August 9, 1966

To the Graduate Council:

I am submitting herewith a thesis written by Paul Kun-Yuan Kau entitled "An Economic Evaluation of the Development of Taiwan's Postwar Agricultural Productivity." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

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Major Professor

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AN ECONOMIC EVALUATION OF THE DEVELOPMENT OF TAIWAN'S POSTWAR AGRICULTURAL PRODUCTIVITY

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

---

by

Paul Kun-Yuan Kau

August 1966

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CHAPTER I

INTRODUCTION

I. THE PROBLEM

To pursue better living is the instinct of human beings. Usually the level of living standard of a nation depends directly upon the level of its economic development. In underdeveloped countries, the standard of living of most people is at or even below the level of subsistence. Therefore, in recent years, especially after World War II, the problem of economic development has attracted attention and interest of less-developed and developing countries. To promote the people's living standard and economic welfare are desirable, not only from economic and political points of view, but also for social and humanitarian reasons.

The motivation for undertaking this study was obtained from the statement of the U. S. Department of State on May 28, 1965:

> Because of the healthy economic growth of the Republic of China on Taiwan, the Agency for International Development is planning to terminate its programs there at the end of next fiscal year, that is June 1966. . . .[1]

---

[1]Richard I. Phillips, "United States Ends Grant Aid to the Republic of China," U.S.D.S. Bulletin 50, 1964, p. 934.

On the other hand, in the statement also:

> . . . Since 1953 the country's gross national product has increased at a rate of more than 6 per cent per year. Agricultural production has increased 4 per cent annually, and industrial production between 10 and 12 per cent annually. . . .[2]

In addition, Professor William I. Myers, formerly dean of the New York State College of Agriculture, Cornell University, described:

> Taiwan has made remarkable progress in moving from a dependent colonial status to a nearly self-supporting national economy since the end of the war. Agricultural output has increased more than 50 per cent above the prewar level, while industrial production has trebled. Exports have risen nearly two-thirds. National income has doubled, and in spite of an increase of one-third in population, per capita income has risen about one-half. In fact, Taiwan ranks next to Japan and Western Germany in the rate of over-all economic growth since the war. . . .[3]

In view of all of the above and the fact that agriculture still constitutes the mainstay of the economy of Taiwan, the following questions need to be answered: (1) What is the present situation of Taiwan's agriculture? (2) To what degree has the postwar development occurred as compared with the prewar level? (3) How has Taiwan achieved its present level of agricultural development with respect to its agricultural characteristics? (4) What implications

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[2] Ibid.

[3] T. H. Shen, Agricultural Development on Taiwan Since World War II (Ithaca, New York: Cornell University Press, 1964), p. v.

are behind the postwar agricultural development of Taiwan? (5) What are some potential problems in the future of Taiwan's agricultural development?

II. OBJECTIVES OF THIS STUDY

In accordance with the problems stated above, the objectives of this study are: (1) to provide general knowledge of Taiwan's agricultural development with special emphasis on the postwar period, (2) to analyze the major factors fostering the remarkable development and examine the methods and functions of their contributions, and (3) to identify the implications for further planning of Taiwan's agricultural development and to reveal some data that may be helpful for other underdeveloped countries in the tropical and subtropical areas.

III. SCOPE AND NATURE OF THE STUDY

This study, in the vertical sense, contains a report of Taiwan's agricultural development for the postwar period, more precisely from 1947 to 1964, although the analysis of the prewar period is included for comparison with these two periods. In the horizontal sense, this study includes the entire Province of Taiwan, including all its small islands. In addition, this study of Taiwan's agricultural development was undertaken from the aspect of agricultural production.

Since the land available for agriculture in Taiwan is quite fixed, this study is specifically focused on an analysis of the development of agricultural productivity.

The nature of this study is both quantitative and descriptive. The quantitative analysis was adopted where the nature of the problems and data permitted it. Otherwise, descriptive analysis was used.

IV. THE PROCEDURE

The present study begins with obtaining a thorough idea of Taiwan's postwar agricultural development by analyzing the aggregate annual growth rates for the whole period and comparing the prewar and postwar periods with emphasis on agricultural productivity as the first step in Chapter II.

Chapters III, IV and V contain the analyses of the major factors and their functions or contributions to the development of agricultural productivity. Chapter III is devoted to the study of the aspects of governmental factors, including agricultural programs and plans; Chapter IV includes the analysis of the organizational factors; and Chapter V is concentrated on the contributions of technical factors to the development of Taiwan's agricultural productivity.

In the last chapter, Chapter VI, the implications for

Taiwan and other developing countries are stated, and possible problems that may be faced in the future of Taiwan's agriculture are discussed. Finally, conclusions are reached.

CHAPTER II

THE DEVELOPMENT OF AGRICULTURAL PRODUCTIVITY OF TAIWAN

I. GEOGRAPHY AND NATURAL CONDITIONS OF TAIWAN

Taiwan, a province of The Republic of China, is an island located about 1,000 miles south and west of Japan and 90 miles off the coast of the China mainland. It resembles a tobacco leaf in shape and is about 240 miles long and 90 miles wide at its broadest point. Its total land area is 13,836 square miles and the present total population is about 12.5 million.

The Tropic of Cancer bisects the island approximately 90 miles north of its southern end. As a result, the climate on Taiwan is tropical in the south and subtropical in the north. The seasonal contrasts in temperature are marked. However, the average annual temperatures are 95.7 F. at Kaohsiung in the south and 70.9 F. at Taipei in the north. The average annual rainfall in the important agricultural regions is about 80 inches, but unevenly distributed seasonally. An average of two or three destructive typhoons plague the island each year between June and October and inflict serious damage to the land and crops of Taiwan's

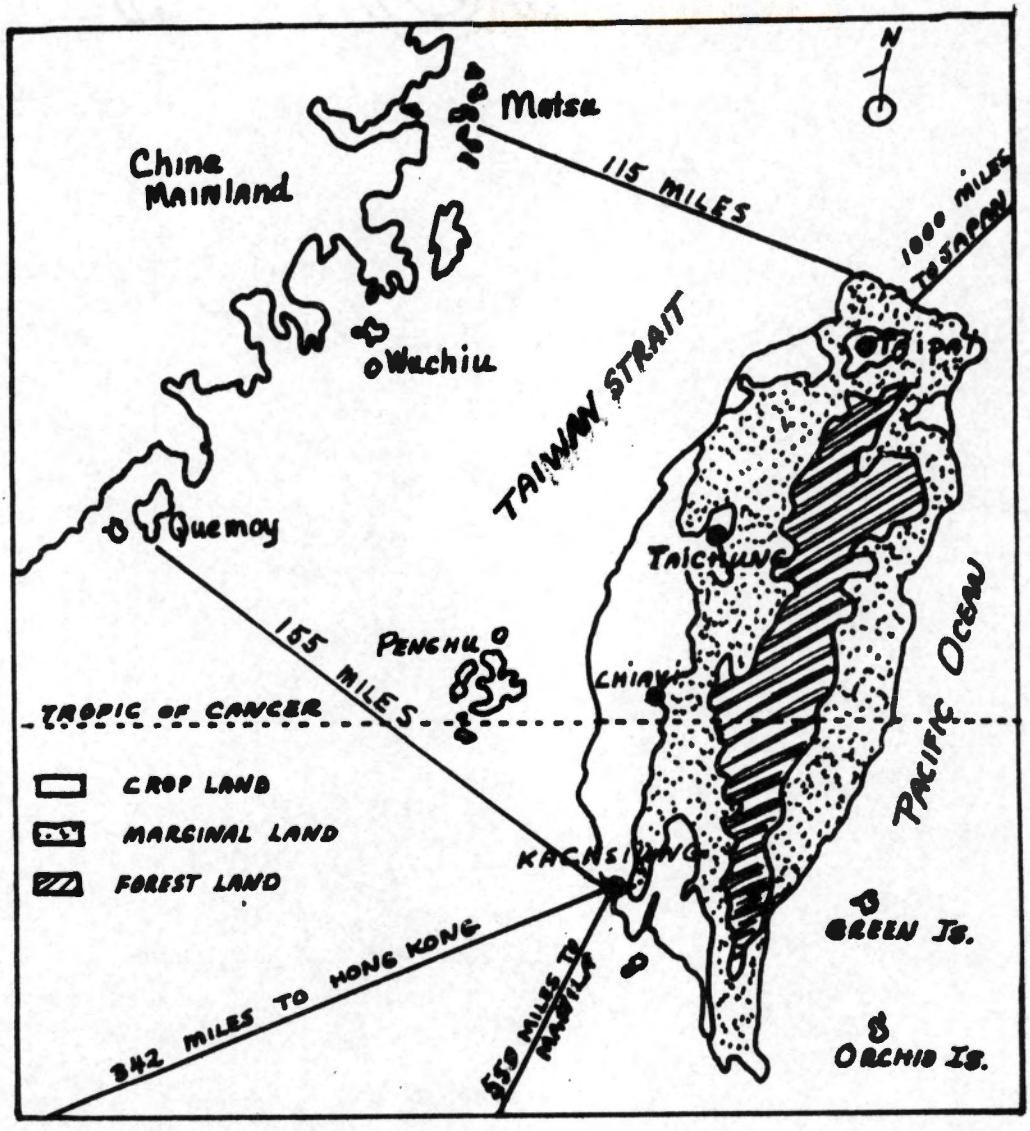


Figure 1. Province of Taiwan, Republic of China.

Source: T. H. Shen, Agricultural Development on Taiwan Since World War II (Ithaca, New York: Cornell University Press, 1964), p. 3.

agriculture. Approximately 55 per cent of the total area is covered by forest and only 24 per cent is suitable for agriculture. Of the cultivated area, about 63 per cent is under irrigation.

Nearly two-thirds of Taiwan is occupied by the Central Mountain Range from north to south. From the mountains down to the plains, the different altitudes provide cold, temperate, subtropical, and tropical climates. Therefore, many different crops can be grown. These crops offer a number of opportunities but also demand a high level of technology and intensive farming operations for the successful development of agriculture.

II. THE CHARACTERISTICS OF TAIWAN AGRICULTURE

Taiwan is still predominantly agricultural with about 45 per cent of its total population on farms and 55 per cent of its employment in agriculture.

In 1964, the average size farm was 3 acres. More precisely, about 50 per cent of the farms were less than 2 acres in size, another 33 per cent were 2 to 5 acres, and less than 0.5 per cent were over 25 acres. Owing to large farm family system, the average land which an individual farmer cultivates is about 0.6 acres. In regard to tenancy in 1961, about 66 per cent of the farms were fully-owned,

21 per cent were partially-owned, and 13 per cent were tenant-operated.

The major crops grown are rice, sweet potatoes, and sugarcane. Peanuts, corn, soybeans, tea, pineapples, bananas, citrus fruits, jute, tobacco, wheat, and cassava are grown, but of less importance.

Farming is highly intensive and more advanced than any Asian country except Japan. Almost all the farms are cropped twice a year, and some farmers even raise three or four crops per year.

The potential for new agricultural land is very limited or almost non-existent. The population is still expanding with a high annual growth rate of 3.3 per cent. The above are some of the problems facing Taiwan's agriculture and challenging the agricultural economists today.

III. A BRIEF ANALYSIS OF THE DEVELOPMENT OF TAIWAN'S AGRICULTURAL PRODUCTIVITY

The agricultural production of Taiwan has made remarkable progress and has been experiencing a rapid development since the end of World War II. The Taiwan official statistics showed that agricultural output of Taiwan regained its prewar level by 1951, and has increased an

additional 78 per cent between 1952 and 1964.[1]

The development of agricultural production, according to Hsieh and Lee,[2] can be roughly classified into the following five periods:

The first period was from 1910 to 1920. This was an initial stage of agricultural development under Japanese colonial rule of Taiwan. During this period, the average annual growth rate of agricultural output was approximately 1.4 per cent. The main contributing factors providing this development were: (1) import of Japanese capital and techniques and (2) expansion of cultivated land.

The second stage was from 1920 to 1939. This was a continued development of agriculture under Japanese colonial rule of Taiwan. During this period, the agricultural output continued expanding with more efficient utilization of Japanese capital and techniques, but the attention was focused on the promotion of the unit yields of crops. The average annual growth rate of agriculture was 4.50 per cent in this period.

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[1] Economic Progress in the Republic of China (Publication of the Council for International Economic Cooperation and Development, Executive Yuan, 1965), pp. 1-5.

[2] S. C. Hsieh and T. H. Lee, An Analytical Review of Agricultural Development in Taiwan (Chinese-American Joint Commission on Rural Reconstruction, Economic Digest Series: No. 12, 1958), pp. 1-3.

The third period was from 1939 to 1945. From an economic point of view, this was an abnormal period. The whole economy of Taiwan was affected by World War II, and agriculture experienced a downward trend of both output and input use, particularly fertilizer use. The average annual growth rate of agriculture was a "negative 12.33 per cent."

The fourth period was from 1945 to 1952. This was a recovery and rehabilitation stage of agricultural development after the war. Taiwan took about six to seven years to accomplish the full recovery of its agriculture from the war damage and regained its prewar level by 1952. The average annual growth rate for agriculture in this period was about 12.90 per cent. The major factors contributed to this recovery were:

1. Contributions of higher qualified economists, agriculturalists, engineers, and administrators and a large quantity of labor from the mainland.
2. Extensive rehabilitation and expansion of irrigation facilities.
3. Introduction of improved and new technology and seeds.
4. Greater application of chemical fertilizer.
5. Excellent technical assistance and financial aid of the Chinese-American Joint Commission on Rural Reconstruction.

6. Enforcement of the land reform program.

The fifth and last period was from 1952 to 1964. This is a further agricultural development stage after the rehabilitation. In this period, Taiwan's agriculture has been facing the challenge of further development of output and technical potentials to meet the needs of increasing population and industrialization of the Island. The average annual growth rate of agriculture for the period was 5.90 per cent according to K. T. Wright's report.[3] The important contributing factors during this period will be presented and discussed more thoroughly in the following chapters.

The development periods and the average annual growth rates of agricultural development which were discussed in the previous paragraphs are summarized in Table I.

As mentioned before, the major crops of Taiwan are rice, sweet potatoes, and sugarcane. The per cent of the three major crops in total agricultural production is shown in Table II. The three major crops are used as examples in Tables III and IV to examine and compare the general development of Taiwan's agricultural productivities between prewar and postwar periods.

From Table III, it is obvious that the unit cropped

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[3]K. T. Wright, "Taiwan's Postwar Agricultural Development," Agricultural Economics Report, No. 19 (Michigan State University, East Lansing, Michigan, 1965), p. 5.

TABLE I

AVERAGE ANNUAL GROWTH RATE OF AGRICULTURAL OUTPUT IN DIFFERENT PERIODS OF AGRICULTURAL DEVELOPMENT IN TAIWAN, 1910-1964

Periods of Development		Years	Average Annual Growth Rates: Agricultural Output	Total Population
I.	Initial stage of agricultural development under Japanese Colonial rule of Taiwan	1910-20	1.40	1.3
II.	Continued development of agriculture under Japanese Colonial rule of Taiwan	1920-39	4.50	2.40
III.	Agricultural development under the impact of World War II	1939-45	-12.33	1.00*
IV.	Recovery and rehabilitation stage of development of agriculture after the War	1945-52	12.90	3.80
V.	Further development of agriculture after the rehabilitation stage	1952-64	5.90	3.50

*The low rate of population growth in this period was due mainly to the effects of war and the return of Japanese to their homeland after the war.

Source: K. T. Wright, "Taiwan's Postwar Agricultural Development," Agricultural Economics Report, No. 19 (Michigan State University, East Lansing, Michigan, 1965), p. 5.

TABLE II

PER CENT OF MAJOR CROPS IN TOTAL VALUE OF AGRICULTURAL PRODUCTION OF TAIWAN, 1961

Major Crops*	Per cent
Rice	44.33
Sweet potatoes	8.66
Sugarcane	6.23
Soybean	1.34
Tea	1.26
Tobacco	1.51

*Crops other than these six crops were less than 1 per cent in total agricultural production and were omitted in this table.

Source: Taiwan Agricultural Yearbook, 1962, pp. 32-33.

TABLE III

INDICES OF AREA, PRODUCTION, AND YIELD PER HECTARE OF THREE MAJOR CROPS OF TAIWAN IN THE PREWAR PERIOD (1901-10 = 100)

	Rice			Sweet potatoes			Sugarcane		
Period	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
1901-10	100	100	100	100	100	100	100	100	100
1911-20	112	117	104	124	128	103	323	306	95
1921-30	128	154	120	137	183	134	371	608	164
1931-40	152	220	145	149	251	168	387	1,155	298

Source: Charles Hsi-Chung Kao, "The Role of the Agricultural Sector in Taiwan's Economic Development" (unpublished Doctor's dissertation, Michigan State University, East Lansing, 1964), p. 50.

TABLE IV

AREA, PRODUCTION, AND YIELD PER HECTARE OF THE THREE MAJOR CROPS OF TAIWAN IN THE POSTWAR PERIOD

Period	Rice			Sweet Potatoes			Sugarcane		
	Planted Area	Production	Yield per hectare	Planted Area	Production	Yield per hectare	Planted Area	Production	Yield per hectare
Peak Before the War	(1938) 625	1,402	2,242	(1937) 140	1,770	12,734	(1939) 162	12,835,395	79,039
	(1,000 hectares)	(1,000 metric tons)	(kg.)	(1,000 hectares)	(1,000 metric tons)	(kg.)	(1,000 hectares)	(1,000 metric tons)	(kg.)
1947	678	999	1,474	213	1,783	8,354	30	796	26,618
1948	718	1,068	1,489	224	2,003	8,932	85	3,113	36,557
1949	748	1,214	1,624	236	2,166	9,172	122	6,194	50,606
1950	770	1,421	1,845	233	2,201	9,443	122	5,861	48,064
1951	789	1,485	1,882	231	2,022	8,737	79	3,585	45,237
1952	786	1,570	1,998	234	2,090	8,953	98	4,801	49,003
1953	778	1,641	2,109	238	2,277	9,576	113	8,394	74,136
1954	777	1,695	2,183	248	2,557	10,328	96	6,310	65,950
1955	751	1,615	2,151	246	2,437	9,928	78	6,089	78,121
1956	784	1,790	2,284	230	2,568	11,154	91	6,343	69,782
1957	783	1,839	2,348	229	2,693	11,774	98	7,083	72,110
1958	778	1,894	2,434	227	2,958	12,934	101	7,521	74,142
1959	776	1,856	3,392	226	2,894	12,778	99	8,093	81,571
1960	776	1,912	2,495	235	2,979	12,654	96	6,736	70,505

TABLE IV (continued)

Period	Rice			Sweet Potatoes			Sugarcane		
	Planted Area (1,000 hectares)	Production (1,000 metric tons)	Yield per hectare (kg.)	Planted Area (1,000 hectares)	Production (1,000 metric tons)	Yield per hectare (kg.)	Planted Area (1,000 hectares)	Production (1,000 metric tons)	Yield per hectare (kg.)
Before the War									
1961	783	2,016	2,577	236	3,234	13,713	100	7,922	79,082
1962	794	2,113	2,660	234	3,080	13,180	93	6,142	65,597
1963	749	2,109	2,815	236	2,148	9,469	94	6,507	69,145
1964	765	2,247	2,937	246	3,348	13,599	95	6,747	70,999

Source: Taiwan Economic Statistics (reprinted from Industry of Free China, Vol. XXIII, No. 5), 1965, pp. 70-72. Indices are computed from the same source taking 1947 as base period.

land productivities of rice, sweet potatoes, and sugarcane did not improve much in the initial stage (1910-1920), but had a tremendous increase in the next stage. The main reasons and the major contributing factors were described in previous paragraphs and are not repeated here.

During wartime and the first year after the war, 1940-1946, the Island's economy was almost completely collapsed. Therefore, this period is skipped in the analysis because of its abnormal situation. The postwar development of unit cropped land productivities of the three major crops is presented in Table IV.

After World War II, the restoration and the increase of the production of rice and sweet potatoes were considered as the first target in order to meet the extra needs for food of the two million people from the China mainland and the rapidly expanding population on the Island. The total output of rice has been exceeding the peak of its prewar production since 1950 and its yield per hectare was restored to the peak of prewar period by 1956. The production of sweet potatoes made the fastest recovery among the three, reached "the prewar peak" in the next year after the war, and has continued increasing. The per hectare yield of sugarcane regained its prewar peak by 1955, but its planted area and total output have not been restored to their prewar peaks because of the shifting of a considerable portion

of its planted area for the production of rice and sweet potatoes since the end of the war.

A trend of the yields per hectare of aggregate agricultural crops of Taiwan during the postwar period is shown in Figure 2.

The aggregate index in Figure 2 was computed by using the Laspeyres Formula:

$$\text{Index} = \frac{\sum V_0 Y_1}{\sum V_0 Y_0}$$

where V_0 is the production value of each crop in the base period, 1950-52. Y_0 is the per hectare yield of an individual crop in the base period. Y_1 is the per hectare yield of an individual crop in any given year. The data were obtained from the Taiwan Agricultural Yearbook, which included data on 76 crops. The development of Taiwan's unit cropped land productivity, as shown in Figure 2, has been increasing with a steady upward movement after the war.

In order to acquire a more thorough concept of the development of agricultural production in Taiwan, a relative comparison of the index number of total agricultural production is provided in Table V.

In general, the agriculture of Taiwan has experienced a long upward trend of output, except a short-run downward movement during the period of World War II. Relatively speaking, the prewar period showed a moderate increase in total output, but the postwar period has had a rather rapid increase in the total agricultural production.

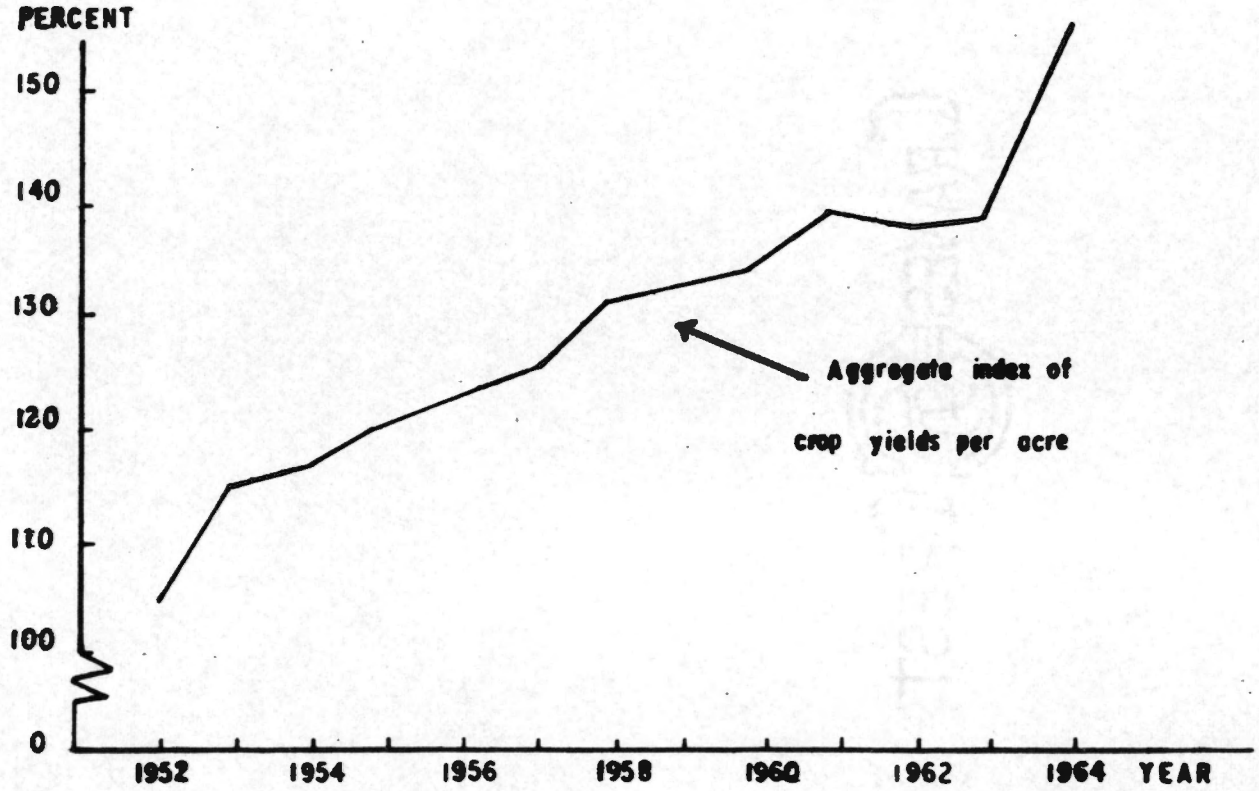


Figure 2. Aggregate index of crop yields per hectare. Base period: 1950-52.

Source: T. H. Shen, "Agricultural Development in Free China" (a report from Chinese-American JCRR, 1965), p. 4-c.

TABLE V

INDEX OF AGGREGATE AGRICULTURAL PRODUCTION OF TAIWAN, 1901-1964 (1935-37 = 100)

Period and year	Index	Period and year	Index
1901-1905	12.0	1949	90.9
1906-1910	14.2	1950	102.6
1911-1915	19.0	1951	104.7
1916-1920	36.3	1952	112.9
1921-1925	48.7	1953	126.3
1926-1930	60.6	1954	126.8
1931-1935	68.9	1955	124.8
1936-1940	100.1	1956	136.9
1941	92.3	1957	159.9
1942	94.0	1958	172.9
1943	90.3	1959	176.8
1944	78.6	1960	175.9
1945	48.4	1961	194.5
1946	55.7	1962	197.0
1947	68.3	1963	204.0
1948	77.1	1964	223.5

Source: The prewar period, 1901-40, is computed into 1935-37=100 based on the data in Charles Hsi-Chung Kao's dissertation, p. 49. The period of 1957-64 is computed from Taiwan Economic Statistics, p. 68. The period of 1935-56 is adopted from Hsieh and Lee, An Analytical Review of Agricultural Development in Taiwan, p. 33.

If two regression lines are drawn for the prewar and the postwar periods, respectively, as shown in Figure 3, it can be seen that the two regression lines intersect at 1956. This indicates that Taiwan's postwar agricultural production recovered to the long-run trend output by 1956, even though it had regained the peak of prewar output in 1951.

In Figure 3, the sharp decrease in output in 1940 was due to an unusually heavy typhoon damage. The longer drop from 1942 to 1945 was directly affected by the war (Japan joined the war in December, 1941, and Taiwan was under Japanese rule at that time). The rapid increase of output after the war was mainly due to the extension of rice seed in 1947, the use of new insecticides and the first four-year plan in 1953, the second four-year plan in 1957, and the third four-year plan in 1961. However, the major factors affecting Taiwan's postwar development of agricultural production will be discussed in more detail in Chapters III, IV, and V.

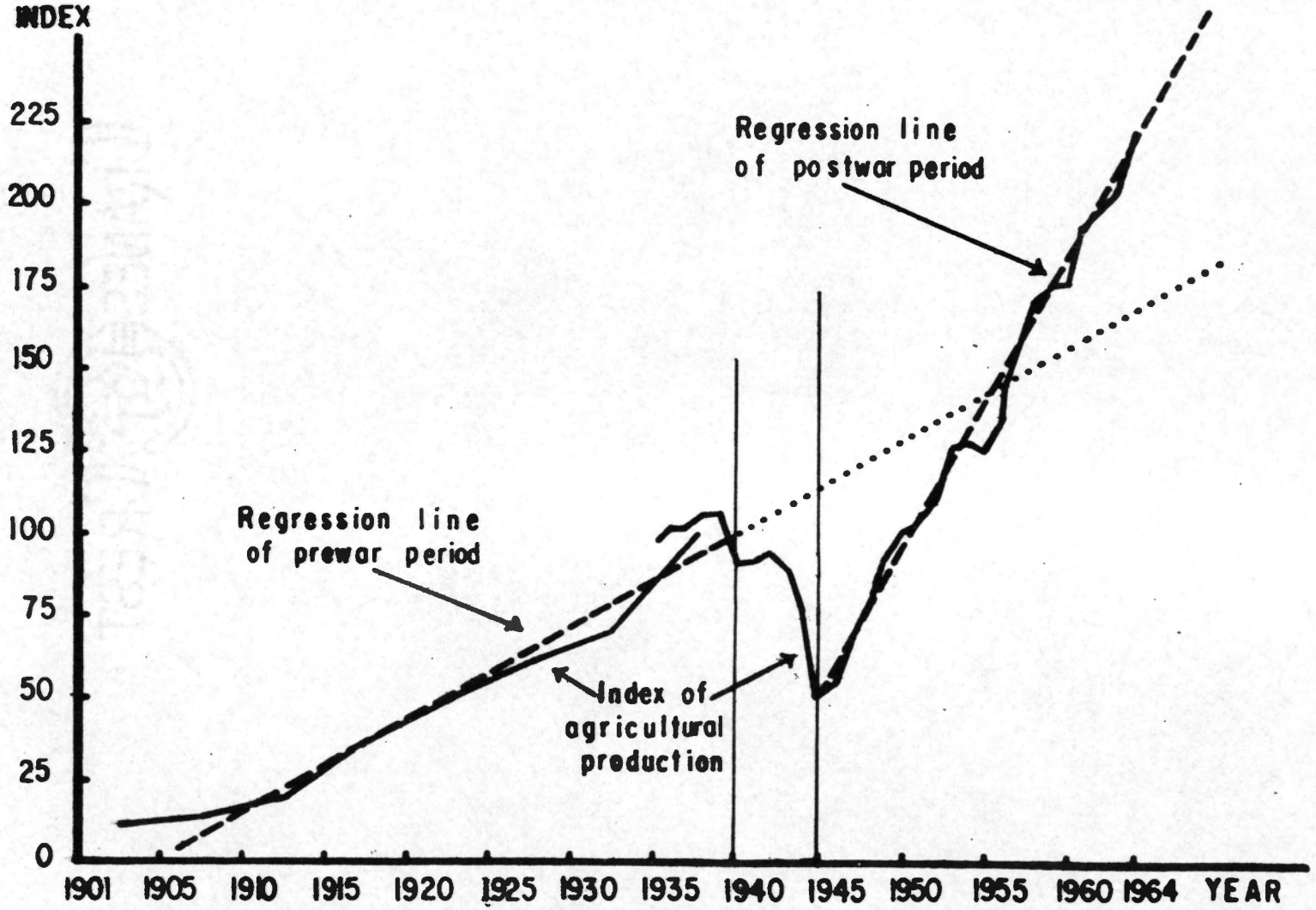


Figure 3. Index of agricultural production of Taiwan, 1901-1964. Base period: 1935-37.

CHAPTER III

THE EFFECTS OF AGRICULTURAL PROGRAMS AND PLANS ON THE DEVELOPMENT OF TAIWAN'S POSTWAR AGRICULTURAL PRODUCTIVITY

I. LAND REFORM

Taiwan's land reform was part of the realization of the basic agricultural policy of the Republic of China--"Equalization of Land Rights," which is a part of the Three Principles of the People--the highest guiding principle for national construction and development, advocated in 1896 by Dr. Sun Yat-Sen, the founder of the Chinese Republic.

Land reform in Taiwan consisted of the rural land reform and the urban land reform. In this study, the latter is omitted and attention is given only to the rural land reform which caused direct effects on the agricultural productivity of Taiwan.

Importance of the Rural Land Reform

Before the introduction of land reform in 1949, of the total tenancy distribution in Taiwan, tenant farmers composed approximately 39 per cent of the total farming population, about 25 per cent were partially-owned farms, and only 36 per cent of the farms were fully-owned.

Therefore, the tenancy system was quite predominate in the rural area. Besides, the tenancy conditions were extremely harsh to the farmer. Usually rents were more than 50 per cent of the harvest. In the more fertile areas, the rent ran as high as 70 per cent of the harvested crop. The rent also extended to by-products in some cases. Only a small proportion of leasings was done with signed contracts; most of them were oral and without any definite period of time. In addition, the tenants had to furnish their own farm equipment, seed, fertilizer, and farm buildings. Taking all these together, the tenants paid high rent and cost with most of their fruits and benefits going to the landlord. Also, this method of farming (tilling the land that did not belong to them) provided no security or encouragement for the tenants to have a special love for the soil and their farms. Under such an unreasonable situation, it was impossible to expect the improvement of farm land and to hope for an increase in farm production. This was the reason why the land reform was urgently needed in the rural area at that time. It is also clear that land reform itself consisted of a very valuable incentive from an economic point of view.

Under the above mentioned unfavorable situation, the tenants had to live in misery in spite of the year-long efforts in the fields, while the landlord could live very comfortably without working. The results of this fact were

discontent and unrest in the rural region and a serious conflict between social classes. In order to maintain the social justice and to prevent the Communist infiltration, land reform was carried out with both social and political consideration taken into account.

Objective and Main Steps of Land Reform

The ultimate objective of rural land reform was to realize the "land-to-the-tiller" ideal so that the fruits of labor could be enjoyed by the cultivator himself. In order to achieve this aim without failure, the Government proposed a peaceful and reasonable program step by step in a democratic way. The important steps of the land reform program in the rural areas are briefly described in the following.

Farm rent reduction. The farm rent reduction program was put into effect by the former Governor of Taiwan Province, Chen Cheng, in March, 1949. It actually included a twofold purpose, namely reduction of farm rent and increased security of tenancy. The new reformed rental rate was set at 37.5 per cent of the annual main crop which was given a "standard yield" in advance by the Government according to the fertility and productivity of the farm. Therefore, after the enforcement of this program, the rent paid by the tenant was definitely fixed, and all the surplus outputs over this amount belonged to the tenant. This

served as a great stimulus to the farmers to increase production.

The ways of providing security of tenancy for the farmers were: (1) the farm lease contracts had to be written and the least period was not to be shorter than six years; (2) the landlord might not terminate the contract except for legally specified reasons; (3) the contract should be renewed at the request of the tenant, unless the lessor should take the land for his own cultivation; and (4) in case the lessor should give up the right of ownership to a third party, the contract would remain valid with respect to that third party.[1]

Sale of public farm land. This second phase of land reform began in 1951. The purpose of this program was to distribute the 180,000 hectares, or about 20 per cent of the total cultivated land, of public land which the Chinese Government took over from the Japanese Government and Japanese Nationals to the farm families. The first priority was given to those who would till the farm by themselves. The price was fixed at 2.5 times the amount of annual main crop yield. The farmer could pay the purchase price in semi-annual installments spread over ten years without interest.

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[1]Chen Cheng, Land Reform in Taiwan (China Publishing Company, 1961), pp. 18-23.

The financial burden of a tenant purchaser, including both the installment payments and the farm land tax, should not be higher than the 37.5 per cent of the farm rent paid by tenant farmers on private lands. The greatest portion of government income from these sales was set aside as funds to assist the implementation of the land reform program. According to the official report, about 63,000 hectares of public land were sold to 122,000 farm families under this phase of the program.[2]

Land-to-the-tiller program. After having increased the farmer's income by farm rent reduction in 1949 and having set an example to landlords by the sale of public farm land in 1951, the Government started to require private landowners to sell their excess land to tenants.

The Government conducted a general survey of landholdings to ascertain the actual distribution of land ownership throughout the whole province as a preliminary step of this program. Based on this survey, the Taiwan Provincial Government drew up the provisions and enacted the "Land-to-the-Tiller Act" in January, 1953.

The main provisions of the Act can be summarized as follows:

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[2]T. H. Shen, Agricultural Development on Taiwan Since World War II (Ithaca, New York: Cornell University Press, 1964), p. 42.

1. Each landlord was permitted to retain 3 hectares of medium-grade paddy land or twice that much dry land. Acreage exceeding that limit should be purchased by the Government and resold to tenant farmers. Religious institutions were allowed to retain double the area as that permitted for individual landlords.

2. The purchase price, set at 2.5 times the annual main crop value, shall be paid by 30 per cent in government enterprise stocks, and 70 per cent in land bonds which shall bear interest at an annual rate of 4 per cent and shall be redeemable in twenty equal semi-annual installments including interest.

3. The resale price paid by a purchasing farmer was the same as the purchase price. Paddy land should be paid in rice, while dry land should be paid in cash equivalent to the market price. The total annual financial burden of a purchasing farmer should not be more than 37.5 per cent of his main crop yield.

4. A farmer can own any amount of land he actually operates with his family labor.

5. The farmer who purchases the land acquires ownership of the land after his first payment, but may not transfer or sell the land until he has paid the price in full.

This Land-to-the-Tiller Program was completed in January, 1954. About 55 per cent of the total private

tenanted lands had been purchased by the Government and resold to 194,823 farmers.

As T. H. Shen, the present chairman of JCRR, described:

> . . . It was supported by the public. The tenant is grateful to the government for the realization of his cherished dream of owning the land he and his forefathers have tilled for decades. . . .[3]

Contributions to Taiwan's Agricultural Productivity

After the enforcement of the rent reduction program, the farm rent which a tenant farmer has to pay was fixed at a rate of 37.5 per cent of annual main crop yield regardless of his harvest. All surplus above this fixed rent went to the tenant himself. Therefore, farmers would exert their best and try all the ways they could to increase their farm output. As a result, the total agricultural production has increased under such an incentive situation as shown in Table VI.

Taking 1953, the year the Land-to-the Tiller Program was implemented as the base year, the total agricultural production index was 59.8 in 1948, 76.4 in 1950, and 171.9 in 1964. Take the production of rice, the most important agricultural production of Taiwan for example, the output index was 65.1 per cent in 1948 and was 86.5 in 1950,

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[3] Ibid., p. 44.

TABLE VI

INDICES OF SELECTED AGRICULTURAL PRODUCTION IN SELECTED YEARS (BASE PERIOD: 1953)

Year	Total	Crops	Livestock	Rice
1948	59.8	64.8	30.8	65.1
1950	76.4	85.0	56.5	86.5
1953	100.0	100.0	100.0	100.0
1956	111.3	105.0	113.0	98.4
1960	135.3	122.1	138.2	112.9
1964	171.9	151.3	171.1	136.9

Source: Taiwan Economic Statistics (reprinted from Industry of Free China, Vol. XXIII, No. 5, 1965), pp. 68-69.

increased 21.5 per cent during only two years after the rent reduction, and had increased to more than double that of 1948 by 1964. The total production of agricultural crops also increased about 20 per cent during the two years immediately after the rent reduction.

Another result of land reform was the increase in returns to family labor. The rent reduction and the increase in the number of owner-farmers enabled the farmers to receive a larger proportion of farm income for their family labor. From 1950 to 1955, net farm income was increased about four times. The increased income was used by the farmer in either consumption or production purposes.

In the consumption phase, the farmers used their income for improvement of their living, such as sufficient food and better nutrition, as well as for providing better education for their children. Both of these ways contributed to improving the human factor and resulted in promoting labor productivity in the long run. According to a study conducted by JCRR,[4] labor productivity advanced 13 per cent from 1950 to 1955.

In the production phase, the major portion of the increased income was utilized in agricultural investment. The increase in agricultural investment made by the farmer was

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[4] Ibid., pp. 44-45.

also stimulated by two other factors, namely, the incentive of promotion in production induced from rent reduction and the acquirement of the land ownership bestowed from Land-to-the-Tiller Program.

Since the implementation of the Land-to-the-Tiller Program, farm families owning all or part of their land in Taiwan increased from 61 per cent in 1949 to 86 per cent in 1961 of the total farm families. Owner-operated land in the whole Province also increased from 59 to 90 per cent from 1949 to 1961. Most of the farmers in Taiwan are now tilling their own land. When the farmers were cultivating land that belonged to other landlords, they frequently hesitated to make agricultural investment of a permanent nature. After the Land-to-the-Tiller Program, all the fruits of their investment were to be enjoyed exclusively by themselves. As a matter of course, farmers usually expand their agricultural investment in order to improve their farm land use and implements. In the earlier period, from 1950 to 1955, the working capital, mainly for fertilizer, feed, and pesticides, increased about 75 per cent. Since the implementation of Land-to-the-Tiller Program, the fixed capital has greatly increased. This fact can be observed from Tables VII and VIII.

As a result of the increase in agricultural investment, the productivity of agricultural resources, especially

TABLE VII

FACILITIES EMPLOYED TO IMPROVE FARM LAND USE BEFORE AND AFTER THE IMPLEMENTATION OF THE LAND-TO-THE-TILLER PROGRAM IN TAIWAN

Item	July 1949-June 1953		July 1953-June 1956		July 1956-June 1960	
	Quantity	Annual Average	Quantity	Annual Average	Quantity	Annual Average
Storage of compost (in 1,000 short ton)	193,521	48,130	249,733	62,433	191,018	63,673
Water pumps bought	311	78	2,484	621	1,914	638
Well sunk	1,124	281	4,343	1,086	5,183	1,727
Windbreaks planted (in 1,000 feet)	435	109	1,108	277	1,294	431

NOTE: The figures in this table are based on statistical materials of an investigation made of 284,590 farming families purchasing public and private farm land throughout the province.

Source: Chen Cheng, Land Reform in Taiwan (China Publishing Company, 1961), p. 85.

TABLE VIII

INCREASE OF FARM IMPLEMENTS, DRAFT CATTLE, AND AGRICULTURAL EQUIPMENTS BEFORE AND AFTER THE LAND-TO-THE-TILLER PROGRAM IN TAIWAN

Item	July 1949-June 1953		July 1953-June 1956		July 1956-June 1960	
	Quantity	Annual Average	Quantity	Annual Average	Quantity	Annual Average
Farm implements:						
Threshers	16,139	4,035	30,616	7,654	33,259	11,086
Winnows	6,709	1,677	11,605	2,901	18,013	6,004
Deep-furrow plows	54,999	13,750	87,232	21,808	83,248	27,749
Ox carts	675	169	10,071	2,518	13,354	4,451
Sprayers	1,565	391	4,327	1,082	21,867	7,289
Handcarts	1,532	383	9,007	2,252	6,884	2,295
Draft Cattle	73,551	18,388	152,564	38,141	120,834	40,278
Agricultural equipment repaired or constructed:						
Drying grounds (1,000 sq. ft.)	12,804	3,201	19,526	4,881	42,422	14,142
Compost houses (1,000 sq. ft.)	2,668	667	11,048	2,762	8,753	2,918
Animal shelters (1,000 sq. ft.)	2,173	543	5,999	1,500	4,626	1,542

NOTE: (1) The implementation of the land-to-the-tiller program in Taiwan began in July, 1953.
(2) The figures in this table are based on the statistical materials of an investigation made of 284,590 farming families purchasing public and private farm land throughout the province.

Source: Chen Cheng, Land Reform in Taiwan (China Publishing Company, 1961), p. 86.

the productivity of unit land was increased. Based on the above-mentioned study, the aggregate productivity of agricultural resources in Taiwan advanced about 7 per cent from 1950 to 1955, of which the unit land productivity advanced 22 per cent and the labor productivity also increased about 13 per cent, but the capital productivity decreased 28 per cent during the period from 1950 to 1955. This fact indicates that the crop and livestock improvements in Taiwan were mainly due to the highly intensive use of land.

The development of Taiwan's postwar agriculture has been a result of joint-effect contributed by many factors instead of by land reform alone. It is extremely difficult to determine to what extent land reform has contributed to the development. However, it is generally believed that the rural land reform program created an immense incentive for agricultural production and has had a very favorable effect on the productivity of Taiwan agricultural resources.[5]

II. THE THREE AGRICULTURAL FOUR-YEAR PLANS

The ultimate success or failure of a development program depends upon whether or not it is wisely and well planned. The postwar agricultural development on Taiwan is

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[5]Chen Cheng, op. cit., pp. 42-43, 82-84; and T. H. Shen, op. cit., p. 46.

a good illustration of this statement. If the three Agricultural Four-Year Plans had not been carried out, Taiwan's agriculture would probably still have been in a less developed state. Hence, it can be seen that the contributions of these agriclutural development plans are indispensable to the development of Taiwan's agriculture.

Due to the destruction of the war, the rehabilitation of Taiwan's economy was desperately needed. A general policy was formed, known as "balanced growth policy," that proposed to develop both the agricultural and the industrial sectors equally. To carry out this policy, the Four-Year Plan was drawn by the Taiwan Provincial Government. Until the Economic Stabilization Board was established with the Premier of the Cabinet as chairman in 1953, Committee D, the Committee of Agricultural Programs in the Board, was assigned to work out the First Agricultural Four-Year Plan covered from 1953 to 1956. It consisted of six main agricultural development programs: namely, food crops, special crops, forest, fisheries, animal industry, and water conservation. After the First Four-Year Plan, the Second and the Third were planned from 1957 to 1960 and 1961 to 1964, respectively.

The objectives of these three 4-year plans were as stated on the Third Agricultural Four-Year Plan:

> The overriding objectives of all the development activities will be to continue to step up the output of crops, forest, fisheries, and livestock products in an effort to achieve the following: (a) self-sufficiency in food supply, as well as better nutrition for a growing population; (b) coordination with U. S. Aid Program to gradually achieve economic self-support in Taiwan, through increase in quantities and varieties of agricultural exports; and (c) giving support to Taiwan's industrialization by providing industry with requisite raw materials of agricultural origin.[6]

From the above, it is obvious that the fundamental and central theme of the agricultural development plans was to promote agricultural production.

Based on these agricultural plans, many production programs were developed. For each production program, Committee D worked out: (a) working policies, (b) specific projects, and (c) regional production goals. In order to illustrate the production programs, the rice production program in the First Agricultural Four-Year Plan can be used as an example. The rice production goal in 1956 was set at 1,850,000 metric tons. To achieve this goal, the first step was to increase rice area from 781,689 hectares to 825,000 hectares through irrigation and other methods. The second step was to increase the yield per hectare from 1,901 to 2,240 kg. through improvements of seed, fertilizer, pest control, and cultural methods. More specifically, each of

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[6]K. T. Wright, "Taiwan's Postwar Agricultural Development," Agricultural Economic Report No. 19 (Michigan State University, East Lansing, Michigan, 1965), p. 31.

these technical items constituted a project and a number of related projects reaching down from the Committee to the farmer at the township or village level. The regional goals were developed annually so that the related local agencies could check and make adjustments each year according to the practical conditions that they faced.

From the per cent of actual achievement shown in Table IX, it is evident that most of the production goals were nearly accomplished. The average per cent of actual achievement was 95.9 per cent during these nine years. Not only the crop production, but all the other agricultural production programs such as forestry, fisheries, and animal industry were well planned and supported with carefully formulated projects. As a result, the planned goal for total agricultural production was almost perfectly reached (0.9 per cent below the goal for 1953-1956 and 1.1 per cent above the goal for 1957-1960), as shown in Table X.

From the above illustration, it is evident that good planning and thorough enforcement are necessary for a successful development program. It may be concluded that land reform laid an excellent foundation for Taiwan's agricultural development and the three agricultural Four-Year Plans promoted it. As T. H. Shen said:

> . . . As a result of these three Four-Year Plans, the aggregate agricultural output of crops, livestock, fisheries, and forest products in 1964 almost doubled that

TABLE IX

GOALS AND ACTUAL PRODUCTION OF BROWN RICE UNDER THE FIRST AND SECOND AGRICULTURAL FOUR-YEAR PLANS

Periods	Production Goal (1,000 metric tons)	Production Achievement (1,000 metric tons)	Per cent Achieved
1950-52 Avg.		1,492	
1953	1,654	1,641	99.2
1954	1,760	1,695	96.3
1955	1,800	1,615	89.7
1956	1,850	1,789	96.8
1957	1,900	1,839	96.8
1958	1,950	1,894	97.1
1959	2,000	1,856	92.8
1960	2,000	1,912	95.6
1961*	2,050	2,016	98.4

*The first year of the Third Agricultural Four-Year Plan.

Source: T. H. Shen, Agricultural Development on Taiwan Since World War II (Ithaca, New York: Cornell University Press, 1964), p. 66.

TABLE X

INDEX OF ACHIEVEMENT OF AGRICULTURAL PRODUCTION GOALS

Items	Periods 1950-52 Average	1953	1954	1955	1956	1953-56 Average	1957	1958	1959	1960	1957-60 Average
All agriculture											
Planned	100	122.8	129.4	132.2	136.1	130.1	147.6	154.3	162.1	171.0	158.8
Actual	100	123.3	125.5	128.1	138.9	129.0	149.9	162.8	165.0	164.3	160.5
% of difference		0.4	-3.0	-3.1	2.0	-0.9	1.5	5.5	1.8	-3.9	1.1
A. Crops											
Planned	100	115.1	121.5	122.7	127.7	121.8	134.2	139.3	143.9	145.7	140.8
Actual	100	118.0	117.4	115.9	127.1	119.6	134.6	142.4	142.7	142.3	140.5
% of difference		2.5	-3.4	-5.5	-0.5	-1.8	0.3	2.3	-0.8	-2.3	-0.2
B. Livestock											
Planned	100	152.7	156.0	159.4	161.0	157.3	165.7	168.6	192.0	240.4	191.7
Actual	100	148.8	153.4	161.0	172.2	158.9	195.1	221.8	217.7	206.6	210.3
% of difference		-2.5	-1.7	1.0	7.0	1.0	17.8	31.6	13.4	-14.1	9.7
C. Fishery											
Planned	100	125.9	139.6	153.4	162.9	145.5	198.1	221.4	231.7	243.9	221.3
Actual	100	127.9	148.5	174.9	186.1	159.4	200.5	220.9	235.4	247.5	226.1
% of difference		1.5	6.3	14.0	14.3	9.5	1.2	4.5	1.6	1.5	2.2
D. Forestry											
Planned	100	142.4	149.7	152.5	138.2	145.7	195.2	222.6	210.3	203.2	207.8
Actual	100	119.2	121.5	122.8	127.2	122.7	147.0	180.7	205.6	206.4	184.9
% of difference		-16.3	-18.8	-19.4	-8.0	-15.8	-24.7	-18.8	-2.3	1.6	-11.0

Source: T. H. Shen, Agricultural Development on Taiwan Since World War II (Ithaca, New York: Cornell University Press, 1964), p. 78.

of the 1950-1952 average or that of the prewar peak year. The average annual growth rate of agriculture was 6.0 per cent under the First Four-Year Plan, 4.6 per cent under the Second, and 4.9 per cent under the Third.[7]

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[7] T. H. Shen, "Agricultural Development in Free China" (a paper prepared for seminar in 1965), p. 4.

CHAPTER IV

THE EFFECTS OF THE ORGANIZATIONAL FACTORS ON THE DEVELOPMENT OF TAIWAN'S POSTWAR AGRICULTURAL PRODUCTIVITY

Organizational factors have played an important part in the history of Taiwan's agricultural development. Among these factors, there are two unique organizations, the Chinese-American Joint Commission on Rural Reconstruction and the Taiwan Farmers' Associations. This chapter is devoted to a brief study of these two organizations, which are still relatively new and not found as such in any other country.

I. THE CHINESE-AMERICAN JOINT COMMISSION ON RURAL RECONSTRUCTION

History and Nature of the Chinese-American Joint Commission on Rural Reconstruction

The Chinese-American Joint Commission on Rural Reconstruction (JCRR hereafter) was established by the authority of the 1948 China Aid Act Section 407 of Public Law 472 of the 80th U. S. Congress at Nanking in October, 1948. The headquarters of JCRR were transferred to Taiwan in the fall

of 1949, when the Government of the Republic of China moved there.[1]

The Commission is composed of five members, three of them, including the chairman, being appointed by the President of the Republic of China and the other two by the President of the United States. As to its organization, JCRR consists of five administrative offices and ten technical divisions, as shown in Figure 4. At the present time, it has a staff of 89 technicians and 95 supporting and administrative personnel.

JCRR is a semi-autonomous agency in Taiwan and its joint nature is its most identifying characteristic. Therefore, it has often been described as moderate in policy and unique in position. JCRR is not an executive, but rather an instrumental agency to provide technical and financial assistances to the worthwhile projects which are sponsored by other governmental or private agencies.

Objective and Function of JCRR

Social welfare has been the foremost problem in China. After World War II, the political subversive influences were taking advantage of the confusion and poverty of the Chinese rural area. Since China has been primarily

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[1]T. H. Shen, Agricultural Development on Taiwan Since World War II (Ithaca, New York: Cornell University Press, 1964), p. 37.

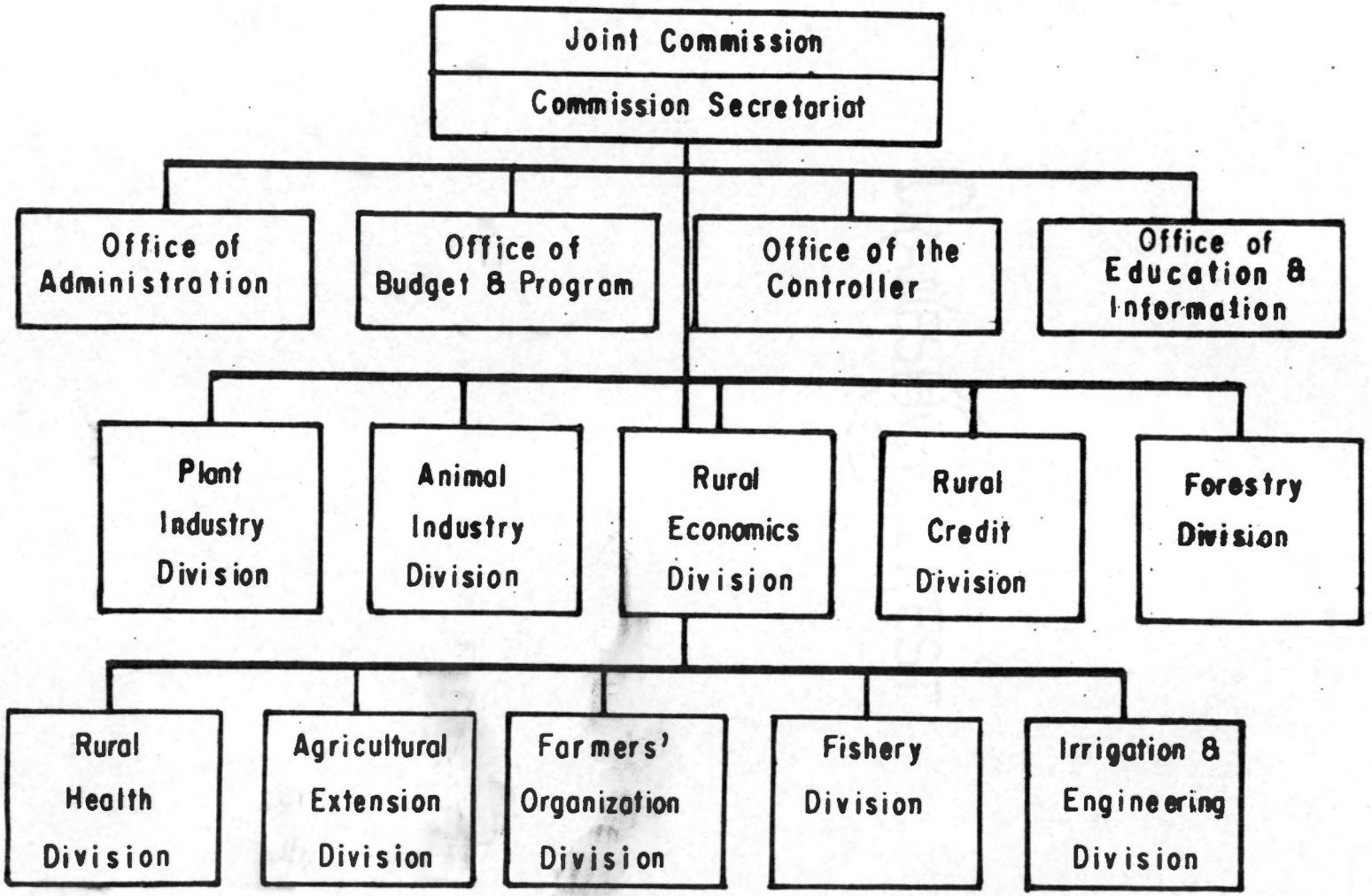


Figure 4. Organization chart of the Joint Commission on Rural Reconstruction.

agricultural, with 80 per cent of its population living on the farm in 1945, the initial objective of JCRR, established according to the 1948 China Aid Act, was to increase agricultural production and promote farmers' income and welfare. This basic objective has been held as a guiding policy of JCRR throughout its existence.

The relationship between the JCRR and other governmental and private agencies can be better understood by observing the illustrative chart provided in Figure 5. From this chart, there are at least two things which deserve special attention. First, the relationships between JCRR and other agencies are more functional than administrative or supervisory. Secondly, the functions of JCRR are mainly downward and more related with the agencies at the local level. Therefore, the main function of JCRR is to provide both technical and financial assistance to governmental and private agencies in carrying out their developmental programs and projects for Taiwan agriculture.

Contributions of JCRR to the Development of Taiwan's Agricultural Productivity

The contributions of JCRR to Taiwan's agriculture, in accordance with its objective and function, have been both technical and financial. The significant contributions made by JCRR to the development of Taiwan's agricultural productivity are analyzed as follows:

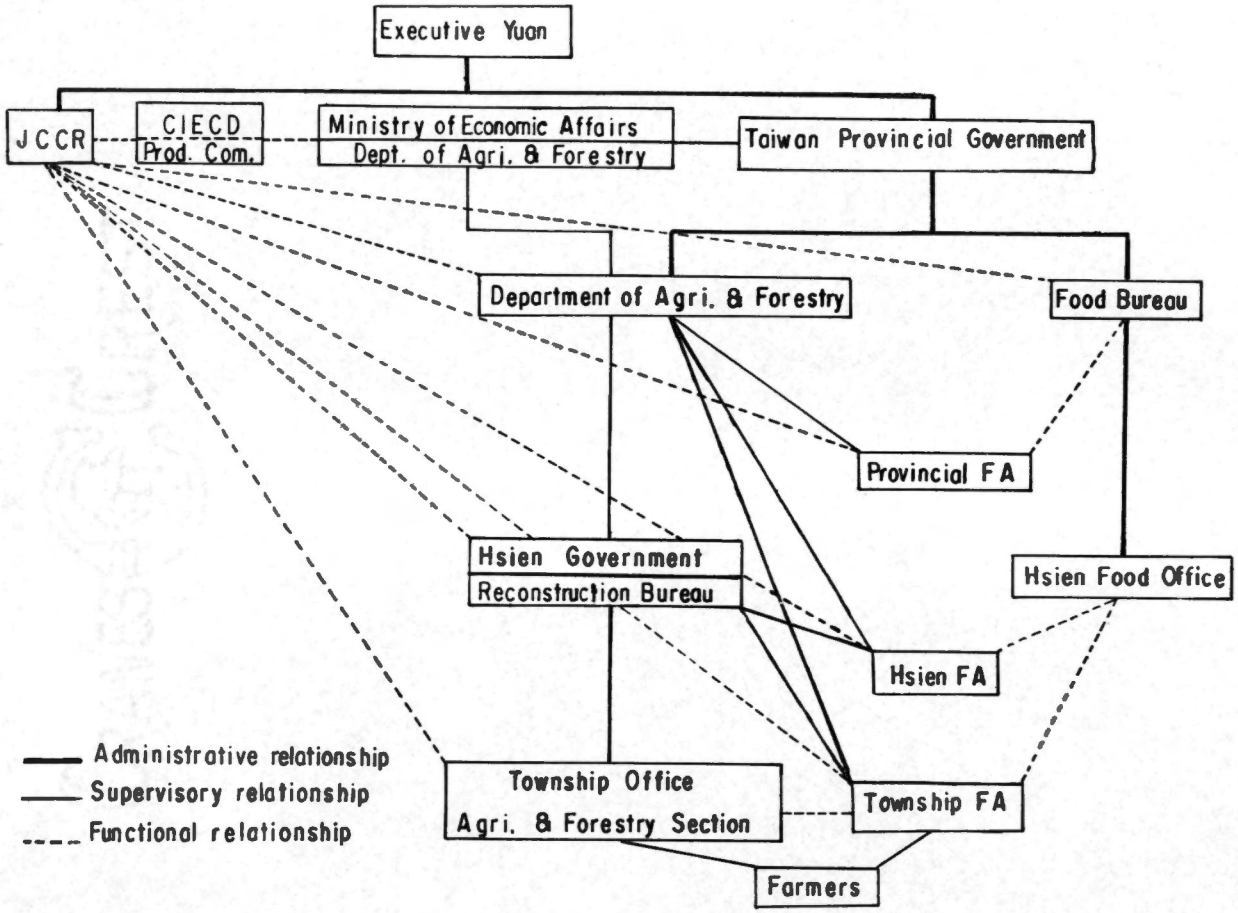


Figure 5. Relationship between government agencies and farmers' associations.

Source: Y. S. Tsiang, "A Report on the Joint Commission on Rural Reconstruction" (a publication of JCRR, 1964), p. 21.

The contribution of formulating and supporting a number of developmental programs and projects. JCRR started its function with a program of crop improvement and irrigation in 1949, and then gradually expanded its field of activities to land reform, forestry, fisheries, animal husbandry, rural credit, and rural health. All these programs were provided with technical and financial aid by JCRR based on the same objective--promotion of production.

Many remarkable results have been achieved in increasing crop production, through JCRR's assistance, such as better varieties and improved cultural method, heavy fertilization, widespread use of pesticides, and more effective use of irrigation water. New soybean varieties were adapted in the area where this crop was not previously grown. A new and simple cultural practice for wheat--drilling instead of broadcasting seed--increased wheat yield by 20 per cent. In fisheries, through 78 fishermen's associations, JCRR also assisted both coastal fisheries and fish culture to increase production.

On the land reform program, JCRR contributed substantial technical and financial assistance to the Provincial Land Bureau in planning, implementation, and administration during the three-step program. On the three Agricultural Four-Year Plans, the contributions of JCRR in providing financial aid, mainly for agricultural fixed capital formation

and improvement of farm, to support the budgetary limitations of the government, were essential to the successful development in the yield of unit land and resource productivity.

The contribution of strengthening agricultural organizations. The farmers' associations in Taiwan, set up by the Japanese, were weak and disordered at the end of the War. In order to increase farm production, JCRR realized that reorganization of the farmers' associations deserved the first priority. Upon the recommendation of JCRR in 1952, a new Farmers' Association Law was approved by the government. In addition, JCRR supported a series of projects for training directors and managers to improve the professional ability of staff members. Therefore, the farmers' associations were reorganized and strengthened. More than 2,000 members of the board of directors of farmers' associations and 10,000 chiefs of small agricultural units have been trained during the period of 1952 to 1964. As a result of this reorganization, trememdous contributions were made to the development of Taiwan agricultural productivity. This is discussed in more detail in the latter part of this chapter.

Another example of strengthening agricultural organizations that can be illustrated here is the Banana Growers'

Cooperatives.[2] Bananas have been one of the main export agricultural products for Taiwan. In the past, over 95 per cent of all bananas exported had been handled by fruit exporters with profits squeezed by the middlemen. The banana growers could only get a small part of the profits from export sales and therefore lost interest in growing bananas. On the recommendation of JCRR in 1963, a Banana Production and Marketing Guidance Committee was established. Under this organization, there are a number of local banana growers' cooperatives. The banana growers' cooperatives are allowed an export quota of 50 per cent of the total amount of bananas exported by Taiwan. Thus, banana farmers did not have to depend on the exporters for selling their products. The purchase price was raised and the banana farmers' income increased. As a result, the acreage planted increased from 18,300 hectares in 1962 to 25,400 hectares in 1964, and the yield per hectare also increased from 9 metric tons in 1962 to 10 metric tons in 1964. Besides, many other agricultural organizations, such as farm irrigation associations, fishermen's associations, agricultural cooperatives, and 4-H clubs were also considerably strenthened through the assistance of JCRR.

The contribution of expansion in agricultural

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[2]Yien-Si Tsiang, "A Report on the Joint Commission on Rural Reconstruction" (a publication of JCRR, 1964), p. 13.

research and extension. JCRR provided techniques and finance to expand the research work conducted by various governmental and private research institutions. In cooperation with the government agencies concerned, JCRR completed the aerial survey of land capabilities and use and the marginal land survey by 1963. Besides, a province-wide soil survey was also undertaken in 1964 for the purpose of better utilization of the land in Taiwan.

The development of Taiwan's postwar agriculture has been achieved mainly through demonstration and extension of the positive results of agricultural research. JCRR deserves much credit for its task of expanding agricultural extension work in Taiwan. Through the effort of JCRR, an Agricultural Extension Advisory Committee was organized in each of the 291 townships in 1963. The committee serves the function of transferring a new or improved technique from the research institution to the farmer. By 1960, approximately 2,616 research results and 1,194 method demonstrations on improved farm practices had been given by farm advisers to the farmers.

One remarkable example in successful extension work, supported by JCRR, was the "rat control." As is common in all tropical and subtropical countries, field rats constantly caused serious damage to crops in Taiwan with an estimated annual loss of 200,000 metric tons. Taiwan Sugar

Research Institute, technically supported by JCRR, started a scientific study on field rat control mainly for protecting sugar cane in 1950. A test program was carried out in 1953-54 and was quite successful. At the same time, JCRR reported that rat damage was spreading to rice, sweet potatoes, peanuts, and vegetables. In 1956 a demonstration project was conducted in 14 townships and 13 prefectures with JCRR assistance. Excellent results were obtained. Then an extension--"rat campaign"--was launched in 1956-57. A total of 6,902,729 rat tails was collected from farmers. The estimated number of rats killed during the campaign was 27.6 million. Farm crops redeemed from this rat campaign were estimated at 138,000 metric tons. The total cost of the campaign was U. S. $766,747, of which JCRR contributed 21.7 per cent. The land and labor productivities therefore were increased by the technical and financial investments of JCRR.

JCRR also helped increase agricultural productivity indirectly through improvement of rural health. In 1948, there were only 104 township health stations in Taiwan, of which 46 per cent were dormant and the remainder were poorly maintained with inadequate facilities. Through the encouragement and financial aid of JCRR, the 104 existing stations were brought up to the minimum standard and 148 other new health stations were established in 1950. In 1951, another

104 new stations were established. Today there are 393 health stations in Taiwan and 93 per cent of these have standard building and furniture. Through these health stations, the outbreaks of some dangerous diseases in Taiwan rural area, such as smallpox, cholera, malaria, and plague, have been completely controlled, and the general level of rural health has been greatly improved. This improvement in the human factor helped provide the necessary condition for the development of agricultural productivity in Taiwan.

The contribution of improving agricultural facilities. The financial assistance of JCRR, which provided the funds for the fixed agricultural capital formation, resulted in direct contributions to the development of agricultural productivity of Taiwan.

Up to 1960, JCRR had supported 92 irrigation projects and 13 drainage projects which furnished a complete water supply to 56,340 acres of formerly dry land and provided better drainage for 667,800 acres. The recently completed Shihmen Dam project, assisted by JCRR, provided irrigation for over 53,000 acres of new paddy land and improved the flow to 185,000 acres already under cultivation.[3]

During World War II, about 50 per cent of the

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[3]E. Stuart Kirby, Rural Progress in Taiwan (JCRR publication, 1960), p. 27.

physical plants of the farmers' associations were destroyed. In order to meet the requirement in handling increasing quantities of food crops, fertilizer, and livestock, JCRR, in cooperation with the government, has renovated and built about 400 rice and fertilizer warehouses during the past 14 years. In addition, JCRR introduced the small power-tillers for Taiwan's farm mechanization.

The contribution of effective utilization of U. S. economic aid. The supply of credit and capital available from U. S. economic aid was one of the most important contributions to Taiwan's agricultural development. All U. S. aid allocated for the agricultural sector was operated through JCRR. The U. S. Economic Aid Program was ended in June, 1966, because of the healthy economic growth of the Republic of China.[4] From 1949 to 1964, JCRR has approved a total of 6,010 work projects carried out by sponsoring agencies at different levels. In order to support these projects, JCRR has spent approximately U. S. $135 million, which consisted of 5.3 per cent in U. S. dollars appropriated directly from U. S. foreign procurements and 94.7 per cent in local currency allocations; 67.8 per cent has been in the form of grant-in-aid; and the other 32.2 per cent in

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[4]Richard I. Phillips, "United States Ends Grant Aid to the Republic of China," U. S. D. S. Bulletin 50, 1964, p. 934.

the form of loan. A distribution of U. S. economic aid by major agricultural activities is shown in Table XI.

From the aspect of optimal utilization of U. S. aid, there has been some discussion on the most effective ways of improving agriculture. Jacoby argued that "more aid funds should have been allocated to research, extension activities, fishing, and less to flood control and irrigation," and "concentration of agricultural assistance in fewer projects would have been more productive."[5] However, there is little doubt that the JCRR's utilization of U. S. aid to promote Taiwan's agricultural productivity was effective and efficient, as M. L. Chiang, the former chairman of JCRR, used to say that "the Chinese commissioners are morally responsible, and the American commissioners legally responsible, for spending the American taxpayer's money."[6] The Chinese-American Joint Commission has demonstrated an excellent cooperative contribution to the agricultural development of Taiwan. "Sino-American cooperation in the postwar development of Taiwan will long stand as a landmark in the history of international economic cooperation."[7]

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[5]Neil H. Jacoby, "An Evaluation of U. S. Economic Aid to Free China, 1951-1965" (a report of Bureau for the Far East, Agency for International Development, 1966), p. 64.

[6]T. H. Shen, op. cit., p. 40.

[7]Neil H. Jacoby, op. cit., pp. iv-v.

TABLE XI

JCRR ALLOCATION OF U. S. AID TO MAJOR CATEGORIES OF ACTIVITY, 1950-1964

Activity	NT $* Amount (thousands)	NT $* Per cent	U. S. $ Amount (thousands)	U. S. $ Per cent
Crop production	$ 377,463	10.2	$1,024	14.4
Livestock production	252,902	6.9	349	4.9
Water use and control	1,205,202	32.7	2,552	35.9
Forestry and soil conservation	187,441	5.1	476	6.7
Rural organization and agricultural extension	243,693	6.6	88	1.2
Economic research and agricultural credit	347,541	9.4	11	0.2
Fisheries	241,285	6.5	31	0.4
Land reform	25,812	0.7	0	0.0
Rural health	127,968	3.5	318	4.5
Agricultural research and education	89,942	2.4	731	10.3
Rural electrification and communication	53,163	1.4	0	0.0
Government budget support to local agricultural program	242,946	6.6	1,027	14.5
Miscellaneous projects (including Outlying Islands and Mountain Resources Development)	136,310	3.7	195	2.7
Administration	159,082	4.3	305	4.3
Total	$3,690,750	100.0	$7,107	100.0

*NT $ = New Taiwan Dollar.

Source: Neil H. Jacoby, "An Evaluation of U. S. Economic Aid to Free China, 1951-1965" (a report of Bureau for the Far East, Agency for International Development, 1966), p. 57.

II. THE TAIWAN FARMERS' ASSOCIATIONS

Organization and Nature of the Farmers' Associations

The farmers' associations in Taiwan were initiated by the Japanese early in the beginning of this century, then reorganized and strengthened by the Chinese in 1954. It is the largest and also the most important organization among all the rural organizations in Taiwan.

The farmers' associations are a federated system of cooperative organizations. In Taiwan, they operate at four different levels: 1 association on the provincial level, 22 associations on the county and municipal level, 317 associations on the township level, and 4,803 small agricultural units on the village level. One member represents a farm family. These small agricultural units are the basic structure of the organization of the farmers' associations.

The chairman of a unit is selected by its members. Each unit in the same township selects three or four representatives to an annual township farmers' associations convention. A board of directors, which is ually composed of eleven to twenty-one members, is selected in this convention and is the governing body of the township association. The directors select the chairman of the board and appoint a general manager who carries out the decisions and policies of the board. In the township association, there is another board called Board of Supervisors, which is composed of

three to seven members. The function of this board is to inspect and approve the financial operations of the association.

Every township association in the same county selects two or three representatives to the annual county farmers' associations convention. The general pattern of the county farmers' association convention is the same as that of the township. In the same way, the county farmers' association selects two or three of its representatives, depending on the size of its membership, to the Provincial Farmers' associations. Therefore, the organization of the farmers' associations in Taiwan is completely farmer governed and operated. The Taiwan Provincial Department of Agriculture and Forestry (PDAF) has a Farmers' Organization Division to supervise the extension services and legal function of the farmers' associations.

Contributions of the Farmers' Associations to the Development of Taiwan's Agricultural Productivity

The farmers' associations in Taiwan provide a great variety of services and facilities. The 1,118 rice warehouses, 579 fertilizer warehouses, and 409 rice mills owned by the farmers' associations in Taiwan make the associations able to collect and process 700,000 metric tons of rice and distribute 600,000 metric tons of fertilizer and 100,000 metric tons of feeds to farmers for use in agricultural

production annually.

In addition to these services in agricultural production and marketing, they provide banking service for farmers. In 1964, there were 295 farmers' associations with credit departments that had total deposits of N.T. $900,000,000. These provide a great convenience for farmers to obtain the agricultural credit needed for production and other purposes.

Another important contribution of the farmers' associations that merits special emphasis is the function of carrying out the agricultural extension work in Taiwan. As mentioned above, the development of Taiwan's postwar agriculture has been achieved mainly through demonstration and extension of the positive results of agricultural research, and the farmers' associations in Taiwan are the executing agencies for the extension work. Thousands of research results and method demonstrations on improved farm practices have been given to farmers through these associations.

As noted before, it is extremely difficult to determine precisely to what extent the organizational factor--the function of the farmers' associations--contributed to the development of Taiwan's agricultural productivity. However, it may be concluded that the farmers' associations in Taiwan served as a connecting function between government

and farmer, project and implementation, research and extension, and provided a vehicle for faster agricultural development on Taiwan.[8]

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[8]K. T. Wright, "Taiwan's Postwar Agricultural Development," Agricultural Economic Report No. 19 (Michigan State University, East Lansing, Michigan, 1965), p. 38.

CHAPTER V

THE EFFECTS OF THE TECHNICAL FACTORS ON THE DEVELOPMENT OF TAIWAN'S POSTWAR AGRICULTURAL PRODUCTIVITY

I. IRRIGATION

Irrigation is vital to Taiwan's agricultural production. Irrigation has been playing an extremely important role during the past fifteen years, especially in increasing crop production. Because of Taiwan's topographical limitations, typhoons, and uneven distribution of rainfall, good control and better utilization of water are necessary conditions for the promotion of crop production.

The temperature of Taiwan favors year-round crop production, but the water supply is usually inadequate. In order to overcome this deficiency, several measures have been taken in Taiwan. Two measures are of special importance. One is expansion of irrigation facilities and the other is improvement of the irrigation method.

In expansion of irrigation facilities, the improvement of existing facilities and the development of a ground water program are outstanding contributors to increased agricultural productivity. Under the First Four-Year Plan, as a result of the rehabilitation and repair of damaged

irrigation facilities, an average annual conversion of 8,449 hectares of non-irrigated land into paddy fields and improvement of about 29,271 hectares of crop rotation fields and single-crop paddy land were brought under improved irrigation. Furthermore, by means of continual strengthening of the old and constructing new facilities under the Second Four-Year Plan, an average annual conversion of 4,125 hectares into paddy fields and improvement of 50,017 hectares were accomplished. Therefore, the total irrigation and drainage area of Taiwan was 652,531 hectares in 1960, exceeding the prewar peak as much as 90,532 hectares.

For the purposes of irrigation, water supply, and flood control, reservoirs are indispensable in Taiwan. During the prewar period, 7 reservoirs were built with a total storage capacity of 329,020,000 cubic meters. From the end of the War to 1964, 9 reservoirs had been completed with a total storage capacity of 107,970,000 cubic meters, and another 3 were under construction in 1964. The estimated total capacity of these 3 was 439,700,000 cubic meters.

In order to reduce water losses by 40 per cent along the main canal, laterals, and sublaterals before it reached the farm, the Canal Lining Project was proposed to line 1,024 km. with concrete in 1959. Through this plan, an amount of 10,400,000 cubic meters of water has been saved each year.

The ground water development was an innovation in Taiwan's agriculture. Owing to the modern methods of drilling and finishing a well, more water was produced from a single well and the ground water had some additional advantages, such as availability in dry season, no evaporation, and saving both time and money in construction and maintenance. Therefore, the program of deep-well construction was widely adopted in Taiwan. Up to 1958, the total number of deep-wells constructed was 55,996 and the amount of ground water yielded from these wells has been estimated to be 2,600,000,000 cubic meters per year.

In 1958 the Provincial Government established a Provincial Ground Water Development Bureau (PGWDB). PGWDB conducted a number of surveys and plans. The Yunlin Ground Water Development Project, the first large-scale attempt to use ground water for irrigation in Taiwan, was one of the six major projects accepted by the Provincial Government in 1958. (See Table XII.) This project proposed to drill 250 deep-wells in Yunlin County and utilize the existing irrigation system to distribute the ground water to crop fields in that area. The total pumpage of these wells is estimated at 139,060,000 cubic meters per year. The area to be benefited is 53,820 hectares, and the increase in rice production as a result of improved irrigation is estimated at 70,518 metric tons. The value of the additional crop outputs, including rice, is estimated at NT$197,368,800.

TABLE XII

GROUND WATER DEVELOPMENT PLAN FOR THE YUNLIN DISTRICT AND ITS ESTIMATED BENEFITS

Irrigation Association	Irrigation System	Areas to be Benefited (ha.)	Before Construction	After Construction	No. of Wells to be Drilled
Toulin Irrigation Association	Toulin Grand Canal	3,168	3-year 1-rice-crop rotation	3-year 2-rice-crop system	22
	Original Canal System	3,711	1-rice-crop paddy field	2-rice-crop paddy field	23
	Original Canal System	2,778	2-rice-crop paddy field (with water shortage)	2-rice-crop paddy field	7
Chianan Irrigation Association	Chokan Canal	37,062	3-year 1 rice-crop rotation	3-year 2-rice-crop system	152
	Branches of Hsin Hu Wei Chi	5,617	3-year 1 rice-crop rotation	3-year 2-rice-crop system	30
	Combined irrigation district of An Ching Canal and South Fen Chi Lake	614	2-rice-crop paddy field (with water shortage)	2-rice-crop paddy field	5
	Pei Lun Combined irrigation district	455	1/3 1-rice-crop paddy field		
			2/3 2-rice-crop paddy field	2-rice-crop paddy field	5
	Combined irrigation district of Lu Chang Ke Canal	415	3-year rice-crop rotation	2-rice-crop paddy field	6
Total		53,820			250

Source: T. H. Shen, Agricultural Development on Taiwan Since World War II (Ithaca, New York: Cornell University Press, 1964), p. 129.

The major irrigation project developments under construction or planning, their purposes, and their respective estimated benefits in Taiwan up to May, 1962, are shown in Table XIII.

In the improvement of the irrigation method, the most remarkable achievement in Taiwan is known as "rotational" irrigation. Previously, Taiwan farmers usually flooded their rice fields continually without interruption. In order to utilize the limited and precious irrigation water more economically, a senior engineer of JCRR, L. Chow, developed a new system. Under this new method, the water is provided on a field-by-field basis and the farmer receives enough, but not too much water. A series of tests and demonstrations conducted in 1954 and 1955 found that about 20 per cent to 50 per cent of the water could be saved without affecting crop yield. Under this new system, the field can be made alternately dry and wet to suit the life cycle of the crops. This method also saves fertilizer, facilitates soil aeration, and prevents many water disputes.

In 1957 the government formulated a four-year plan as part of the Second Agricultural Four-Year Plan to let 116,746 hectares of paddy fields receive rotational irrigation. It is estimated that this plan provided supplementary irrigation to 10,850 hectares which had previously been inadequately irrigated and added 9,000 hectares of newly

MAJOR PROJECTS OF IRRIGATION DEVELOPMENT UNDER CONSTRUCTION OR PLANNING[1]

Name of Project	Location (Hsiens)	Estimated Increase of New Irrigation Area Reported in ha.	Estimated Improvement of Existing Irrigation Area Reported in ha.	Estimated Annual Increase of Rice in m/t	Estimated Project Cost or Allocation to Irrigation in NT$	Principal Purposes of Development
1. Paiho reservoir	Tainan	2,721	2,068	8,400	164,601,000	Irrigation, water supply, flood control, recreation.
2. Houlung reservoir	Miaoli	1,682	316	7,964	148,000,000	Mainly for irrigation.
3. Tsengwen reservoir	Chiayi	7,301	80,468	100,000	1,937,480,000	Irrigation, water supply, power.
4. Tachia reservoir	Taichung	13,515	20,562	56,000	1,197,264,000	Power generation.
5. Shihmen reservoir	Taoyuan	15,096	37,513	74,000	1,707,595,000	Irrigation, flood control, water supply, power generation, recreation.
6. Kaoping basin development	Kaohsiung and Pingtung		63,151	No est.	No estimate	Mainly for irrigation.
7. Choshui basin development	Nantou, Changhwa & Yunlin			No est.	No estimate	Irrigation, flood control, power generation, water supply.

TABLE XIII (continued)

Name of Project	Location (Hsiens)	Estimated Increase of New Irrigation Area Reported in ha.	Estimated Improvement of Existing Irrigation Area Reported in ha.	Estimated Annual Increase of Rice in m/t	Estimated Project Cost or Allocation to Irrigation in NT$	Principal Purposes of Development
8. Peinan basin development	Taitung	1,831	1,812	No est.	No estimate	Irrigation, power generation, flood control.
9. Canal lining	Chiayi and Tainan		123,400	28,000	300,000,000	Water saving.
10. Rotational irrigation	Island-wide	10,822	48,527	60,000	376,480,000	Irrigation improvement.
11. Ground water development	Island-wide			246,378	788,100,000	Supplementary irrigation.

[1]As of May 8, 1962.

Source: E. L. Rada and T. H. Lee, Irrigation Investment in Taiwan, Economic Digest Service: No. 15, JCRR, 1963, p. 137.

irrigated land. The expected increase in the annual production of paddy rice was set at 60,000 metric tons.

After the implementation of this new irrigation method, the Chianan Canal system, one of the two largest irrigation systems in Taiwan, prolonged the irrigation interval from 5.5 days to 7.5 days. This made much water available to more crop fields. The Kwangfu Canal, which was formerly almost a dry canal because of no water from its water source, Taoyuan Main Canal, now receives considerable water from its source and sufficiently irrigates the rice fields in its district. From these two examples, it is evident that the benefits received from rotational irrigation are significant.

It is methodologically difficult to measure the precise impact of irrigation on the yield per unit land or land productivity because of the interaction of variables and the problem of multicollinearity. Theoretically, the rice yield of per unit land is affected by irrigation, fertilizer, pesticide, labor efficiency and management, and rice prices. In 1963, Rada and Lee conducted a multiply correlation analysis and used data for Taiwan as the case.[1]

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[1]E. L. Rada and T. H. Lee, Irrigation Investment in Taiwan, Economic Digest Series: No. 15, JCRR, 1963, p. 44.

Let: P stand for rice prices
W stand for irrigation
F stand for fertilizer application
Y stand for per hectare rice yields

then, the multiple regression equation obtained for the period of 1950-1960 was: $Y = -186.5523 + 0.4971F + 2.47861W - 0.0047P$, and the resulting multiple correlation determinant was $R^2 = 0.97$.

From the above result, it is obvious that the relationship between dependent and independent variables is highly reliable as the determinant comes out larger than 0.90. Irrigation is one of the key factors which affects the yields of rice. It may be concluded that the amount of irrigation helps determine both the acreage of rice plantation and rice yields per unit land, and these two factors determine the total production of rice. As Rada and Lee said:

> From the study of production statistics, it is apparent that rice production is dependent on irrigation and that the farmers' propensity to produce rice is extremely strong. Farmers seem to automatically turn to rice when adequate water becomes available.[2]

However, the potential paddy land in Taiwan is estimated at about 85 per cent of total arable land. From the past experiences of Taiwan, each 1 per cent increase in aggregate irrigated area has been associated with a 1.164 per cent increase in the multiple-crop index and about a NT$100

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[2] Ibid., p. 43.

million increase in the real value of agricultural production.

II. CHEMICAL FERTILIZER

In the history of agricultural development of Taiwan, another key factor which contributed to the increase in agricultural output is chemical fertilizer. According to H. C. Kao's analysis,[3] there is a significant relationship between per hectare yield of rice and the amount of fertilizer allocated in per hectare.

The above statement can be identified by examining the statistical data of rice production in the period of 1930-1960. In Table XIV the fertilizer applied to rice was 64,000 metric tons in 1948 and 500,716 metric tons in 1958, an increase of almost 8 times during 10 years. On the other hand, for the same period, the cultivated acreage remained almost the same, but the total output increased only about double in the same period because of diminishing return in fertilizer applied. If the above data are presented graphically, their relationships can be seen as shown in Figure 6.

From Figure 6 it is obvious that the total production of rice fluctuates in accordance with the fluctuations of

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[3]Charles Hsi-Chung Kao, "The Role of the Agricultural Sector in Economic Development" (an unpublished Doctor's dissertation of Michigan State University, East Lansing, Michigan, 1964), pp. 80-81.

TABLE XIV

RICE PRODUCTION, CULTIVATED ACREAGE, AND AMOUNT OF FERTILIZER DISTRIBUTED, 1930-1960

Year	Acreage Cultivated (ha.)	Brown Rice Produced (1,000 M.T.)	Fertilizer Distributed (M.T.) Gross	N	P_2O_5	K_2O
1930	614,390	1,052	234,933	-a-	-a-	-a-
1931	633,726	1,068	232,398	-a-	-a-	-a-
1932	664,325	1,278	243,267	-a-	-a-	-a-
1933	675,476	1,194	258,869	-a-	-a-	-a-
1934	666,979	1,298	317,324	-a-	-a-	-a-
1935	678,629	1,303	320,954	-a-	-a-	-a-
1936	681,548	1,365	362,523	-a-	-a-	-a-
1937	657,685	1,319	373,265	47,850	18,256	7,625
1938	625,398	1,402	389,334	48,653	13,572	3,570
1939	626,131	1,307	351,088	37,141	15,225	3,810
1940	638,622	1,128	297,110	27,796	13,424	2,249
1941	646,927	1,199	269,739	34,672	13,722	1,801
1942	616,529	1,171	226,843	-a-	-a-	-a-
1943	610,051	1,125	227,991	-a-	-a-	-a-
1944	600,688	1,068	77,047	-a-	-a-	-a-
1945	502,018	638	1,958	150	287	104
1946	564,016	894	4,181	857	-a-	-a-
1947	677,557	999	59,446	9,527	6,714	-a-
1948	717,744	1,068	64,000	12,612	4,499	-a-
1949	747,675	1,214	100,962	17,452	5,845	-a-
1950	770,262	1,421	231,765	39,764	10,758	-a-
1951	789,075	1,484	279,857	46,261	9,288	5,791
1952	785,729	1,570	362,117	51,833	18,948	7,729
1953	778,384	1,641	378,363	52,163	21,511	8,649
1954	776,660	1,695	460,179	64,762	22,708	9,297
1955	750,739	1,614	442,080	62,857	25,020	10,340
1956	783,629	1,789	490,281	66,878	26,375	11,192
1957	783,267	1,839	492,291	68,299	26,280	12,820
1958	778,189	1,894	500,716	70,032	27,152	14,499
1959	776,050	1,856	498,736	69,105	26,662	16,983
1960	766,409	1,912	405,592	58,479	21,710	15,284

-a- = No data available.

Source: T. H. Shen, Agricultural Development on Taiwan Since World War II (Ithaca, New York: Cornell University Press, 1964), p. 139.

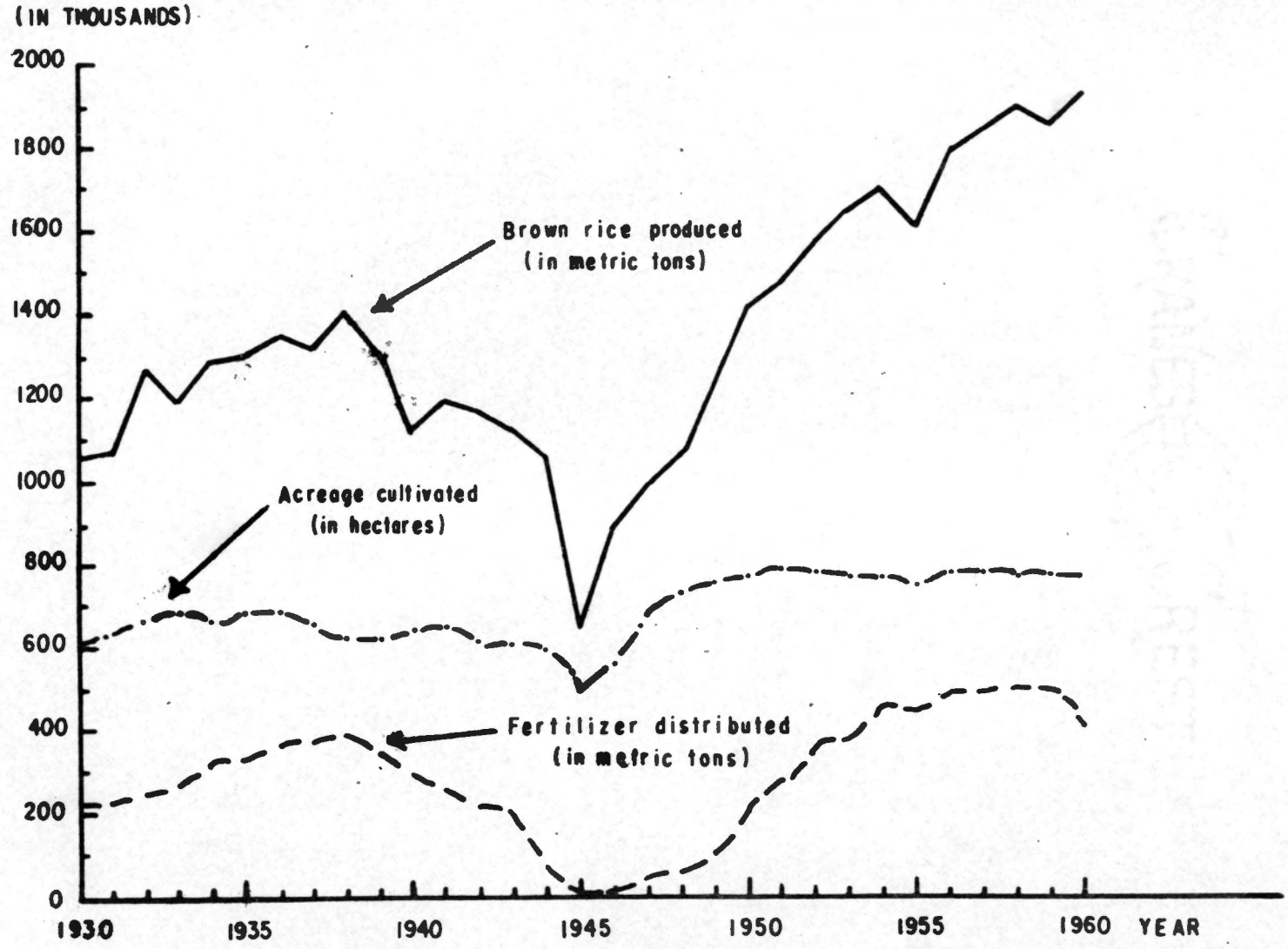


Figure 6. Rice production, cultivated acreage, and fertilizer distributed for the years 1930-1960.

both its cultivated acreage and the amount of fertilizer applied, but the influence of the latter tends to be greater than the former. T. H. Shen explained that "it will be noted that fertilizer has been a major cause of increased rice production."[4]

From more detailed study, the productivity of fertilizer can be expressed in terms of the average return of unit fertilizer supplied per unit land. In Taiwan, the major chemical fertilizers applied are nitrogen (N), phosphoric acid (P_2O_5), and potash (K_2O). The average return from 1 kg. fertilizer in per hectare is shown in Table XV.

Even though the returns to fertilizers differ for various crops, it is undeniable that their productivities are requisite in crop production. However, from the above analysis, it is apparent that the vast application of chemical fertilizers is one of the most important factors contributing to the increase in postwar crop production in Taiwan.

III. CULTURAL METHOD

A part of Taiwan's postwar agricultural development has resulted from improved cultural methods. Among those methods the most remarkable one is the "multiple cropping."

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[4]T. H. Shen, Agricultural Development on Taiwan Since World War II (Ithaca, New York: Cornell University Press, 1964), p. 138.

TABLE XV

AVERAGE RETURN IN YIELD (Kg.) WITH THE APPLICATION OF EACH UNIT OF FERTILIZER NUTRIENT (Kg.) AT THE RECOMMENDED RATE (Kg./ha.)

Crop	N (Kg.)	P_2O_5 (Kg.)	K_2O (Kg.)
Rice I (grain)	10.6	3.5	1.7
Rice II (grain)	6.8	2.6	2.6
Wheat (grain)	5.5	3.7	6.4
Sweet potatoes (fresh tubers)	42.5	27.7	35.5
Sugarcane (sugar)	23.	3.	10.
Jute (crude fiber)	13.8	7.1	7.3
Tea (fresh leaves)	22.5	*	*

*P_2O_5 and K_2O are not applied to tea production.

Source: T. H. Shen, Agricultural Development on Taiwan Since World War II (Ithaca, New York: Cornell University Press, 1964), p. 138.

As subjected to natural conditions, Taiwan has been extremely limited in arable land. Therefore, in order to increase agricultural production, strategies have been focused on the intensive use of agricultural land. The system of multiple cropping contributed directly to this purpose and naturally increased the agricultural land productivity of Taiwan.

The experiments of this system started with an analysis of yield factors for a given crop by concerned government agencies and ended with a synthetic summary of all favorable factors in a rotational system. Then a synthesized formula was recommended to farmers that included a new variety, the time of planting, the manner of rotation, the spacing of plants, irrigation, the use of fertilizer, and the measures for pest control.

Under this system, crops are normally harvested three to four times a year on the same field. The following example is given for illustration. In the northern part of Taiwan, the winter is relatively cold and wet. Therefore, on the irrigated land only two crops of rice are grown. After the harvest of the second rice crop, the fields remain idle about 100 days from early December to March of the next year. Noting this fact, the Taiwan Agricultural Research Institute, with JCRR's assistance, tried to grow Astragalus during this period of interval. Astragalus seeds were sown between rice rows about two to three weeks before the

harvest of the second crop of rice. This crop produces 20 to 30 metric tons per hectare to be plowed under for green manure in early March. As Astragalus contains plenty of organic matter and 40 kg. of nitrogen, which is equivalent to 200 kg. of ammonium sulphate, about 10 metric tons of Astragalus green manure are sufficient for 1 hectare. Therefore, the remaining 10 to 20 metric tons per hectare are utilized in the following ways. The tips of the young plants are topped as a vegetable and the grown plants are cut before flowering and, after mixed with grass, are fed to cattle and hogs. The plants in the blooming stage are turned under to serve as green manure, which is badly needed to improve the heavy soil texture of the red earth. With Astragalus green manure, the rice yield per hectare increased 10 to 20 per cent.

In addition, a high-valued soybean, "Sanchou soybean,"[5] a variety originating in Japan, was introduced into over 10,000 hectares of so-called "weather-depending" land in northern Taiwan. In the central part of Taiwan, rape (a new crop for oil extraction), wheat, and soybeans were cropped as winter crops after the second crop of rice. In southern Taiwan, the sugar cane belt, a new cropping system involves interplanting peanuts, sweet potatoes, soybeans,

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[5]Lester R. Brown, "Taiwan: Twelve Years of Rural Progress," Foreign Agriculture, January, 1961, p. 12.

cotton, rape, or onions in the early stages of the growth of sugar cane. The average yield per hectare of these interplanted crops are: soybean 1,000 kg., cotton 974 kg. of seed cotton, rape 2.4 to 3.0 metric tons, and onions 15 to 20 metric tons. Since sugar cane takes 18 months to mature, farmers like to have interplanted crops in order to earn some early cash income.

Through the island-wide extension of this multiple-cropping method, the actual cropped area in Taiwan was greatly expanded and the cultivated land productivity was thus increased to a great extent. The expansion of actual cropped area can be seen clearly from the study of multiple-cropping index as shown in Table XVI.

The index of multiple cropping has been increasing since 1946 and up to 1960. It has exceeded the peak of pre-war period by about 50 per cent. From this table, it is also apparent that the actual cropped area in Taiwan was almost double the physical cultivated area in 1960, and the trend is still going upward.

The increase of cultivated land productivity is also tremendous. In 1950 to 1952, most paddy land produced only two rice crops a year, with an average yield of 3,854 kg. brown rice per hectare. In 1957 to 1958 not only the per hectare yield of rice increased, but also most of the double rice crop fields grew a supplementary crop in winter

TABLE XVI

MULTIPLE CROPPING INDEX OF TAIWAN, 1939-1960

Year	(1) Total Crop Area (1,000 ha.)	(2) Total Cultivated Land Area (1,000 ha.)	(3)=(2)÷(1) x 100 Multiple Cropping Index
1939	1,147	860	133.4
1940	1,174	861	136.5
1941	1,184	859	137.8
1942	1,155	854	135.3
1943	1,128	839	134.5
1944	1,119	808	138.5
1945	904	816	110.8
1946	981	832	117.9
1947	1,193	834	140.1
1948	1,345	863	155.9
1949	1,438	865	166.2
1950	1,484	871	170.4
1951	1,483	874	169.7
1952	1,506	876	171.9
1953	1,505	873	172.4
1954	1,519	874	173.8
1955	1,495	873	171.3
1956	1,535	876	175.2
1957	1,563	873	179.0
1958	1,590	884	179.9
1959	1,594	878	181.5
1960	1,596	867	184.0

Source: T. H. Shen, Agricultural Development on Taiwan Since World War II (Ithaca, New York: Cornell University Press, 1964), p. 156.

and another one in summer, thus harvesting four crops a year, as shown in Table XVII.

The average yield per hectare in 1958 was 4,782 kg. of brown rice plus one of the following supplementary crops: 1,791 kg. of wheat, 1,000 to 1,400 kg. of soybeans, 2,400 to 3,000 kg. of rapeseed, 1,200 kg. of broad beans, 1,928 kg. of tobacco, or 4,000 kg. of hybrid corn, and plus one summer crop which is usually melon or vegetable, the high-cash-value crops. Therefore, in the double cropped rice area, the total annual yield per hectare was among the highest in the world.

Multiple-cropping system requires high level farming techniques and facilities. Taiwan has been improving and increasing irrigation facilities, fertilizers, seeds, pesticides, and farm machines to meet the expansion of this important system.

In addition to increased agricultural production, the multiple-cropping system has also brought the benefit of diversification to agricultural production, which helps to stabilize Taiwan's agricultural economy.

Before concluding this section, another important question needs to be examined: Does the multiple cropping method exhaust soil fertility? By examining the fact that the average yield of double rice crops per hectare was 2,110 kg. of brown rice in 1937-1939 or the peak of the Japanese

TABLE XVII

MULTIPLE CROPPING SYSTEM ON PADDY FIELDS

Number of crops	Period from Planting or Transplanting to Harvesting
1. The first rice crop	February to June
2. Summer crops	
Jute	Mid-April to early August (relay planting)*
Melon	Late May to early August (relay planting)
Oriental pickling melon	Early June to early August (relay planting)
Chinese cabbage	June to July
Soybeans (for table use)	Early June to late July
Sesbania (green manure)	June to early August
Watermelon (for seeds)	Late May to early August
3. The second rice crop	August to October
4. Winter crops	
Wheat	Late October to late February
Barley	Late October to late February
Tobacco	Mid-September to early February (relay planting)
Rape	Mid-October to early March
Corn	Mid-October to early February
Soybeans (for table use)	Mid-October to mid-February
Flax	Late October to early March
Vegetables	Mid-October to mid-February

*Relay planting is the interplanting of a new crop before the growing crop is harvested.

Source: T. H. Shen, Agricultural Development on Taiwan Since World War II (Ithaca, New York: Cornell University Press, 1964), p. 162.

period, 2,182 kg. in 1953-1956, and 2,391 kg. in 1957-1958, it may be answered that the multiple cropping method does not result in soil exhaustion under the multiple cropping, soil management practice.

CHAPTER VI

SUMMARY AND IMPLICATIONS

I. SUMMARY

The objectives of this study were threefold. The first was to provide some general knowledge of Taiwan's agricultural development with special emphasis on the post-war period. The second was to analyze the major factors fostering the remarkable agricultural development and examine the methods and functions of each factor's contribution. The third was to identify the implications for further planning of Taiwan's agricultural development and to reveal some data that might be helpful for other underdeveloped and developing countries in the tropical and subtropical areas.

Taiwan is an island with both tropical and subtropical climates which provide favorable conditions for agriculture, but its natural resources are rather limited. The basic characteristics of Taiwan's agriculture are the small-farming systems and high man-land ratio. The potential for new agricultural land is almost non-existent, but the population is still expanding with a high annual growth rate of 3.3 per cent. For these reasons, the further development of Taiwan's agriculture is facing a great challenge

in the near future.

The agricultural development of Taiwan can be roughly divided into five stages, but the focus of this study has been on the postwar period, which includes the last two stages. In the rehabilitation state, from 1945 to 1952, efforts were concentrated on the recovery of agricultural production to the prewar level to meet the needs of food for the increasing population. The average annual growth rate achieved in agriculture during this period was 12.90 per cent. In the further development stage, 1952 to 1964, the objectives were aimed not only to achieve a self-supported economy, but also to accelerate industrialization and aggregate economic development in Taiwan. The average annual growth rate achieved in agricultural production during this period was 5.90 per cent. By a regression approach, it was estimated that Taiwan's postwar agricultural production recovered to the long-run trend output by 1956, even though it had regained the peak of prewar output by 1951. The development was mainly achieved through increases in unit land productivity. According to the statistical data of United Nations in 1954, Taiwan's unit land productivity ranked second among the nations in the world.

The major factors and their functions of fostering this remarkable postwar development were examined and analyzed in this study from the aspects of agricultural programs

and plans, organizational factors, and technical factors, respectively.

Among a series of agricultural developmental programs and plans, land reform laid a necessary foundation for further agricultural development and created an invaluable economic incentive for intensive use of land and increasing agricultural productivity. The main contribution of the three Agricultural Four-Year Plans was providing the practical step-by-step procedures and projects which made the achievements of the developmental goals possible.

In considering the organizational factors, there were two unique organizations, the Chinese-American Joint Commission on Rural Reconstruction (JCRR) and Taiwan Farmers' Associations (TFA), which are still relatively new and not found in many countries. Their contributions to the development of agricultural productivity deserve world-wide interest and attention. The technical and financial assistances of JCRR were essential to Taiwan's postwar development. Almost all the successful developmental programs and projects could probably not have been achieved without JCRR's assistance. The important contributions of JCRR included the formulating and supporting of agricultural programs and projects, strengthening agricultural organizations, expanding agricultural research and extension, improving agricultural facilities, and effective utilization of U. S.

economic aid. Taiwan Farmers' Associations (TFA) are executive agencies of agricultural extension work. If the agricultural growth of Taiwan can be organically compared to a human body, the functions of JCRR and TFA should be equal to the "heart" and "artery or circulatory system" to the body, respectively.

This study does not tend to conclude that the Taiwan's postwar agricultural development would have been impossible without JCRR and TFA. But it does emphasize that Taiwan's agricultural development would be entirely different in both of its speed and degree without these two important organizations.

Another important contribution to Taiwan's agricultural development came from technical factors. Among these, irrigation, chemical fertilizer, and multiple cropping system were of most importance. By improvement and expansion of irrigation facilities, total crop production was immensely increased through both increases in cropped acreage and yield per hectare. Increased application of chemical fertilizer resulted in a definite improvement in unit land productivity. The productivity of fertilizer also can be seen from the return of unit fertilizer applied to crop production. The multiple cropping method also contributed a positive effect on increasing unit land productivity through intensive use of cultivated land. It was

also concluded that under the present soil management, the multiple cropping method would not result in soil exhaustion.

II. IMPLICATIONS

As pointed out in this study, the arable land and natural resources of Taiwan are extremely limited. Therefore, the intensive use of land becomes a key factor of Taiwan's agricultural development. In regard to the increase in agricultural production, the cultivated acreage and the productivity of unit cultivated land are the two fundamental elements of determinant.

For further increases in the arable land, attention will have to be focused on the development of the areas of mountain slopes and reclamation of tidal basins. When considering increases in the productivity of unit cultivated land, the factors of technology, labor, and capital appear to be especially important for Taiwan's further agricultural development.

Since the U. S. economic aid was phased out in June, 1966, there will probably be no more technical assistance from the United States and training of Chinese technicians in the United States under AID program. In the past, the agricultural experimental stations in Taiwan have succeeded in making a series of practical technical improvements without undertaking much basic research. Now, the first problem

faced is how to keep an incessant improvement of agricultural technology which is indispensable for the development of Taiwan's agricultural productivity. In order to fill this gap, it seems essential to train more agricultural technicians and personnel and to strengthen both applied and basic research through advanced agricultural education. In doing this, special efforts will have to be placed on the development of technologies for small-farming systems and for reducing the damage of crop yields from natural hazards which do considerable damage to Taiwan's crop production every year.

The increase of labor productivity has been one of the factors which promoted the aggregate agricultural producitivity in the past fifteen years. For further development in labor productivity, better utilization of labor, which is the only abundant production factor in Taiwan, and the releasing of surplus agricultural labor to nonagricultural sectors are the most urgent tasks for further development of Taiwan's agricultural productivity.

Since the U. S. economic aid has been discontinued, the public investment from governmental budgets for land improvement and expansion of irrigation facilities will have to be increased if Taiwan's agricultural productivity is to continue increasing. Besides, the program of production loans will have to be strengthened and expanded to meet the

increasing needs for working capital, which also has been contributing greatly to Taiwan's postwar agricultural development.

Before concluding, there is another significant point that should be noted. While emphasizing the importance of technical factors, the institutional factors should not be neglected, including developmental programs and plans of government and organizational factors. These are the prerequisites and fundamental conditions for a successful agricultural development. Both institutional and technical factors need to be based on a balanced priority in policy making and planning agricultural development.

What Taiwan has been experiencing in her agricultural development after the War should be shared and may be of help to other underdeveloped and developing countries in the world. Especially, the remarkable land reform, the unique organizations and functions of JCRR and TFA, the ways of successful utilization of U. S. economic aid, and the balanced policy of institutional and technical factors may reveal some valuable implications for other countries in planning their further agricultural development.

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APPENDIX

TABLE XVIII

AGRICULTURAL LAND PRODUCTIVITY
IN SELECTED COUNTRIES

Country	Net Agricultural Production (millions US$)	Total Agricultural Land Area (1,000 ha.)	Land Productivity (US$ per ha.)	Relative Ranking
China-Taiwan	322	938	344	2
Canada	2,633	61,232	43	11
Denmark	808	3,119	259	4
Germany, W.	2,811	14,269	197	7
India	12,662	158,275	80	10
Italy	3,489	20,892	167	8
Japan	2,965	6,598	460	1
Netherlands	517	2,310	223	6
Norway	350	1,036	338	3
Thailand	1,162	4,750	245	5
United Kingdom	2,281	19,331	118	9
U.S.A.	20,279	450,644	45	12

Source: T. H. Shen, Agricultural Development on Taiwan Since World War II (Ithaca, New York: Cornell University Press, 1964), p. 166. The original statistics were based on United Nations Statistical Yearbook (New York: U. N., 1954).