but years of continuous and well-coordinated efforts will have to be exerted before any sizable portion of the farmers could begin to see the importance of soil conservation in its true light. Before then, it would be next to impossible to ask the tea growers to remove the tea from the steep slopes or to change the lay out of their plantations drastically to conform to the principles of soil conservation. These are the practical difficulties which perhaps have to be condoned for the time being, though no time should be lost in seeking speedy remedies.

Meanwhile a fool-proof soil chnservation project has been started on tea plantations by the Forestry Division of JCRR in 1953. Under this project, PDAF is subsidized to multiply a total of 13,025,000 Acacia seedlings for extension on the tea plantations as shading trees. To each hectare of tea plantation, 500 Acacia seedlings will be provided. The 13,025,000 seedlings shall cover some 25,000 hectare of tea, amounting to more than half of the total tea acreage of the Island. If this project is continued for another year, all of Taiwan's tea plantations can be planted with this leguminous shading tree. Fortunately tea itself was originally an undergrowth of the tropical forest. It can sustain a considerable amount of shading. In Ceylon, planting high or medium shade trees over tea has become a definite part of the green manure policy on tea estates. It is especially recommended in that country that the shading trees should be of such species, preferably leguminous, that develop deep penetrating roots which reach levels of the soil below the tea root zone. Such deep rooted

species, once their roots get well down, aside from providing canopy for protecting the soil from direct beating of the rain, could explore new layers of soil from which fresh supplies of plant food are brought up and returned to the top layers of the soil in the form of fallen leaves, where they become available to the tea.

In Taiwan, leguminous shading trees should be used. Since the depth of the surface soil on most of our hill-side tea plantations is rather shallow, there is bound to be some root competition between tea and the shading tree. The latter, therefore, should not be too densely planted. From what can be observed from the tea plantations where Acacia cover has already been established, it can be safely said that planting Acacia at 500 trees per hectare, in proportion to 8,000 to 10,000 tea plants per hectare, would be tolerable to the tea plants, and, meanwhile, provide sufficicient shade and leaf fall to help ease the soil erosion and the weed problem; making it a worthwhile part of tea plantation management.

4. To improve the cultural practices, such as plucking, weeding, cultivation, green manuring, fertilization, seedling multiplication, etc:

Much can be said about the wrong cultural practices prevalent among local tea growers today. These can only be corrected gradually by educational and demonstrational methods. Making the farmers learn and adopt the proper plantation management methods is the most basic element in our effort to increase the yield per hectare of tea.

A pictorial pamphlet illustrating the common malpractices and the proper way to correct them was prepared jointly by JCRR and PDAF. The information provided therein was based upon extensive field observations as well as experimental results from the tea research institutes of the Taiwan Tea Corporation. 10,000 copies of it have been printed for distribution to the agricultural staff of the prefecturl governments, township offices and farmers' associations and the tea farmers in general.

A 2-day conference was called by PDAF and attended by the prefectural and township agricultural extension people. The contents of the pamphlet were delivered in lecture and elaborated by specialists invited

from the tea research institutions, tea vocational schools, PDAF and JCRR.

A large scale demonstration of the improved plantation management methods has been started since the spring of 1953 by PDAF under JCRR project TW-A-306. 2,283 tea plantations in 82 townships with a total area of 1,750 hectare were contracted as demonstration plots. The Council for United States Aid (CUSA) donated 300 MT of calcium cyanamide to this project. 200 kg. were granted to each hectare of the plantation under demonstration. The responsiblity of the owners of these plantations is to adopt the correct cultural practices recommended in the JCRR/PDAF pamphlet and in the PDAF conference. The township agricultural workers are subsidized by PDAF to supervise the operations of these demonstration plots. If this project could be continued for 3 years and closely supervised, these widely scattered demonstration plots can well become show windows for the proper plantation management methods which JCRR/PDAF wish to convey to the tea farmers in general. It would also be an effective way to publicize the use of calcium cyanamide on the tea plantation.

5. JCRR participation in non-project activities concerning tea :

The tea industry in Taiwan, being one of long standing and an important element of the foreign trade, has many deep-rooted economical problems of its own. Opinions expressed by tea manufacturers and exporters frequently include such broad requests as readjustment of foreign exchange rate, provision of production loan and packing credit by the government, reduction of taxes on tea manufacturing and exportation, reduction of export floor prices, etc. JCRR has often been requested by government committees and boards to participate from time to time in conferences pertaining to tea improvement and tea export, and has made due comments on various subjects. These activities will not be mentioned in detail in the present report.

It is our contention that although the foregin exchange rate, export loans and credits, taxes, etc. are immediate economical problems which may profoundly effect the tea industry at one time or another, and due attention should be given them by the Gonernment, the true strength of

Taiwan's tea industry of tomorrow lies in our ability of making overall improvement on our tea plantations, increasing the production and reducing the price of the fresh tea leaves, and keeping down the production cost of tea. With a low product cost, the Formosan tea can continue to be competitive and thrive on the international tea market.

## Summary

1. Taiwan's tea export has been possible in the past when the prices of the Formosan tea were considerably lower than that of the tea from other competing countries. For the past 3 years, it has been increasingly menaced by the falling international tea prices on one hand and the climbing domestic production cost on the other.

2. The mounting production cost of tea in the recent years in Taiwan was mainly fostered by the increase of price of the fresh tea leaves. The latter was high chiefly because new tea factories were being continuously established and the aggregate capacity of them all is estimated to have exceeded the supply of fresh tea leaves by 6 million kg. in terms of crude tea.

3. In spite of the high price of the fresh tea leaves, the tea farmers are among the less prosperous farm groups in Taiwan, because the yield of tea is, in average, very low.

4. The major factors responsible for the low yield of Taiwan's tea plantations are thought to be (a) the high percentage of missing plants, (b) the low natural productivity of the red and yellow earth on which most of the tea is grown, and the low level of fertilizers and manures applied on tea plantations, (c) plowing and weeding practices inducive to serious soil erosion and the lack of measures to control it, (d) overplucking of fresh tea leaves, and (e) other erroneous cultural practices.

5. It is believed that the basic means for combatting the difficulties confronting the tea industry should include the following steps: (a) rapidly raising the yield per hectare of tea and thus increasing the supply of fresh leaves without opening up new plantations (b) stopping further expansion

or reducing the capacity of the local tea factories, (c) lowering the price of the fresh tea leaves without affecting the total income of the tea farmers on per hectare basis, (d) lowering the production cost of crude and refined tea to facilitate export.

6. JCRR tea program is designed chiefly to overcome the factors limiting the yield of tea, and to achieve the objectives outlined under the preceeding paragraph. The main projects include (a) multiplication and extension of tea seedlings for filling up missing plants on existing plantations, (b) Advocation of use of calcium cyanamide and extension of lupine as green manure on tea plantations, (c) introduction and experimentation of new green manure crops and ground covering crops, (d) multiplication and extension of Acacia as shading trees on tea plantations, and (e) demonstration of improved tea plantation management methods.

## Literature Cited

1. Bureau of Inspection & Quarantine, Taipei, Taiwan, Unpublished data.

2. Chen, K. R. Report on Tea Production and Tea Export from Taiwan. June 6, 1953 English, mimeographed.

3. Department of Agriculture and Forestry, Provincial Government of Taiwan, China. Report on a Survey of Tea production Capacity of Taiwan (JCRR project TW-M-14). May, 1952 Chinese with English table headings.

4. Hsi, L. T. and Chang, S. C. A report on Soil Fertility and Soil Survey in Taiwan. Figure 9, The Reaction of Soils in Taiwan. Taiwan Fertilizer Co. Technical Bulletin, No. 5. June, 1951 Chinese.

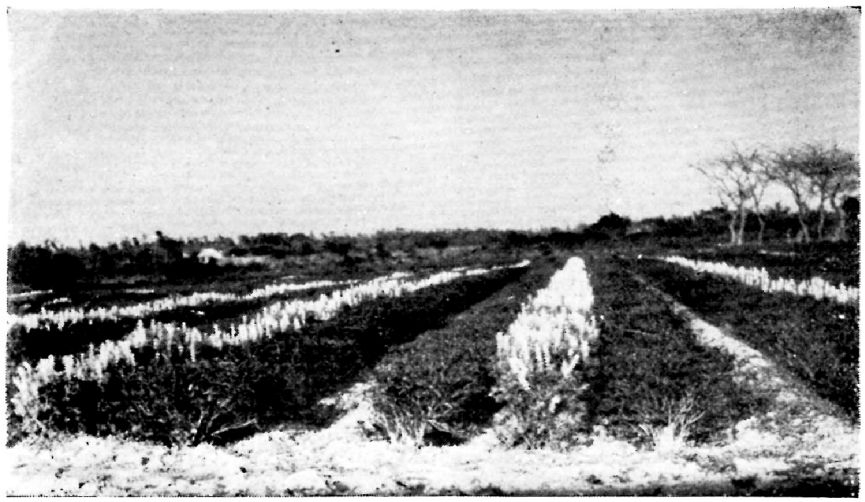
5. Pincheng and Yutze Tea Research Institutes, Taiwan Tea Corporation. Abstracts of Results of Experiments (1910-1951) on Tea. March, 1952 Chinese.

6. Portsmouth, G. B. The Role of Green Manuring in the Maintanence of the Fertility of Tea Soils. The Tea Quarterly of the Tea Research Institute, st. Coombs, Talawakelle, Ceylon Vol 22, Part 3, Sept. 1951.

7. ----------. The Weed Problem on Tea Estates. same as (5).

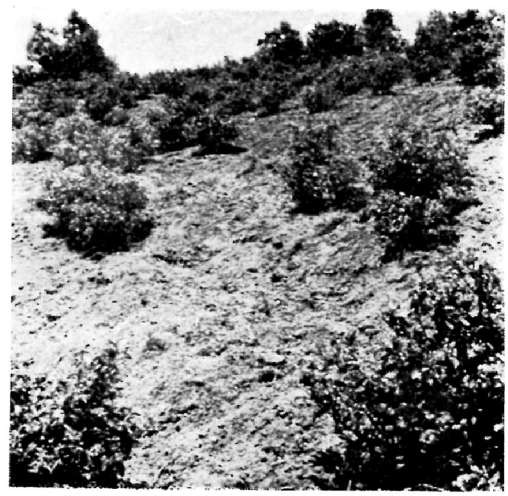
8. Statistical Section, Department of Agriculture and Forestry, Provincial Government of Taiwan, China. Preliminary Release of Statistics on Acreage and Production of Major Crops in Tiwan in 1952. Released in May, 1953. Chinese, mimeographed.

9. Rural Economics Division and Plant Industry Division, JCRR. A memorandum to Dr. T. H. Shen of JCRR on "The Problem of Support Prices for Tea and Tea Exports". June 26, 1952. English, mimeographed.

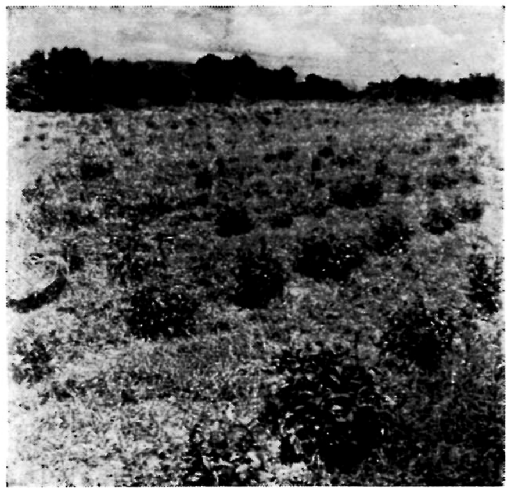


Well prunned tea shrubs, with Lupine grown between tea rows. Note the relatively small amount of land exposure.

High degree of missing plants and lack of ground cover heave much land exposed and vunerable to soil erosion.



Cultivation and weeding on hillside lossen the surface soil and induce soil erosion.



Weeding is necessary for the immediate well being of the tea shrubs. Picture shows a weedy plantation.

Weeding and cultivation, however, are friends of erosion. Note in the picture how the root stumps are exposed half a foot above the soil as a result of soil erosion.

Over-plucking stunts the growth of the tea shrubs, reduces the yield, and makes plucking a back-breaking inefficient job.

Girls plucking tea at comfortable waist-height from prunned surface of well nurished shrubs.