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AGRICULTURAL DEVELOPMENT AND ITS CONTRIBUTIONS TO ECONOMIC GROWTH IN TAIWAN

—Input-Output and Productivity Analysis of Taiwan Agricultural Development—

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TAIPEI, TAIWAN, CHINA

This publication represents a study report on a Phase B - Taiwan under a cooperative project of USAID - USDA - JCRR for a study on "Factors Associated with Differences and Changes in Agricultural Production in Underdeveloped Countries".

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FOREWORD

As we learn more about the factors associated with the orderly process of economic growth in nearly every developing country of the world, we become more aware of the role which a progressive agriculture must play in this process. Only a few years ago, developing countries believed it essential to place overriding emphasis on industrialization, since industrial development was considered to be synonymous with modernization, while any significant concentration of effort on agriculture marked a country as a nation of inferior status. This concept of development is now being reassessed, partly because of the realization that more food is going to be needed to feed the world's rapidly growing population, and partly because a more important value is being given to agriculture as a solid foundation on which to establish an industrialized society. The newly emerging concept of development emphasizes that in most cases a developing country cannot neglect the agricultural sector in its march towards the achievement of a modern industrial state.

The Republic of China has embraced this policy of balanced agricultural-industrial economic growth in the development of the Province of Taiwan. Taiwan's agriculture has responded by making rapid strides in total physical production, practically doubling agricultural output in the fifteen-year period preceding 1965 without any appreciable change in the area of cultivated land. And at present the Province of Taiwan is moving steadily forward in industrial development due, in part, to the establishment of a solid agricultural base, involving a higher level of production and productivity of the island's 800,000 farms accompanied by a rising prosperity of its farming population.

Since Taiwan has achieved a considerable measure of fame and recognition for its agricultural accomplishments, the questions have often been raised — How was this progress attained? What were the necessary conditions which contributed to Taiwan's agricultural development? What lessons are to be learned from the Taiwan experience that have applicability to other countries? The purpose of this publication is to provide, in considerable measure, answers to these inquiries.

The authors commissioned by the Sino-American Joint Commission on

Rural Reconstruction (JCRR) to undertake this study are highly competent agricultural economists, who have written numerous articles on various aspects of Taiwan's agricultural development. In 1958, they co-authored a JCRR publication entitled "An Analytical Review of Agricultural Development in Taiwan — An Input-Output and Productivity Approach". This analysis has been widely acclaimed as an important contribution to the international literature devoted to a better understanding of the technological, economic, social, human and institutional factors which have played an interrelated role in Taiwan's small-farm agricultural development.

The present publication stands on its own feet, so to speak, in its contribution to the literature on this subject. However, it may also be considered complementary to a related study on Taiwan's agricultural progress entitled "Development of Agriculture in Taiwan, 1885-1963", undertaken by the U. S. Department of Agriculture at the request of the U. S. Agency for International Development.

These two documents will serve as important reference materials for the Taiwan (East Asia) Seminar on Agricultural Development, to be held in Taipei in June 1966 under the joint sponsorship of JCRR and the U. S. Agency for International Development.

Gerald H. Huffman
Commissioner
Sino-American Joint Commission
on Rural Reconstruction

April 20, 1966
Taipei, Taiwan

AGRICULTURAL DEVELOPMENT AND ITS CONTRIBUTIONS TO ECONOMIC GROWTH IN TAIWAN

— INPUT-OUTPUT AND PRODUCTIVITY ANALYSIS OF TAIWAN AGRICULTURAL DEVELOPMENT —

Chapter I.

Introduction

The objective of the study in this part is twofold: to survey the experience of agricultural development in Taiwan with special reference to the input-output relationship and productivity change in production; to review specific aspects of Taiwan experience in terms of the major sequences of institutional and organization innovations and in relation to its economic growth as a whole.

The experience of agricultural development in Taiwan is an example, under their traditional small farming systems, having successfully advanced and transformed its agricultural productivity, which has, in turn, made effective contributions to its economic growth. In the case of Taiwan's experience, the workable labor force in rural areas has been on the increase. The average size of farm was about 2.04 hectares in 1911-15 and declined to 1.14 hectares in 1956-60. At the same time, the production index of agriculture increased from 100 to 337, the average crop yield index rose from 100 to 184 in the same period. With respect to individual crops, the per hectare yield of brown rice increased from 1,346 kg. in 1911-15 to 2,391 kg. in 1956-60. The yield of sweet potatoes increased from 6,834 kg. to 12,259 kg. and that of sugar cane from 23,837 kg. to 73,622 kg.. The farming was diversified and the multiple cropping index increased from 116 in 1911-15 to 180 in 1956-60. The rise in agricultural productivity in terms of land and labor was registered at 267% and 225%, respectively, in 1956-1960 as compared with the base period of 1911-15.

This aspect of the development of Taiwan agriculture--the rapid growth of agricultural productivity in the framework of a high population

pressure and small-scale farming - - is of deep technical interest to the developing countries of Asia today. In those countries the dominant system of agricultural production is one in which a relatively large rural population subsists on small-scale farms. There is an urgent need to raise the productivity of agricultural output to meet the food needs of a rising population and also as an essential part of general economic development. At the same time, however, the tempo of population growth is so fast and the problem of finding employment for the growing labor force is so great that providing more employment opportunity in farming becomes an indispensable condition. In spite of these facts, Taiwan could maintain the rapid growth of agricultural productivity without decreasing the labor force in agriculture.

The central point of interest in the high growth of agricultural productivity was in the adoption of capital-saving techniques in the initial period. This made possible an economical use of scarce capital in the process of agricultural development and then made capital available for industrial transformation. The adoption of new techniques in agriculture involved a number of institutional changes. There was the need to provide help to the small-scale farmers to adopt new technology. This involves the functional changes in farmers' organization, irrigation association, the tenure system and the township office. All of these factors relate to the need for developing and transmitting the technological knowledge to the farmers and for giving them incentives for improved productivity and increased production. Government role in all of these activities is important.

It is a vitally important factor that the government, having the services of efficient officials and technicians at its disposal, takes the lead in improving the existing institutional framework, establishing research institutions, sponsoring extension and educational programs, and planning and conducting water resources development programs. The government's role in promoting agricultural development is particularly necessary in the less developed and developing countries.

The interest in agriculture's role in the economic growth of Taiwan, however, was not merely in the supply of agricultural output and production resources for industry, but also in the need for maintaining the momentum of its economic transformation and the use of its scarce resources

in two sectors. To be specific, maintaining the relatively constant capital output ratio and the high growth rate of labor productivity without a rapid increase in wage rate in the process of economic development are the major causes contributing to the higher growth rate of the economy as a whole in Taiwan. The abundant resources of labor and scarce capital funds have well been combined with a specific technique to increase output, not along a given production curve, but by upward movement of the production curve, due to the improvement in management and organization, better combination of resource use and technological advancement.

The experience of Taiwan was unique in several respects that are common to the rest of Asia. The historical setting of the early stage of Taiwan's economic development, however, differed to a considerable extent from that of the newly developing countries of Asia. For example, the initial stage of Taiwan's agricultural development occurred at a time of food shortage in Japan. As a Japanese colony at the time, Taiwan had less difficulty in expanding agricultural output to increase foreign exchange earnings. In this respect, the later stage of agricultural development in Taiwan, that after the Second World War, was more similar to the present situation of other Asian countries in so far as the difficulties they encounter in the promotion of their agricultural exports are concerned. As population grows rapidly and the concept of welfare sinks deeper into the people's minds, some measures adopted in Taiwan today might be usefully adopted by the other Asian countries. Taiwan's experience showed how it has made good use of the advantages offered by the current high level of technology and the inflow of foreign capital to supplement domestic resources in production and investment in infrastructure. These are a few examples demonstrating how Taiwan's experience, with some modifications, can be utilized by other countries to accelerate their agricultural and rural development. The most important task for students and planners is to study and evaluate Taiwan's remarkable achievements against its local situation and basic conditions that differ from those of other countries for modification and practical application.

The most valuable lesson of Taiwan's experience to researchers may lie in its selection of industries and its choice of resource use to achieve a balanced growth of the agricultural and non-agricultural sectors. This, in some ways, makes Taiwan's experience one of the most interesting economic growth models for other countries.

Chapter II.

Conception

A. Theoretical Model for Agricultural Development

For the convenience of analysis, we may divide the whole national economic structure into two sectors: agriculture (A) and non-agriculture (N). As economic development is expressed in terms of an increase of per capita real income over a period of time, we may indicate the rate of change of per capita real income as G. Then, G is the weighted sum of G_A and G_N, or $G=G_AW+G_N(1-W)$, where W indicates the weight of per capita real income from agriculture. According to Engel's proposition, increase of per capita real income tends to decrease the proportional expenditure for food of the individuals. In other words, income elasticity of demand for food is usually less than unity, and increase of per capita real income does not increase the expenditure for food in same proportion for the individuals as the consumption of food is limited by the capacity of human stomach. If we set η as income elasticity of expenditure for food, P the growth rate of population, and D the proportional increase of demand for food, we can obtain a functional relation as indicated by $D=G\eta+P$. This functional relation tells us that the growth rate of total demand for food is a function of (1) per capita real income, (2) income elasticity of demand for food, and (3) the growth rate of population. Since income elasticity of demand for food is always less than unity ($\eta<1$), the growth rate of total demand for food (D) will increase less proportionally than the growth rate of per capita real income (G). As agricultural products are used mainly for food for human consumption, there is a great tendency for the relative contribution of agriculture to national products to decline through long-run process of economic development due mainly to the low income elasticity of demand for food.

If we assume that the shifts of demand and supply curves of agricultural products are at an equal rate during the course of economic development and trend movement under an open economic system as in Taiwan, the rates of change of demand and of supply will be in the same proportion

and the relative prices of agricultural products will remain unchanged. If g indicates the growth rate of average productivity of resources and n as the rate of change in resource use, then, a shift of supply curves of agricultural products and non-agricultural products could be expressed by the following models:

$$\text{Supply of agricultural products} = S_A = g_A + n_A$$

$$\text{Supply of non-agricultural products} = S_N = g_N + n_N$$

The above analysis on the elasticity of demand for food has made clear that the rate of increase of total demand for food (D) tends to become smaller than the rate of increase of total real income. In the course of economic development and increase of real income, the increase of total demand for non-food items will be more than that for food items. Therefore, under the assumed condition, the supply of agricultural products (S_A) will increase less proportionally than the supply of non-agricultural products (S_N). Moreover, the growth rate of average productivity in agriculture g_A and the rate of change in resource use in agriculture n_A tend to decrease in the process of economic development because of more human resource and other limited resources employed in the agricultural sector. On the other hand, the situations in industrial sector are quite different from those in agricultural sector in several aspects: First of all, the limitation of land resources in industrial production is not so important as in agricultural production. Secondly, the operation of the law of diminishing returns in agriculture is usually more effective than in industry, and many industrial operations are under the condition of increasing returns to the scale of operation. Thirdly, industry generally benefits by higher levels of technological and mechanical innovation than in agriculture. Due mainly to these reasons, the increase of the average productivity in agriculture always lags behind the increase of average productivity in industry in the process of economic development. As a result of this unequal rate of growth of average productivity in the agricultural and non-agricultural sectors, per capita real income in agriculture tends to increase at a diminishing rate and to be at a lower level than that in non-agriculture. In an underdeveloped country, agriculture usually stands as the mainstay of the economy, contributing to the major source of national income, and per capita real income in agriculture (G_A) constitutes a large proportion of the per capita real income in general (G). Therefore, a trend of decreasing growth rate of G_A in the process of eco-

nomic development of the underdeveloped countries will hamper greatly the improvement of overall position of per capita real income (G) in the economy. Economic development will be retarded by such a situation.

As the basic problem in this connection is the unequal growth rate of average productivity in agriculture and non-agriculture in the process of economic development, it is, therefore, necessary to increase the average productivity in agriculture to a level at par with non-agriculture. This means that action should be taken to shift labor force out from agriculture to non-agriculture or to increase the supply of non-human resources in agriculture in order to change the pattern of resource combination and use in agricultural sector. This is another challenge to the economic planners and executives to maintain the comparable growth rates of agriculture and non-agriculture for a balanced development of the economy in the process of long-run economic development.

The situation which has just been considered and discussed might represent the economic phenomenon of economic development in the capitalistic countries judging from the past experience and historical development of those countries. Problems encountered today in the underdeveloped areas are quite different from those in the capitalistic countries during the process of their economic development. In the early period of economic development, the capitalistic countries were generally benefited by the vast opportunities in the economic frontier and colonies. The profits of war also contributed to the procurement of capital and expansion of market outlets for their economic development. These benefits are now not available to the underdeveloped countries. The functions of agriculture in the underdeveloped countries today are not only to shift employment from agriculture to other industries to meet the increased demand for labor, but also to fulfill the following responsibilities for industrialization: (1) to provide adequate supply of food and raw materials to meet the requirements of the increasing population and new industries, (2) to expand the domestic market outlets for industrial products through the increase of purchasing power in agriculture, (3) to accumulate adequate capital in agriculture for contribution to industrial development and to expand agricultural exports for exchange of increased imports of capital goods for industrialization, and (4) to adjust the resource allocation and use in agriculture for more diversified production of food products to meet the

change of consumption pattern in the process of economic development.

As agriculture usually constitutes the major industry in the national economy of the underdeveloped countries, agricultural development will naturally play an important role in the industrialization of those countries. At the initial stage of industrialization, the prevailing situations existing in the underdeveloped countries, such as rapid growth rate of population, shortage of capital and technicians, bottleneck of resource use, lack of social overhead and public utilities, and other traditional social and institultional conditions, are generally unsuitable for economic development and will constitute a hindrance to economic growth of those countries. Among the improvements that are conducive to econcmic development, increasing agricutural production and level of per capita real income in agriculture are the necessary and sufficient conditions for supporting economic development in general. Increasing agricultural production usually necessitates the diversion of more resources and adoption of improved technology in agricultural production, which, in turn, always require more capital use in the production process. Taking the small scale operation of agricultural production in Taiwan as an example, it is easy to observe that new technological improvements in agriculture, such as improved seeds, more input and better use of fertilizer, land improvement, new and improved farm implements and improved irrigation facilities, always require additional input of capital in the production process. Therefore, technological improvements in agriculture are closely related to more intensive use of capital in agricultural production. Consequently, we can say that the investment plan for agriculture will play a very important role in agricultural development, and a successful arrangement of investment targets is the pre-requisite for successful operation of agricultural development program.

B. Productivity and Factors Affecting Production Efficiency

As explained previously, economic progress is generally conceived in terms of rising real income per person. Defined in this manner, economic progress can be achieved through advance in techniques of production which will enable us to produce a greater output with the input of a given quantity of resources, or it may occur as a result of the substitution between labor and capital, or as an effect of resource shifting from sector of lower productivity to sector of higher productivity. Accepting this concept of economic progress, the changes of productivity could be considered in two

respects: technological effects of productivity change and economical effects of productivity change.

For the measurement of technological and economical effects on productivity changes, a number of economists have suggested an approach based on the changes in total input per unit of output. If we compile the Laspeyres input index and the Laspeyres output index from a base year (T_0) to a current year (T_1), the percentage difference of indices of input per unit of output between T_1 and T_0 indicates the improvement of economic efficiency which is contributed by technological and economical effects during the two periods. This means that the production function in two periods could be represented by a linear equation and a technological process in the base period (T_0) is replaced by a new technological process in the second period (T_1). Set output as O, the rate of change in technological contribution to output as A(t), capital input C, labor input W and land input L, production function in linear form could be written as $O=A(t).f(C.W.L.)$. Difference of the technological process in T_1 period and T_0 period can be conceived as the change of the rate of combination in productive resources. The rate of change in technological contribution to output A(t) in different processes in the two periods is the strategical factor influencing the output change yearly.

From the above consideration on the procedure to measure economic development in agriculture, percentage change of output is simply conceived as the problems of resource combination and levels of technological and economical contribution to output.

Productivity is not an observable variable, but an induced concept measured in terms of output per unit of input used. It represents, therefore, a joint efficiency of productive resources and capacity of production. On individual farm, there may be many measurable and unmeasurable factors affecting its productivity. For instance, soil fertility, manager's ability, resource input and capability of response to new technological improvements are all important factors. But in aggregate sense, the factors affecting aggregate agricultural production are different from those affecting the individual farms. The changes of aggregate agricultural productivity are affected by two factors: technological effects and economic effects.

Technological effects stem from changes in production capacity induced by different combinations of resources in agriculture under new technical conditions or induced by qualitative improvements of resources. Defined in this manner, we could suggest that technological effects are the cases of productivity changes that occurred in either crops or livestock production. The measurement of the changes of technological effects for the whole agriculture was made by aggregating productivities of different sectors in agriculture between two periods after consideration was given to the weights of resource use in different sectors. It means that an aggregate technological effect in agriculture is a compounded concept of sector's productivities, and could be indicated by the requirement of less input to produce a given output in agriculture. On the other hand, economic effects are conceived as the results of changes of relative contribution of individual sector to the aggregate productivity due to the shifting of resources between sectors, and the measurement of the economic effects is made by estimating the difference between two periods of the overall productivity in agriculture based on the fixed weights of sector's resource use and the overall productivity based on the variable weights of sector's resource use.

Economic effects on agricultural productivity will happen not only under the above-mentioned situation, but also under a situation of resource shift between agriculture and non-agriculture. However, such kind of economic effects on agricultural productivity is excluded from this study for the reason that the scope of our analytical review is limited to an analysis of aggregate productivity of agriculture in Taiwan.

In addition to the technological and economic factors, there are institutional factors affecting the changes of agricultural productivity. For instance, land reform, rent-reduction, reorganization of farmers' associations, strengthening of rural credit activity, improvement of rural organization, etc. are all institutional factors affecting agricultural productivity. As institutional factors produce only indirect effects on agricultural production and are relatively difficult to measure in terms of quantity and statistics, economists, in most cases, usually made descriptive statement to present their effects on agricultural productivity without going into statistical verification. It is for this reason that the effects of institutional factors on agricultural productivity shall not be appraised statistically in

this study, but a descriptive statement shall be made on their possible effects on agricultural development in Taiwan.

Chapter III.

Trends in Farm Output

The efforts for economic development in Taiwan started around 1898—the third year of Japanese occupation. Throughout the period from then to 1960 or the period under review, agricultural development had been a vital component of the overall economic program on the island. An upward trend in agricultural production marked the entire period except for the short-run decline in output during World War II.

Broadly speaking, the whole period could be divided into four phases of development. The first phase covers the period from 1910 to 1939, representing an initial and continued development of Taiwan agriculture under the colonial condition. The second phase extending from 1940 to 1945, was characterized by a downward trend of agricultural output due to war damage. The third phase covers the period from 1946 to 1952, representing a recovery and rehabilitation of Taiwan agriculture after the war period. The fourth phase represents further development of agricultural resources and technology since 1952. Taking 1935-37 as a base period, the movement of the indices of aggregate agricultural output for the whole period, 1910-60, is shown in Figure 1.[1]

The computed regression equation indicating the trend line of the first phase of development, 1910-40, could be represented by: $Y=31.14+2.38t$, in which Y indicates the index of output and t the number of years. It means that the aggregate agricultural output during the first phase of development increased annually at 2.38%. The aggregate output index was about 40% in 1910, and reached to 107% in 1939, the highest year in the first phase of development. During the period of World War II, agricultural production decreased from 107% in 1939 to 48% in 1945, or a decrease of about 55% during six years. Beginning from 1946, Taiwan

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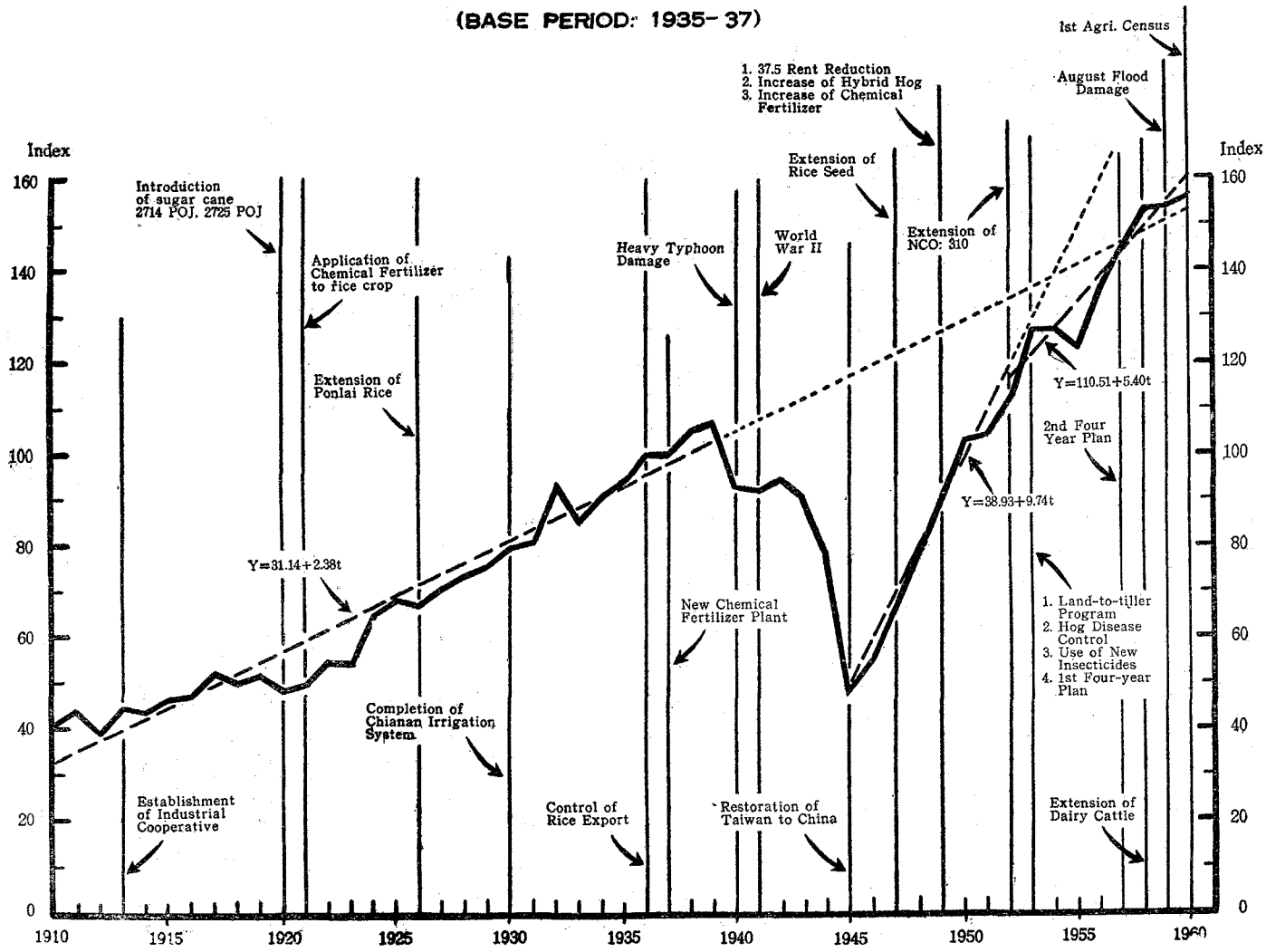
[1] S. C. Hsieh and T. H. Lee "An Analytical Review of Agricultural Development in Taiwan" —An Input-Output and Productivity Approach— Chinese-American Joint Commission on Rural Reconstruction, Economic Digest Series No. 12, July 1958, Chapter II.

FIGURE 1; INDEX OF AGGREGATE AGRICULTURAL OUTPUT IN TAIWAN
(BASE PERIOD: 1935–37)



agriculture experienced a rapid rehabilitation and further development as indicated by the computed regression equations for the period 1945-52: $Y=38.93+9.74t$; for the further development period 1952-60: $Y=110.51+5.40t$. The equations indicate the constant annual increments of 9.74% and 5.40% for the respective period, which is more than four and two times of the annual increment of output in the first stage of development. The highest aggregate output index was registered at a level of 155% in 1960, which is a higher level of output in 1960, projected from the regression equation for the period 1910-40. The two projected regression lines for the first and third phases of agricultural development intersected at the year of 1957 and this fact indicates that the trend of agricultural production of Taiwan already recovered to the long-run trend output until 1957, even though the pre-war maximum output was recovered in the year of 1951.

The higher level of output in 1960 in comparison with the secular trend output projected on the basis of 50 years' experience of development will have great economic significance on agricultural development in Taiwan, since it is generally expected that over a relatively long period of time, the rate of agricultural development in the later period will be smaller than that in the previous period due mainly to the limitation of land resource and the operation of the law of diminishing returns in agriculture. As the slope of the regression line for the period 1945-52 represents a high rate of annual increment of output during the recovery and rehabilitation stage of Taiwan agriculture, the rate of annual increment of output, 9.74% was declined to 5.40% in the latter period of further agricultural development.

For further analysis and review of agricultural development, annual growth rate of agricultural output is introduced in this study. The annual growth rates of agricultural output in different stages of development of agriculture in Taiwan are shown as follows:

Table 1. Average Annual Growth Rate of Agricultural Output in Different Stages of Agricultural Development in Taiwan, 1910—60

Stage of Development	Period	Average Annual Growth Rate of Agricultural Output	Average Annual Growth Rate of Total Population
Initial stage of agricultural development under Japanese colonization rule of Taiwan	1910—20	1.66%	1.31%
Continued development of agriculture under Japanese colonization rule of Taiwan	1920—39	4.19	2.40
Agricultural development under the impact of World War II	1939—45	-12.32	0.46
Recovery & rehabilitation stage of development of agriculture after the war	1945—52	12.93	4.93
Further development of agriculture after the rehabilitation stage	1952—60	3.98	3.61
Average of pre-war period	1910—39	3.31	2.02
Average of post-war period	1945—60	8.06	4.17
Average of whole period	1910—60	2.67	2.40

It can be seen from the above table that the average annual growth rate of agricultural output fluctuated considerably during the period under review. It rose from 1.66% in the initial phase of development (1910-20) to 4.19% in the second stage of continued development (1920-39). Then, during the war years (1939-45) due to typhoon and war damages, it dropped sharply to -12.32%. During the post-war period of recovery and rehabilitation (1945-52), the agricultural output again expanded rapidly at the average annual growth rate of 12.93%, but after that the growth rate slowed down and registered an average of 3.98% annually during 1952-60. On the whole, the annual growth rate of agricultural output at 2.67% in Taiwan is higher than those in most of the developing and developed countries in the corresponding period.

It is necessary to compare the average annual growth rate of agricultural output with the average annual growth rate of total population in Taiwan in order to clarify the real situation of agricultural development in relation to the general economy of Taiwan over the 50 years under review. As shown in Table 1, it can be seen that except the wartime period, 1939-

45, the average annual growth rates of total population in Taiwan were always smaller than the average annual growth rates of agricultural output in all other four periods of agricultural development. The average annual growth rate of population for the whole period, 1910-60 inclusive, was 2.40% while that of agricultural output was 2.67%

A. The Initial Phase of Agricultural Development

Table 1 shows that agricultural development in this period progressed slowly. The annual growth rate of agricultural output averaged only 1.66%, but population increased at less rate of 1.31% per annum. For lack of adequate statistics, it will be difficult to examine the conditions of agricultural development in 1895-1910, the earliest stage of Japanese occupation of the island. However, there are some relevant data available to indicate a significant change in the initial phase of agricultural development.

Table 2. Acreage and Output of Major Crops, 1900-1920

	Brown Rice		Sugarcane		Sweet Potato		Cultivated Land (ha.)		
Year	1,000 ha.	1,000 m.t.	1,000 ha.	1,000 m.t.	1,000 ha.	1,000 m.t.	Total	Paddy land	Dry land
1900	326	307	16	410	40	206	347	194	153
1905	447	622	24	694	98	684	625	305	320
1910	456	598	62	2,161	102	642	674	332	342
1915	491	684	86	2,360	110	810	700	343	357
1920	500	692	105	2,630	112	837	749	367	382

The above table shows that the production of rice, sugarcane and sweet potato prior to 1910 increased rapidly in both acreage and output, and there was also a fast growth in cultivated land area. After 1910, however, the situation changed, and these increases came about apparently at much slower rates. Similarly, the per hectare yields of crops also increased more rapidly in the former period than in the latter, as shown in the following table:

Table 3. Increase of Per Hectare Yields of Major Crops, 1900-1920

Year	Brown Rice (kg.)	Sugarcane (kg.)	Sweet Potato (kg.)
1900	943	25,572	5,169
1905	1,390	28,564	6,949
1910	1,311	35,134	6,285
1915	1,392	27,366	7,354
1920	1,383	25,015	7,417

The period of 1910-20 can therefore be called the latter period of the initial phase of agricultural development in Taiwan in the setting of Japanese occupation. The expansion of agricultural output was slow in the period when compared with that in 1895-1910.

B. Continued Development of Agriculture under Japanese Colonial Rule

For the entire period under review, agricultural development in 1920-39 was second only to that of the postwar period of recovery and rehabilitation from 1945 to 1952 in so far as the rate of development was concerned. The annual growth rate of agriculture in this period averaged 4.19%. In terms of sub-sectors, crop production marked at 4.4%, followed by livestock at 2.7%. Among them, crop production was the most important which accounted for 88% of total agricultural output. As the growth rate of crop production surpassed the population increase rate of 2.40% in the period, a triple increase in agricultural export in terms of constant dollar value was made possible. The percentage of agricultural exports in total agricultural production also increased from 23% in 1921-25 to 42% in 1936-40. Meanwhile, the per capita consumption of food increased by more than 30%.

C. Period of Recovery and Rehabilitation

Agricultural production in the period from 1940 to 1945 decreased rapidly due largely to typhoon and war damages. Total output in 1945 went down nearly to the 1910 level. Since this period was relatively of less importance, it is skipped from our review.

Taiwan was restored to China and placed under a different administration system after World War II. Its economy was in disorder at the beginning of the postwar period. Inflation threatened the people's living, and the situation of food shortage was aggravated by the large influx of migrants from China mainland. The price of food was 40% higher than the general price level in 1945-50. However, this situation did not last long. Under the favorable price of farm products, and with the continued supply of production goods, particularly chemical fertilizer, from UNRRA, agricultural production revived gradually and steadily. The positions left by Japanese technicians were filled up by Chinese by late 1940's, but most of the farmers' organizations were inoperative during the period.

In 1949, JCRR started in Taiwan to handle the agricultural part of US economic aid provided in the form of technical and financial assistance systematically and effectively. By 1952, most of the projects for agricultural recovery and rehabilitation were completed. The index of agricultural production with 1935-37 as base was 113 in 1952 as compared with 106.5 in 1939. Intensive land use and diversification of farming were the important factors contributing to the increase of agricultural output in this period. Statistical finding indicates that the total crop production index in 1949 was only 89% of the 1939 level, while multiple-cropping index rose by 25% in the same period. Total cultivated land area increased slightly by 16,532 ha., from 859,568 ha. in 1939 to 876,100 ha. in 1952. On the other hand, the total number of farm families increased by 251,258, from 428,492 in 1939 to 679,750 in 1952. Agricultural population also increased by 1,332,355 persons, from 2,924,781 in 1939 to 4,257,136 in 1952. This fact resulted in the rapid decrease of average farm size from 2.0 ha. in 1939 to 1.3 ha. in 1952. Due to the expansion of crop acreage, however, the average crop area per farm decreased at a slower rate.

From the foregoing review, we can call the period from 1945 to 1952 the recovery phase of agricultural technology after World War II. However, the main achievement in technological rehabilitation was mainly connected with diversification of farming rather than increase of crop yield.

D. Period of Further Growth

In this period, 1952-60, agricultural production went up steadily toward a long-run trend of continued growth extended from the period of 1910-40. In spite of the inherent unfavorable basic conditions created by insufficient land resources and overpopulation, agriculture of Taiwan advanced impressively in the period.

After 1952, agricultural output has continuously increased. The agricultural output index registered at 136.73 in 1960 compared with the base of 1952 as 100. The achievement of agricultural output in the period of 1952-60 is slightly lower than that in 1920-39, and far less than that in the recovery period of 1946-52.

The decline of the annual growth rate of agricultural output in the period of further development was due mainly to the limited land resource

and the natural hazards of floods occurred in 1959 and 1960. oCmpared with population growth in 1952-60, the trend of the annual growth rate of agricultural output declined, while the trend of population growth rate was maintained at about the same level.

The postwar advance of agricultural technology was most remarkable. Following the technical progress made in the pre-war period, new and improved methods or techniques were continuously being developed and put into general practice. Small farmers made effective use of the new chemical and fertilizers and other production goods which became increasingly available. The major progress of agricultural technology which was seen in this period included the extension of optimum application ratio of fertilizer and increase of the use of compost; rapid increase of the application of pesticides such as BHC, DDT, Parathion, etc.; new varieties of rice, sugar cane, pineapple, tobacco, peanut, sweet potato, tea, orange, wheat and soybean which have been developed through introduction, selection and hybridization for higher yield, good quality, disease resistance and/or early maturity; the extension of improved cultural methods including the practice of small-hill-close-spacing and straight-row transplanting in rice culture, drilling wheat in rows instead of broadcasting, deep plowing by tractors and power-tillers in sugar cane culture, closer planting distance for pineapple, terracing or contour planting in fruit orchards and intercropping system of vegetable, sweet potato, sugar cane, peanut and soybean. As a result of the technical effort made in this period, considerable gains have been made in boosting the per hectare yield, and in increasing the index of multiple cropping with a better crop rotation system.

The livestock improvement programs included the establishment of prefectural veterinary diagnostic centers, conducting the mass vaccination of hog and other livestock, the programs of hybrid hog production and its extension, promotion of dairy cows and use of artificial insemination in breeding animals [1].

In conclusion, the agricultural development in this period can be summarized as a stage of intensive technical development in relation with

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[1] T. H. Shen, Agricultural Planning and Production, Taipei, Taiwan, China, March 1958.

capital and labor. Injection of new idea to move was continuously being made through JCRR's technical and financial assistance and programs or projects for improvement and development were carried out by the sponsorship of government and private agricultural agencies at various levels.

Table 4. Indices of Major Crops and Livestock in Taiwan

	Total output	Food Commodities								Fiber crops	Cocoon	Special crops
		Total	Main food	Substitute food	Beans	Vegetables	Fruits	Miscellaneous food	Meat & livestock poultry products			
1911—15	100.00	100.00	100.00	100.00	100.00	—	100.00	100.00	100.00	100.00	100.00	100.00
1916—20	115.19	115.22	103.78	106.48	106.27	100.00	183.66	155.76	116.07	109.81	255.92	104.57
1921—25	134.10	134.19	121.24	130.62	79.05	349.25	396.94	162.70	126.14	124.52	487.65	80.11
1926—30	165.64	165.79	147.05	159.15	65.16	513.09	536.26	210.62	152.27	144.26	699.56	99.97
1931—35	202.60	202.74	185.74	191.28	60.36	669.76	746.47	229.71	178.95	191.80	572.74	95.07
1936—40	229.35	228.82	196.15	205.18	53.06	708.27	879.82	326.44	198.25	353.14	439.30	130.56
1941—45	182.64	182.15	159.92	190.08	48.16	587.21	589.93	276.21	124.64	263.87	325.34	253.84
1946—50	178.70	177.76	178.54	249.77	112.52	846.45	518.77	153.29	111.83	226.06	283.88	813.65
1951—55	269.90	264.64	249.47	299.44	195.76	1,072.69	544.59	254.89	251.33	460.24	1,127.44	4,181.05
1956—60	337.08	330.79	294.37	374.86	379.24	1,266.25	754.92	335.85	373.02	653.68	1,998.34	4,567.42

Attention is now turned to the growth of individual crop and livestock production in Taiwan. With the changes in food consumption pattern and foreign requirements in the long period, production of agricultural output has shown the different rates of increase in group items. As shown in Table 4, the indices of commodity groups classified by consumption indicate unequal rates of growth in both pre-war and post-war periods.

It can be seen in Table 4 that 1936-40 and 1956-60 were the peak years of total agricultural output in Taiwan before and after the war, respectively. Judging from the total output indices of agriculture in the period 1956-60, it can be said that Taiwan is still experiencing an expanding agriculture. If comparison is made between the two periods before 1935-40 and after 1945-50, which were under different economic conditions as explained in the foregoing part of this section, it is clear that the production patterns of crops and livestock in the post-war period were quite different from that in the pre-war period. An aggregate index of total output in 1936-40 compared with 1911-15 was 229.35 with an index of 228.82 for all food crops and livestock, 196.15 for main food crops (rice, wheat, etc.), 205.18 for substitute food crops (sweet potato and corn, etc), 53.06 for beans, 708.27 for vegetables, 879.82 for fruits, 326.44 for miscellaneous food crops (sugar cane, and peanut, etc.), and 198.25 for meat and livestock, poultry products. Fiber crops registered at 353.14, cocoon for 439.30 and special crops for 130.56. From then, indices of crops and livestock declined sharply and reached their lowest levels in 1946-50, under which the total agricultural output decreased by about 22%, with main food crops decreased by 9%, fruits 41%, miscellaneous food crops 53%, meat and livestock, poultry products 44%, fiber crops 36%, cocoon 35% and with the increase of substitute food crops by 22%, beans 112%, vegetables 20%, special crops 523%. After the restoration of Taiwan to China in 1945, the whole economic condition of Taiwan has been changed from the colonial dependency on Japan to an independent economic system. This change of economic structure of Taiwan has also influenced greatly the patterns of agricultural production. During the period of 1946-60, agricultural production had been recovered to the pre-war level and advanced to a large extent. The index of total agricultural output reached a high level of 337.08 in 1956-60 which was higher than that in 1936-40. Between the peaks of agricultural output in 1936-40 and 1956-60 in the pre-war and post-war periods, total agricultural output in Taiwan increased by about 47%, but the rates

of change of individual crops and livestock products varied, and the relative ratio of crops and livestock in total agricultural output had also been changed as seen in Table 5.

In the pre-war period, miscellaneous food crops including sugar cane and peanuts, etc. and fruits had shown a remarkable increase in its relative importance while common food crops had decreased and other crops had been kept quite stable. This reflects the fact of colonial dependency of Taiwan with exporting more sugar and fruits to Japan. That situation has been altered after the war, and the domestic food and raw material requirement has become the most important incentive to agricultural production. It means that after the war period the exportable sugar decreased rapidly, while rice, special crops, vegetables, beans and livestock products increased quite rapidly. Their relative ratios were also increased. Such changes of crop pattern and production structure in Taiwan reflects the fact that diversification of agricultural production was advanced in accordance with the change of dietary pattern of national consumption and comparative advantage of crop production through the influence of domestic and foreign markets. The more detailed analysis of agricultural production indicates that exportable crops and import substitution commodities have increased, while the products for the basic foods such as wheat, sweet potato and rice increased at a smaller rate.

Such change of product choice in the recent period of development is quite different from the trend of production pattern dominated in the period 1945-56. This fact reveals that the open economic system of agriculture is more appropriate and necessary means for Taiwan today to achieve the balance of supply of and demand for agricultural products.

The structural changes of total requirement of agricultural products brought about by long-run period of economic development are shown clearly in Table 5, which indicates not only the trend of domestic consumption, but also the trend of foreign requirement of agricultural products of Taiwan. It is rather difficult to distinguish the changes of domestic requirement from foreign requirement of Taiwan agricultural products. However, as Table 5 indicates, the quantities of exportable products, such as fruits, other foods including sugar and tea have decreased, while the quantities of products for domestic consumption, such as rice, wheat, beans, vegetables, meats and other livestock products have generally increased.

These facts are consistent with the economic situations of a rising per capita real income, rapid increase of population and change of the whole economic system happened in recent ten years in Taiwan. Such change of product choice in agriculture will continue to happen in the future, and agriculture of Taiwan tends to produce more products for domestic consumption than for export.

Table 5. Relative Importance of Crops and Livestock in Total Agricultural Output

	Total output Total	Food Commodities												Special crops
		Total food	Main Food		Auxiliary Food						Fiber crops	Cocoon		
			Common food	Substitute food	Beans	Vegetables	Fruits	Miscellaneous food	Meat and livestock and poultry products					
1911—15	100	99.38	61.44	7.42	1.35	—	0.97	15.09	13.11	0.50	0.01	0.11		
1916—20	100	99.41	55.19	6.86	1.24	0.96	1.54	20.41	13.21	0.48	0.01	0.10		
1921—25	100	99.45	55.04	7.23	0.79	2.89	2.86	18.31	12.33	0.47	0.02	0.06		
1926—30	100	99.47	54.01	7.13	0.53	3.43	3.13	19.19	12.05	0.44	0.03	0.06		
1931—35	100	99.45	56.13	7.01	0.40	3.66	3.56	17.11	11.58	0.48	0.02	0.05		
1936—40	100	99.15	52.26	6.64	0.31	3.42	3.71	21.48	11.33	0.77	0.01	0.07		
1941—45	100	99.12	52.58	7.73	0.36	3.56	3.12	22.83	8.94	0.72	0.01	0.15		
1946—50	100	98.86	58.43	10.38	0.85	5.25	2.80	12.95	8.20	0.64	0.01	0.49		
1951—55	100	97.45	55.42	8.24	0.98	4.41	1.95	14.25	12.20	0.86	0.02	1.67		
1956—60	100	97.53	51.89	8.26	1.51	4.16	2.16	15.04	14.51	0.97	0.04	1.46		

Chapter IV.

Trend of Agricultural Inputs

With comparatively high degree of growth rate, agriculture in Taiwan has experienced a great expansion of output over a long period of about 50 years. However, it has been observed that the annual growth rate of output tends to decline after 1936-40 and agricultural output in recent years has risen at a decreasing rate of growth. Up to the present time, the increase in agricultural output is still greater than the increase of population, and agricultural production is still in adequate supply to meet the requirements for domestic consumption and exports. In other words, demand and supply curves of agricultural products in Taiwan have shifted at the same direction to the right. Since the relative prices of farm products to non-farm products remained approximately unchanged in the period under review except during the period of World War II, it can be assumed that the shifts of demand and supply curves were at about equal rates. However, this situation has been witnessed in such a way that the shift of supply curve has been slower than that of demand curve in the recent period. As regards the shift of supply curve of farm products, we need to consider two factors affecting the expansion of agricultural output: (1) increase of input factors used in agricultural production, and (2) improvement and advancement of technology and transformation of agricultural organization. This section deals primarily with an analysis of the changes of resource use and inputs in Taiwan agriculture.

Let us examine, first, the changes of inputs in agriculture occurred in the period from 1911-15 to 1956-60. Taking 1911-15 as 100, index of aggregate input in agriculture computed at constant dollar of 1935-37, increased to 150.46 in 1936-40 and then decreased to 134.55 in 1946-50. After this period, it increased again to 184.19 in 1956-60. Comparing the index of aggregate input with the index of aggregate output, it is clear that the increase of inputs between the period of 1911-15 and 1956-60 is about 84%, while the increase of outputs is about 237%.

The trend of change of agricultural inputs in the period 1911-15 to

1956-60 is shown in Table 6. Among the input factors, cultivated land area was the most stable input with least increase of 26.52% from 1911-15 to 1956-60. In actual figures, cultivated land area was about 692,272 hectares in 1911-15 and increased to 875,897 hectares in 1956-60. The average annual increase was about 4,100 hectares. But it increased more rapidly at the average of 6,500 hectares per annum in the early period of 1911-1940 compared with the annual increase of 990 hectares in the latter period of 1936-60. In fact, the cultivated land area reached the maximum of 883,466 hectares in 1958 and then declined to 869,223 hectares in 1960. It can, therefore, be expected that the future expansion of cultivated land area in Taiwan will be very limited. However, the expansion of crop area was quite significant

Table 6. Indices of Agricultural Inputs in Taiwan

	Cultivated Land Area	Crop Area	Agricultural Worker	Labor Input	Working Capital	Fixed Capital	Aggregate Input
1911-15	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1916-20	105.64	107.35	97.32	111.56	130.94	109.55	109.46
1921-25	109.56	114.12	97.54	118.09	160.13	183.52	117.74
1926-30	115.88	121.82	102.87	125.82	225.90	319.07	132.29
1931-35	118.49	133.82	111.38	138.87	279.74	339.49	141.11
1936-40	123.67	141.21	119.01	144.62	324.92	309.97	150.46
1941-45	120.91	136.18	—	138.52	189.09	281.86	134.83
1946-50	123.20	159.78	143.60	141.38	163.68	268.33	134.55
1951-55	126.24	186.26	150.83	178.74	381.73	318.14	166.13
1956-60	126.52	195.43	149.42	198.44	511.66	389.86	184.19

in the period from 1945 to 1950 during the recovery stage of agricultural development. From 1952 to 1960, crop area increased only to a small extent reflecting also the limit for its further expansion.

As two to three crops are usually grown on the same piece of crop land in Taiwan every year, so long as other resources and irrigation facilities permit, the input of crop area is, therefore, more flexible than the input of land area. Furthermore, crop area is also affected by the changes of acreages planted to perennial or long-term crops. For instance, the growing period of sugarcane usually takes about 15-18 months, or an equivalent period for growing three crops of rice or sweet potato. The shifting of acreages from sugarcane to other crops will increase the crop area. The

sugarcane acreage in 1959-60 decreased by about 41 per cent from the acreage of 1938-39, resulting in the increase of 39 per cent of the total crop area in 1960. As crop area is fundamentally restricted by the acreage of land and the limit of multiple cropping, further expansion of crop area in the future in Taiwan will be at a much lower rate than in the past.

Agricultural workers in Taiwan also experienced an increasing trend during the period under review. They accounted for about 1,155 thousand workers in 1911-15, and increased to 1,725 thousand in 1956-60, or an increase of about 49 per cent in 45 years. The average annual growth rate of agricultural workers was about 0.9 per cent, which is far below the annual growth rate of agricultural population at 2.5 per cent. In recent years, the total number of agricultural workers in Taiwan was comparatively stable and maintained at a level of around 1,700 thousand. This indicates that with the restriction of land resource, agriculture will provide only limited additional opportunity for the employment of more working population in agricultural production and under-employment represents one of the serious problems in agriculture in Taiwan. Development of industry and other lines of economic activities is necessary to facilitate the movement of working population out of agriculture to other sectors. Farm operation in Taiwan is characterized by intensive use of labor. Average labor input per hectare of land increased from 195 man-days in 1911-15 to 305 man-days in 1956-60, indicating an increasing trend of labor input per hectare in agriculture during the period under review. On the other hand, the annual average working days per farm worker was 117 man-days in the period 1911-15, and increased to 143 man-days in 1926-30 and decreased to 138 man-days in 1951-55 and increased again to 155 man-days in 1956-60, indicating an increasing trend of working days per worker in future. These facts show that more intensive labor input in agriculture will become more serious than ever. Total labor input in agriculture was about 135 million man-days in 1911-15, and increased to about 268 million man-days in 1956-60, or an increase of about 98 per cent, which is larger than the increase of agricultural workers in the same period.

The supply of working capital in Taiwan agriculture indicates greater flexibility than the supply of other inputs. The index of working capital reached to as high as 511.66 per cent in 1956-60 compared with 1911-15. It shows that working capital including fertilizer and feed inputs is the most

important strategical factor influencing the expansion of agricultural output. The annual input of chemical fertilizers used in agriculture was 50,767 m/t in 1911-15, increased to pre-war maximum of 483,042 m/t in 1936-40, and then decreased to only 129,508 m/t in 1946-50. After the war, it was recovered to 483,419 m/t in 1951-55, and further increased to 663,534 m/t in 1956-60. Innovation in Taiwan agriculture is featured primarily by the increased use of fertilizer which requires relatively small capital outlay and permits application in variable quantities on small farms. As farmers in Taiwan are dominantly small operators, generally handicapped by small acreage of land plot and shortage of capital, this innovation is of special significance to agricultural development under Taiwan's condition. For these reasons, fertilizer input is conceived as a very important factor in agricultural production in Taiwan, and changes of fertilizer used in production usually exercise a great effect on agricultural output.

Fixed capital includes depreciation on farm houses and farm implements, interest on working cattle, and fee paid for public irrigation service. As shown in Table 6, input of fixed capital in Taiwan agriculture decreased in the period from 1931-35 to 1946-50, and then increased in the period from 1946-50 to 1956-60. Fixed capital input in 1956-60 was about 13 per cent higher than the level in 1935-37. In the period 1951-55 to 1956-60, fixed capital input in agriculture increased by about 23 per cent, while agricultural output increased by about 25 per cent. Estimated deflated fixed capital input at 1935-37 constant dollar accounted for Taiwan dollar 22,144 thousand in 1931-35, decreased to 17,504 thousand in 1946-50, and then increased to 25,400 thousand in 1956-60. Since Taiwan agriculture recovered rapidly after the war and irrigation facilities were extensively rehabilitated and expanded, people may question why fixed capital input in agriculture in 1956-60 was not much higher than the level of 1931-35. In fact the flow cost of fixed capital input in terms of current monetary value in 1956-60 was greater than that in 1931-35. But due to the rapid depreciation of currency in Taiwan after the war, deflated fixed capital input in 1956-60 in terms of constant dollar increased not so much as in 1931-35. Taking irrigation as an example, the irrigated area under the management of public water conservancy associations was about 236,135 hectares in 1911-15, and increased to 456,806 in 1931-35 and 527,293 in 1956-60.

Table 7. Percentage Distribution of Input Categories in Taiwan Agriculture

	Land Area	Labor Input	Working Capital	Fixed Capital	Total
	%	%	%	%	%
1911-15	62.98	26.29	8.61	2.12	100.00
1916-20	60.78	26.80	10.30	2.12	100.00
1921-25	58.62	26.36	11.72	3.30	100.00
1926-30	55.18	25.00	14.71	5.11	100.00
1931-35	52.89	24.94	17.08	5.09	100.00
1936-40	51.77	25.27	18.60	4.36	100.00
1941-45	56.48	27.01	12.08	4.43	100.00
1946-50	57.67	27.62	10.48	4.23	100.00
1951-55	47.87	28.28	19.79	4.06	100.00
1956-60	43.27	28.32	23.93	4.48	100.00

The change of the relative importance of different categories of input in agriculture could be indicated by the change of percentage distribution of input categories in every five years during the period under review.

As indicated in Table 7, it can be seen that land area is the most important input of agricultural production in Taiwan accounting for on an average more than 50 per cent of the total input. Due to the effect of war, the percentages of working capital and fixed capital input declined to a low level in 1946-50 and 1951-55, at only 11 per cent and 4 per cent of the total input, respectively. In the post-war recovery period, the percentage of working capital input increased to about 24 per cent of total input in 1956-60, while fixed capital input increased only to about 4.48 per cent. Therefore, it can be said that the increase of working capital in agriculture represents a significant factor contributing to the rapid recovery of agricultural output in Taiwan after the war.

Observation on relative changes of resource inputs in agricultural production in Taiwan indicates the fact that with relatively constant supply of land area and significant increase of working capital in agriculture, the relative importance of land resource in agricultural production has gradually decreased in the period from 1911-15 to 1956-60. Although supply of land area has been supplemented by the expansion of crop area, fertilizer and irrigation as the major factors of working capital and fixed capital have also substituted for land resource to a great extent in the expansion of

agricultural output. In other words, the limitation of land resource supply has been relieved by increasing land productivity as a result of additional fertilizer and irrigation service inputs.

Therefore, it can be said that the expansion of agricultural output in Taiwan was chiefly accomplished by the substitution of capital for land resource, i. e., to increase the capital/land ratio in agriculture for higher productivity of land. Under such specific relation of resource use between capital and land, the relation between capital and labor is mutually supplementary, i. e., more capital input in agriculture usually calls for more labor input. As indicated in Table 7, with significant increase of capital in agriculture from 1911-15 to 1956-60, the proportion of labor input in agriculture increased very slightly in the same period. The small variation in the percentages of labor input in total input in agriculture over the long period from 1911-15 to 1956-60 indicates that the substitution of capital for labor is limited in a narrow range.

Changes of relative prices of inputs over long period of time will definitely influence the substitution between inputs within the technical feasibility. It is, therefore, worthwhile to analyze the effects of changes in relative prices of inputs on resource use in agricultural production in Taiwan.

Table 8. Indices of Real Prices of Major Inputs in Taiwan Agriculture

	Fertilizer	Soybean cake	Wage	Interest rate*	Rental rate** of land
1911-15	100.00	100.00	100.00	100.00	100.00***
1916-20	106.03	89.85	90.32	93.09	114.80
1921-25	94.74	88.99	83.87	110.57	122.49
1926-30	103.18	88.42	114.52	93.90	128.97
1931-35	89.02	77.66	111.29	85.37	149.71
1936-40	94.00	92.78	146.77	64.64	157.33
1941-45	58.89	64.11	122.57	55.42	134.74
1946-50	149.82	167.04	82.26	669.93	134.80
1951-55	75.28	147.67	100.00	393.09	109.74
1956-60	77.00	158.90	111.29	215.45	107.51

* Interest rate of bank loan.

** Rental rate representing the quantity of paddy rice per hectare of paddy land actually paid by tenants to land owners.

*** For the period of 1914-15 only.

As indicated in Table 8, wage rates in agriculture decreased by 17.74% from 1911-15 to 1946-50, and up to 1956-60, the increase of wage rates was only by 11.29%. These facts indicate that the supply of agricultural workers in Taiwan has increased year after year and that no great shift of agricultural population to non-agricultural sectors occurred in this period has resulted in relative stability of wage rates of agricultural workers. On the other hand, the price of fertilizer decreased by 23% and the price of soybean cake increased by 58.90% in the period of 1911-1960. However, the price of fertilizer was quite stable in the period 1911-45 and increased rapidly to 1946-50 and from then decreased to some extent. The price of soybean cake has the same trend as the price of fertilizer but it decreased quite slowly compared with the price of fertilizer in the period of 1946-60. Local production of fertilizer becomes abundant and the production of soybean cake is not enough to meet the requirements and its major portion of supply depends heavily on imports in recent period. The opposite trends of domestic production of fertilizer and soybean influence the changes in prices at different directions. Land price and rental rate of land had increased quite rapidly in the period of 1911-15 to 1936-40. The decline of rental rate of land in agriculture was witnessed primarily a result of rent ceiling regulation in the Second World War period and rent reduction and land reform program implemented since 1949 which has changed completely the tenure system in agricultural production in Taiwan.

Most prominent increase in the price of input was found in the case of interest rates. It decreased by 45% in the period from 1911-15 to 1941-45, but increased 12 times from 1941-45 to 1946-50 and then declined by 68% from 1946-50 to 1956-60. The present level of interest rate is still kept at a higher level compared with that of 1911-15, indicating an acute shortage of capital in the economy of Taiwan, particularly in the rural areas. It is believed that capital constitutes nationally the bottleneck in agricultural development in Taiwan which has resulted difficulties in agriculture to adopt new technical improvements due to the requirement of more intensive use of capital.

Observation on the changes of relative prices of agricultural inputs in the period of 1911-15 to 1956-60 indicates that the relative prices of farmers' producer's goods (soybean cakes) and interest rates advanced to a much greater extent than the wage rates and rental rates of land. The

price ratio of capital and labor was not favorable for a substitution of capital for labor due to lack of price incentive to induce such a substitution. On the other hand, the substitution of labor for capital in agriculture was favorable in terms of their relative prices and the unlimited supply of labor. However, this factor substitution is limited by the technical combination of labor and capital in agricultural production. Without increase of capital input, it is impossible or unprofitable to increase the labor input in agriculture after the maximum level of labor/capital ratio is reached. Therefore, it is necessary to increase the capital input in agriculture in order that more labor could be possibly and profitably applied in agriculture. Although there was in existence the price incentive for the substitution of land for capital in agriculture after the implementation of land reform in Taiwan, this kind of factor substitution was greatly limited by the inflexibility of physical supply of land resource and the small size of farm in Taiwan.

As a step for further analysis, correlation coefficients between different categories of inputs and output in agriculture for the period of 1935-56 are quoted from the previous study [1] as follows:

Labor input and output:	0.896
Crop area and output:	0.745
Working capital and output:	0.964
Fixed capital and output:	0.557

With the limitation of land area in Taiwan, the expansion of agricultural output depends heavily upon additional working capital and labor inputs as indicated by the high positive correlation coefficients between working capital and output and between labor input and output. In other words, under the agricultural conditions in Taiwan, it is more favorable to adopt technical improvements, which will require more intensive use of capital and labor, for increasing land productivity and labor efficiency. However, increasing land productivity and labor efficiency will necessarily require more fixed capital in the production process.

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[1] S. C. Hsieh and T. H. Lee "An Analytical Review of Agricultural Development in Taiwan" An Input-output and Productivity Approach, July 1958, JCRR, Economic Digest Series: No. 12.

As the study indicates, the relative high prices of producer's goods and interest rates are the major obstacles to capital use and investment in Taiwan agriculture. The economic incentives to induce capital investment in agricultural production on the part of individual farmers are, therefore, hampered. In addition to the technical improvements to increase the efficiency of factor use in agriculture, reducing the levels of relative prices of producer's goods and interest rates is also a basic solution for stimulating capital investment in agriculture. The recommended measures are that the government and the publta institutions should take the place of individual farmers to allocate caipoil funds and initiate capital investment of heavier types in agriculture and procure essential producer's goods for allocation and distribution to the farmers at cost prices.

Chapter V.

Changes in Production Efficiency and Farm Productivity

A. Trend of Production Efficiency

The level of production efficiency in agriculture is usually represented by the amount of input per unit of output. The improvement in production efficiency is indicated by the percentage of input saved in each unit of output as a result of technological advancement in agriculture. Estimation of production efficiency in Taiwan agriculture is made by dividing the aggregate input index by the aggregate output index taking 1935-37 as base period.

Table 9. Production Efficiency in Taiwan Agriculture

(1935–37 = 100)

Period	Aggregate output index	Aggregate input index	Production efficiency (index of input per unit of output)
1911–1915	44.24	66.84	151.08
1916–1920	50.96	73.16	143.56
1921–1925	59.33	78.70	132.65
1926–1930	73.28	88.42	120.66
1931–1935	89.63	94.32	105.23
1936–1940	101.47	100.57	99.11
1941–1945	80.80	90.12	111.53
1946–1950	79.06	89.93	113.75
1951–1955	119.40	111.04	93.00
1956–1960	149.13	123.11	82.55

According to Table 9, efficiency of agricultural production in Taiwan increased in the period from 1911-15 to 1936-40 as indicated by the downward trend of the index of input per unit of output. It decreased again from 1941-45 to 1956-60. The decline in agricultural efficiency during the period 1941-50 was due mainly to the effect of war. As output declined more in proportion than the decline of input in agriculture, the index of input per unit of output increased from a level of about 99 percent in 1936-40 to 113.75 percent in 1946-50. It means that the input

required for producing one unit of output in agriculture in this period was about 14 per cent more than that in 1935-37 base years, reflecting a great decline of agricultural efficiency in the war and postwar period. In the recovery period after the war, agricultural efficiency was improved gradually, and in 1956-60 one unit of output was produced with 17 per cent less input than in 1935-37. The gains in production efficiency in this period have resulted mainly from greater production per hectare and per worker under rapid technological innovations in agriculture in recent years. As indicated in Table 9, in the period from 1911-15 to 1956-60 aggregate input increased by only about 84 per cent, while aggregate output increased by about 237 per cent. The increase of production efficiency stems from the more than proportional increase of output in comparison with the increase of input through the whole period.

Although there was an upward trend in production efficiency in agriculture over the long period of time, cyclical movements have appeared in the time series as the results of war and natural hazards and the accompanying variations in economic conditions. After reviewing the cyclical movements of production efficiency and the underlying influencing factors, it is clear that efficiency of annual agricultural production experienced an up-down-up movement in an upward trend during the period 1910 to 1960. The underlying factors influencing the movement of agricultural efficiency could be divided into six periods. The first is the period of 1910-20, the second 1921-26, the third 1927-34, the fourth 1935-40, the fifth 1940-46 and the sixth 1946-60. The upward and downward trends of production efficiency in the periods of 1910-20, 1921-26, 1927-34 and 1935-40 were influenced by the extension of new crop varieties, more input of fertilizer under rapid biological innovations, more irrigation facilities at the first and followed by typhoon and insect damage in the latter period. The output increase in the period 1935-40 was about 10 per cent. The gain in production efficiency during this period was accompanied by extensive advancement in land and labor productivities before World War II.

During the period of 1940-46, Taiwan was hit by a series of heavy typhoons which caused heavy losses on about 435 thousand hectares of crop area in 1940, 140 thousand hectares in 1941, and 251 thousand hectares in 1942. The natural hazards happened in this period were the biggest ones in the history of agriculture in Taiwan, and had affected greatly on the

yields of major crops.

It is clear that the yields of such maior crops as rice, sugarcane, sweet potato, peanut and vegetables in the period of 1940-42 almost decreased on the average by 10 per cent in comparison with the yields in 1938-39. Since rice and sugarcane are mors sensitive to natural hazards than cther crops, they experienced greater decrease in yields, while the yield of sweet potato was relatively constant. As a result, yield of sugarcane decreased by 20 per cent, rice 14 per cent, peanut 8 per cent, vegetables 6 per cent and sweet potato only 2 per cent.

In the period of 1940-42, aggregate input in agriculture decreased on the average by 3.5 per cent in comparison with the input in 1939. Without any changes of other inputs, the decrease of aggregate input in this period was due mainly to the decrease of fertilizer input by 24 per cent. These facts indicate that the cyclical downward trend of production efficiency from 1939 to 1940-42 was a result of natural hazards and lower level of fertilizer input in agriculture. Therefore, the decrease of production efficiency in this period can be characterized by low land productivity because of constant crop areas and lower crop yields.

In the later period of 1940-46, aggregate output in agriculture declined by 49 per cent in comparison with the output in 1942, while the aggregate input declined by only 20 per cent. Among different categories of inputs, working capital decreased more rapidly by about 70 per cent, fixed capital by 50 per cent, labor input by 23 per cent and land area by 4.50 per cent. With different rates of decline in different categories of inputs, the pattern of resource combination and use in agriculture underwent a change involving the use of less capital goods under the low level of technological condition in agricultural production. As a result of much greater decline in output than in input, efficiency in agricultural production in this period declined by about 55 per cent. That is, a unit of output was produced with 55 per cent more input in 1945 than in 1942. The decline of production efficiency in agriculture in this period was characterized by the low capital input and low technological innovations in agricultural under the later period of World War II.

The period of 1946-60, after the restoration of Taiwan to the Republic of China was characterized by the rehabilitation and recovery of agricul-

ture in Taiwan. Aggregate input increased by about 40 per cent as farmers expanded their crop areas and used more fertilizer and labor inputs in farming. Aggregate agricultural output increased by about 134 per cent, and recovered to the pre-war peak level as of 1952. With greater increase of agricultural output than input, production efficiency in agriculture increased by about 40 per cent. That is, a unit of output was produced with 40 per cent less input in 1952 than in 1945. Although the agriculture of Taiwan recovered to the pre-war peak level in 1952, the factors contributing to the rapid upward trend of production efficiency in agriculture after the war were different from those of 1935-39. In addition to the rehabilitation of irrigation facilities and introduction of new crop varieties and improved technology, there were also important institutional and economic incentives for greater output in agriculture, such as farm rent reduction and Land-to-the-Tiller programs implemented by the government and favorable prices of farm products as a result of food shortage and inflation in the post-war period. The rapid recovery of agriculture in this period was achieved mainly by greater input of working capital and labor, and expansion of crop area, rehabilitation of irrigation systems and advancement of technological conditions in agriculture.

The period after 1953 was also the period during which th First Four-Year Agricultural Plan was put into operation by the government of the Republic of China. Therefore, this period can be specified as a period under economic planning. With more than 20 per cent increase of aggregate agricultural output and only 10 per cent increase of aggregate input, production efficiency in agriculture advanced by more than 10 per cent in this period. The upward trend of efficiency in this period was due mainly to the high crop yields as a result of intensive cultivation with more capital input and technical improvement and introduction of new crop varieties. The important measures adopted to increase the crop yields were: (1) adoption of improved cultural methods, (2) extension of improved crop varieties, (3) increasing use of chemical fertilizers, (4) improvement of irrigation methods, such as rotational irrigation and (5) intensified crop pest and disease control. On the other hand, the coordinated planning and implementation of agricultural production program under the First Four-Year Economic Development Plan contributed also to the achievement of high productivity in agriculture. Efforts have constantly been made to achieve expansion and readjustment of crop acreage through

the promotion of intercropping and expansion of paddy land acreage under extensive irrigation improvement program. As a consequence of technological improvements and coordinated programming in agriculture, yields of major crops in Taiwan advanced to a remarkable level in 1960.

It is clear that the upward trend of agricultural efficiency in this period was primarily a result of high crop yields. There might be some favorable factors and economic incentives which were responsible for the remarkable increase of crop yields and induced the farmers to adopt new technology and to invest more capital in agricultural production. Three factors which deserve further investigation were (1) relative prices of farm products, (2) farm income, and (3) public investment in agriculture.

Incentives or relative prices in favor of farm products may be one of the important factors inducing farmers to increase the input of capital goods and to choose advanced and improved production process in agriculture. After reviewing the farm price situations in Taiwan as indicated in Table 10, it is clear that the terms of trade between agriculture and industry in the period under review was fluctuated with small range period after period. It was conceptually a responsible factor for the increase of agricultural efficiency through the long period.

Table 10 Terms of Trade between Agriculture and Industry

(1935—37 = 100)

1911—15	97
1916—20	80
1921—25	88
1926—30	101
1931—35	92
1936—40	92
1941—45	61
1946—50	125
1951—55	70
1956—60	72

The second factor is farm income incentive which can be considered in terms of farm income redistribution after the land reform program. As shown in Table 11, the structure of farm income distribution by major factors of production in the period after land reform program has completely been changed.

Table 11. The Structure of Farm Income Distribution in Taiwan Before and After Land Reform Program

	Year	Land income %	Capital income %	Labor income %
Before land reform program	1941	52.20	11.48	36.32
	1942	51.99	11.44	36.57
	1943	45.65	10.04	44.31
After land reform program	1953	37.39	8.23	54.38
	1954	38.05	8.37	53.58
	1955	38.19	8.40	53.41
	1956	36.28	7.98	55.74

After the implementation of land reform program, the share of labor income in agriculture increased on the average by 10 per cent of gross farm income as a result of the reduction of rental rate of farm land. As estimated real farm income increased by an average annual rate of 7.7 per cent in this period, the real income shared by farm family labor rose in fact by more than 30 per cent after the land reform program. Such significant increase of farm labor income provided an important incentive for farmers to adopt new cultural methods and to use more capital and labor inputs in production resulting in a higher level of agricultural efficiency.

The third factor is public investment in agriculture which includes (1) subsidies and investment contributed by the public and government agencies in the construction and repairing of irrigation system, compost houses, drying grounds and other farm improvement, and (2) expenditures for financing government program on agricultural extension works to introduce new and improved technology and practices into actual farm operation. Public expenditures and investment on these items accounted for about NT$300 million per year in this period, or about 3 per cent of annual real farm income in Taiwan. It is, therefore, clear that government measures and programs have also played an important role in the development and advancement of agriculture.

B. Trend of Productivity

The productivity of input factors, which can be measured in terms of output per unit of input, is a reciprocal relation to production efficiency. As a result, any change in the latter is indicative of a change in the for-

mer. In order to better understand the changes in productivity, it is important to find out the changes in the productivity of all the input factors. Analyses will be made in this section of: (1) relations between the productivity of aggregate resources and that of land and capital, and (2) relations between labor productivity and the productivity of land and that of capital.[1]

From the standpoint of aggregate analysis, the so-called "productivity" refers but to labor productivity, as the net value of production is exclusive of capital expenses and includes labor returns only. Labor productivity is obtained by dividing the net value of production by labor input, and it is the best indicator of economic efficiency. In agricultural production, the input factors also include land in addition to labor and capital. In this section, the meaning of economic efficiency will be extended to all the production resources, and an attempt will be made to analyze the relations between the productivity of various input factors with the quantity of production as output.

Table 12. Indices of Productivity of Agricultural Resources in Taiwan

(1935-37=100)

Year	Productivity of Aggregate Resources	Land Productivity per Unit of Cultivated Area	Land Productivity per Unit of Crop Area	Labor Productivity per Farm Laborer	Labor Productivity per Man-day	Capital Productivity
1911	67.90	54.89	63.91	53.51	63.50	162.78
1916	68.73	57.53	66.27	56.96	64.00	135.80
1921	67.75	57.53	66.27	61.10	64.50	121.31
1926	78.22	71.86	78.11	76.64	76.50	99.15
1931	88.93	84.64	89.35	86.31	89.50	98.58
1936	99.85	100.96	100.30	101.15	99.50	97.73
1941	94.37	90.60	88.46	87.34	89.00	111.08
1946	72.32	56.43	64.20	47.30	74.50	155.97
1951	100.75	101.18	80.18	80.44	87.50	117.05
1956	116.50	132.04	101.18	105.29	104.50	102.56
1960	125.35	150.33	110.06	116.69	110.58	102.84

[1] S. C. Hsieh and T. H. Lee "An Analytical Review of Agricultural Development in Taiwan" —An Input-output and Productivity Approach - - Chinese-American Joint Commission on Rural Reconstruction, Economic Digest Series No. 12, July 1958, Chapter III.

It can be seen from the above table that the productivity of aggregate agricultural resources in Taiwan registered an 84.60% increase during the period from 1911 to 1960. Excepting 1940-45, the annual growth rate during that period averaged about 1.3%, with that in 1911-20 as -0.46%, 1920-40 as 1.7%, 1940-45 as -6.94%, 1945-50 as 9.8% and 1950-60 as 2.2%, the changes in productivity were caused by the changing conditions in the different periods. From 1946 to 1950 it was a period of recovery and rehabilitation for agriculture, which was marked by a high annual growth rate of productivity of agricultural resources. The growth rate remained relatively high in the period of 1950-60, during which new techniques were introduced and planted acreage was further expanded. Earlier, the period of 1911-20 was the initial stage of agricultural development on the island, in which the annual growth rate of agricultural input was greater than that of output, resulting in low production efficiency and low growth rate of productivity. The next period (1920-40) saw an improvement as the efforts for development in the first period took effect gradually. Then, with the start of World War II, because of reduced input of production factors and labor shortage, the annual growth rate of the productivity of aggregate resources began to drop rapidly. Broadly speaking, the slower growth of the productivity before the war as compared with that after the war indicates the less advanced technology and lower multiple-cropping index in the former period.

The productivity of aggregate resources is affected by such factors as technological and economic conditions of production and multiple-cropping index. But the latter should be disregarded in estimating the pure aggregate productivity which reflects only the effects of technological and economic conditions.

Table 13. Average Annual Growth Rate of Productivity of Agricultural Resources and Indices of Multiple-Cropping in Taiwan

Period	Average Annual Growth Rate of Productivity of Agricultural Resources	Average Annual Growth Rate of Multiple-Cropping Index	Average Annual Growth Rate of Pure Productivity of Agricultural Resources
	(A)	(B)	(A)—(B)
1911-20	—0.46%	—0.01%	—0.45%
1920-40	1.70%	0.90%	0.80%
1940-45	—6.94%	—4.10%	—2.84%
1945-50	9.80%	9.00%	0.80%
1950-60	2.19%	0.70%	1.49%

The average annual growth rates of the pure productivity of agricultural resources given in percentages in Column 3 of the above table may be considered as the percentages of the contribution made by technological advancement and economic effects to agricultural production. The economic effects were produced by the sectorial movements between agricultural resources, and their measurement should be based on an analysis of the flows and combination of these resources. According to our analysis, there were no such effects except in the period of 1945-50. Therefore, the increase of the pure productivity of agricultural resources was caused mainly by technological factors.

As indicated by Table 13, the high growth rate of productivity in 1945-50 was primarily the result of the intensified land utilization represented by multiple-cropping index. During that period, the percentage of the contribution made by technological advancement to the growth of productivity of resources was 0.8% which was the same as that in 1920-40. But it rose to about 1.5% annually during 1950-60, showing that technological factors which included the investment of working capital (fertilizers and agricultural chemicals) and introduction of new varieties and cultivation techniques played an extremely important part in the increase of agricultural production.

The rapid increase of the productivity of aggregate resources can be attributed to the rising trend of the productivity of individual resources. Table 12 shows that the average annual growth rate of land productivity per unit cultivated area during 1911-60 was 2.1%. In other words, there was an annual increase of 2.1% in the yield from every hectare of farm land. The growth of land productivity was brought about by two factors: increase of multiple-cropping index and increase of unit yield. The relations between the three in terms of average indices in five-year periods are shown below:

Table 14. Relations between Land Productivity, Unit Yield and Multiple-Cropping Index

Period	Land Productivity		Unit Yield		Multiple-Cropping Index	
	Index	Annual Growth Rate (%)	Index	Annual Growth Rate (%)	Index	Annual Growth Rate (%)
	1935-37=100		1935-37=100			
1911-15	53.86	—	60.75	—	116	—
1916-20	58.94	1.89	67.10	2.09	118	0.34
1921-25	66.23	2.47	74.03	2.07	121	0.51
1926-30	74.17	2.40	85.25	3.03	122	0.17
1931-35	92.49	4.94	95.67	2.44	132	1.64
1936-40	100.22	1.67	100.48	1.01	133	0.15
1941-45	81.90	-3.66	82.65	-3.55	131	-0.30
1946-50	78.37	-0.86	75.77	-1.66	151	3.05
1951-55	115.45	9.46	95.07	5.09	172	2.78
1956-60	143.93	4.93	111.72	3.50	180	0.93

From Table 14, it can be seen that unit yield and multiple-cropping index had a combined effect on land productivity. The average annual growth rate of unit yield throughout the period of 1911-60 was 1.22%, and that of multiple-cropping index was 0.90%. Since there is a limit to the expansion of land resources in Taiwan, the raise of multiple-cropping index and of the yield per unit crop area through more intensified land utilization will be the only practical way to increase farm income and promote the development of national economy from agricultural point of view. The average annual growth rate of land productivity per unit crop area, which should be the same as that of unit yield, was 1.2% during 1911-60. The rapid increase of multiple-cropping index and high annual growth rate of unit yield accounted for the greater land productivity after the war than before. In the prewar period (1911-15 to 1936-40), there was an increase of 163,836 ha. in the total cultivated area as compared with the gain of 332,238 ha. for the total crop area. In the postwar period (1946-50 to 1956-60), however, the expansion of crop area was more than ten times that of cultivated area, i. e., 287,541 ha. and 22,986 ha., respectively. This indicates that the degree of the utilization of land capacity was greater in the latter period than in the former. During 1956-60, crop area was considerably increased, but the productivity of crop area was only slightly higher than in 1936-40.

In 1960, both the productivity per farm laborer and productivity per man-day increased by about 10% as compared with 1936. Capital productivity climbed from 1936 to 1946 and declined from 1946 to 1960. When the entire period of 1911-60 is considered, the productivity per farm laborer was increased by 118.1%, labor productivity per man-day raised by 74.0%, and capital productivity reduced by 36.8%.

A conclusion can be reached by observing the productivity of individual resources: the increase of the productivity of aggregate resources during 1911-60 was mainly the result of the rapid growth of the productivity of cultivated land, which averaged 2.1% annually. The productivity of agricultural labor also averaged an increase of 1.6% per annum, despite the fact that the number of farm laborers had rose to 1,725,285 persons from 1,154,602 persons. This amply proves that by increasing land productivity in an area where labor is overabundant, labor productivity can still be raised. The productivity per farm laborer is generally regarded as an important indicator of the economic efficiency of national productivity and of labor income. Therefore, the increase of the productivity per farm laborer is as important as the increase of land productivity per unit cultivated area. Since labor resources, unlike capital which is provided in the form of intermediate goods and land which is one of the natural resources, are theoretically a basic factor of production, it is necessary to analyze the relations between the productivity per farm laborer and the productivity of land and that of capital. Suppose the output of agricultural production is Y, the input of labor L, the input of cultivated land D and the input of capital K, then labor productivity, land productivity and capital productivity can be indicated by $\frac{Y}{L}$, $\frac{Y}{D}$ and $\frac{Y}{K}$ respectively.

The relation between labor productivity and land productivity can be illustrated by the following formula:

$$\frac{Y}{L} = \frac{Y}{D} \cdot \frac{D}{L} \quad \cdots\cdots\cdots\cdots (1)$$

Similarly, we have the relation between land productivity and capital productivity as follows:

$$\frac{Y}{D} = \frac{K}{D} \cdot \frac{Y}{K} \quad \cdots\cdots\cdots\cdots (2)$$

In formula (1), $\frac{D}{L}$ represents the ratio of land to labor or the average cultivated land per farm laborer, and $\frac{K}{D}$ in formula (2) is the ratio of capital to land, which usually denotes capital intensity in agricultural production. By substituting formula (2) into formula (1) we have:

$$\frac{Y}{L} = \frac{K}{D} \cdot \frac{Y}{K} \cdot \frac{D}{L} \quad \cdots\cdots\cdots\cdots (3)$$

From formula (3) we can say that labor productivity equals the product of multiplying together capital intensity, capital productivity and average cultivated land per farm laborer. The changes in these three factors in five-year periods over the past are shown in the following table:

Table 15. Changes in Factors Affecting Labor Productivity in Taiwan
(1935—37=100)

Period	Labor Productivity (Y/L)	Capital Intensity (K/D)	Average Cultivated Land per Farm Laborer (D/L)	Capital Productivity (Y/K)
1911-15	50.71	36.99	93.96	146.91
1916-20	60.02	44.37	101.99	132.64
1921-25	69.73	55.63	105.55	118.76
1926-30	81.66	78.00	105.85	98.91
1931-35	92.24	91.02	99.96	101.38
1936-40	97.74	96.32	97.63	103.93
1941-45	—	63.46	—	128.46
1946-50	63.11	55.36	80.16	141.41
1951-55	90.75	108.19	78.64	106.66
1956-60	114.41	142.55	79.56	100.87

The index of labor productivity grew from 50.71 in 1911-15 to 114.41 in 1956-60, registering an increase of 125.62%. In the same period, capital intensity increased by 285.37%, but the average cultivated land per farm laborer decreased by 15.33% and capital productivity decreased by 30.87%. It can thus be seen that the more than 100% increase in labor productivity was largely due to the increase of per hectare input of fixed and working capitals. Although the average cultivated land per farm laborer and capital productivity showed decreases, the resulting adverse effects were

offset by the rapid growth of capital intensity. In analysis, the growth of labor productivity in the prewar period was brought about by increases in capital intensity and in the average cultivated land per farm laborer, and was somewhat checked by the decline of capital productivity. The same growth in the postwar period resulted from the rapid increase of capital intensity and from the stable capital productivity, but the decrease of the average cultivated land per farm laborer in the period had exerted some adverse effect on such growth. It can be concluded, therefore, that the main bottleneck factor in raising labor productivity was the low capital productivity in the prewar years and the dwindling average cultivated land per farm laborer in the postwar years. Under existing conditions in Taiwan where land resources are limited and population is ever expanding, one of the effective ways to further raise labor productivity and land productivity should be to increase the input of both fixed and working capitals in agricultural production.

Being one of the natural resources, farm land can also be regarded as an economic goods in production. Its present productivity is the result of hundreds of years of improvements and investment. Hence, land as a natural goods is far less important than the improvements and investment that enhance its productivity. In order to maintain and enlarge the full utilization of the productive function of land, it is often necessary to make further investments for its maintenance and for the expansion of its capacity and efficiency. Failing so, there will occur such forms of negative investment as soil erosion, loss of soil fertility, drought, etc. In other words, because of the unfavorable factors, negative investment and depreciation, farm land needs capital investment to maintain or further raise its capacity and productivity.

To maintain a balanced development of agricultural labor productivity and industrial labor productivity in Taiwan, it will be more proper to increase the amount of capital investment than the number of laborers. Since farm population and the number of laborers are both increasing at a fast pace at present, the best thing to do should be to improve the use of capital and to keep capital productivity from falling.

From the above analyses, the following conclusions are reached:

1. The increase in the productivity of agricultural resources during

1911-60 was attained mainly through technological advancement which, as analyzed in Section III of this paper, was the result of the introduction of new varieties and techniques with the support of a reasonable combination of resources, especially labor, capital and land.

2. Technological effects on the productivity of resources were seen in the increase of unit yield or the productivity per unit crop area and of multiple-cropping index. In the prewar period, former increase was greater than the latter, while in the postwar period both were prominent.

3. Labor productivity registered an average annual growth rate of 1.6% during 1911-60 chiefly because of the increase of land productivity at the average rate of 2.1% per annum. The main contributing factors to the growth of labor productivity were increased capital intensity and average cultivated land per farm laborer in the prewar period, and increased capital intensity and stable capital productivity in the postwar period.

4. In order to further raise the aggregate agricultural productivity as the principal target of the agricultural development program of Taiwan, it is necessary first of all to increase the per unit area land productivity and the per capita labor productivity. These can be achieved by making more investment of fixed and working capitals in agricultural production, developing and expanding the base of agricultural resources and preventing the average cultivated land per farm laborer from further shrinking, in addition to promoting greater technological advancement.

Chapter VI.

Process of Technical Innovations

Increases in resource inputs and technical innovations have been two primary causes for rapid agricultural development in Taiwan. Technical innovations can be generally classified into three categories: organic (seeds, breeding, etc.), inorganic (farm tools, fertilizers, irrigation, etc.), and institutional (management, organization, etc.). [5] Different types of technical innovations involve different requirements of capital input and educational levels of agricultural technicians and farmers. In his recent book entitled "Agricultural Development on Taiwan since World War II" published by the Cornell University Press in 1964, Dr. T. H. Shen, Chairman of JCRR and prominent plant breeder by profession has written in details the technical achievements in Taiwan agriculture in the last one and half decades as contained in the nine chapters in the Part II of the book, pages 88-254. We shall state only briefly the major technical innovations carried out in Taiwan which relate more closely and directly with economic productivity of agricultural growth.

A. Irrigation

Irrigation is essential in Taiwan because of the predominance of rice culture in its economy and of the uneven distribution of rainfall throughout the year. The steep topography and short and rapid rivers make the work of flood control also indispensable. Therefore, irrigation, drainage, and flood control have played important roles in developing agriculture in Taiwan. Though investment in irrigation development in Taiwan has continued for years, heavy and large-scale investment did not start until 1919.

The annual average capital investment in irrigation during 1901-10 was 6 million Taiwan dollars (T$) (in 1935-37 value) but increased sharply to T$80 million during 1921-30. During the same period, the governmental share of irrigation investment dropped from 92% to 35%, while the private share increased from 8% to 65%.

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[5] Th. Brinkmann, Das Oekonomik des Landwirtschaftlichen Betriebes, Grundis der Sozialohonomik VII, Abt, Economic Principles of Farm Management, Tubaigen, 1914

Table 16. Annual Irrigation Investment and Irrigation Administration Expenditures (in 1935-37 value)

Year	Irrigation Investment by Government and Irrigation Association (T$)	Irrigation Administration Expenditure (T$)	Total (T$)
1901—10	6,229,772	9,417,082	15,646,854
1911—20	9,456,563	19,049,365	28,505,928
1921—30	81,765,447	131,437,646	213,203,093
1931—40	24,709,815	93,569,177	118,278,992
1941—50	19,860,851	50,091,051	69,951,902
1951—60	21,167,913	47,902,039	69,069,952

Source: E. L. Rada and T. H. Lee "Irrigation Investment in Taiwan--An Economic Analysis of Feasibility, Priority and Repayability Criteria", Chinese-American Joint Commission on Rural Reconstruction, Economic Digest Series No. 15, February 1963. p. 37

Table 17. Ratio between Government Investment and Private Investment in Irrigation

Year	Government (%)	Private (%)	Total (%)
1901—10	92.27	7.73	100.00
1911—20	90.61	9.39	100.00
1921—30	35.09	64.91	100.00
1931—40	31.27	68.73	100.00
1941—45	70.07	29.93	100.00
1949—50	3.07	96.93	100.00
1951—60	45.37	54.63	100.00

Source: Computed from Table 14, p. 37 of "Irrigation Investment in Taiwan" by E. L. Rada and T. H. Lee

The governmental investment has spearheaded this very important technical innovation, because the heavy investment and modern technology involved could hardly be provided by private interests in the initial period. Management of irrigation systems for optimum distribution of water among farmers is also a technical improvement contributing to agricultural development.

In 1901 the Taiwan Governor-General's Office promulgated "The Regulations Governing Public Irrigation Canals" to supervise the administration of irrigation associations and give them financial assistance. In 1907

the Governor-General's Office started construction of six large scale irrigation systems covering 39,000 hectares. In 1925 all government and public operated irrigation associations were turned over to the newly set-up semi-autonomous irrigation associations composed of both government and private interests. Henceforward, irrigation in Taiwan developed by leaps and bounds. By 1940 the total irrigated area in Taiwan had reached 546,965 ha., of which 461,543 ha. were irrigated by public irrigation associations and 85,422 ha. by private irrigation associations.

The government bank financed the construction of irrigation canals by loans at half of the market interest rates.

In 1934 the Governor-General's Office promulgated new regulations under which permission to build private irrigation canals had to be obtained from the government, on the ground that water is one of the national resources.

The total acreage of irrigated land increased from 150,456 ha. in 1903 to 545,094 ha. in 1942 and further increased to 582,305 ha. in 1960. (including approximately 80,000 ha. of irrigated land not under the jurisdiction of Irrigation Associatons.) During the same period the acreage of cultivated land increased from 534,157 ha. in 1903 to 854,479 ha. in 1942 and to 869,223 ha. in 1960. The percentage of irrigated land in the total cultivated land expanded may serve to measure the speed of agricultural development in the initial stage. In the early period the speed of cultivated land expansion paralleled the expansion of the irrigated area. During the 15 years from 1923 to 1938, only 100,000 ha. of irrigated land were developed by the farmers themselves, but 250,000 ha. were developed with government subsidies. In the period from 1942 to 1960, the construction of houses and industrial plants gradually took away some irrigated paddy land.

Table 18. Acreage of Cultivated Land and Irrigated and Drained Land

Year	Cultivated Land (A) (ha.)	Irrigated and Drained Land (B) (ha.)	(B)/(A)
1903	534,157	150,456	28.2
1915	700,079	242,455	34.6
1922	750,540	315,095	42.0
1928	806,754	388,274	48.1
1931	810,277	449,649	55.5
1937	856,688	510,868	59.6
1942	854,479	545,094	63.8
1950	870,633	508,401	58.4
1960	869,223	582,305	67.0

Source: Statistics of 1903 to 1942 are quoted from the 51 Years Statistical Abstract, Taiwan Provincial Government, Dec. 1946. Statistics of 1950 on cultivated land and irrigated and drained land and of 1960 on cultivated land are quoted from Agricultural Yearbook published by Provincial Department of Agriculture and Forestry. The irrigated and drained land area for 1960 is estimated by the Rural Economics Division of JCRR.

The relative changes in the areas of cultivated land, paddy land, double-crop land, and rice crop acreage show some interesting facts. The area of double-crop paddy land increased from 33% of the total cultivated land in 1920 to 38% in 1940 and had remained at the level up to 1960. In 1960 about 44% of the cultivated land or 73% of the paddy land were planted to rice. In terms of crop area, the rice crop area exceeded the area of double-crop paddy field by 20% in 1950 and by 16% in 1960. This shows that not all of the paddy land are planted to rice. The area of double-crop paddy land increased from 320,000 ha. in 1950 to about 330,000 ha. in 1960, while the total area of paddy land decreased from 530,000 ha. to about 526,000 ha. during the same period. This shows a decrease in the area of single-crop paddy land.

Table 19. Acreage of Paddy Land and Rice Crop Planting

	1920		1930		1940		1950		1960	
	(ha.)	%	(ha.)	%	(ha.)	%	(ha.)	%	(ha.)	%
Cultivated Land	749,419	100	808,329	100	860,456	100	870,633	100	869,223	100
Paddy Land	367,177	49	396,279	49	529,621	62	530,236	61	525,580	60
Double-crop Paddy land	246,484	33	292,120	36	324,209	38	320,345	37	329,053	38
Rice Planting Acreage	250,085	33	307,195	38	319,311	37	385,131	44	383,205	44
Percentage of Double-crop Paddy Land in Total Paddy Land		67		74		61		60		63
Percentage of Rice Planting Acreage in Total Paddy Land		68		78		60		73		73
Percentage of Rice Planting Acreage in Total Double-crop Paddy Land		102		105		98		120		116

Source: Statistics of 1920, 1930 and 1940 are quoted from Kawano Shigeto "Rice Economy of Taiwan" Yuhi Kaku Book Co., Tokyo, Table 12, P. 45. Statistics of 1950 and 1960 are computed from "Agricultural Yearbook", 1951 and 1961 editions. Provincial Department of Agriculture and Forestry

It is difficult to differentiate the contributions of the various technological innovations from the increase in agricultural productivity. Development of irrigation must be coupled with improvements in breeding, culture methods, fertilization, and other production technology, in order to achieve any increase in agricultural productivity.

Table 20 shows the average yields, annual yield increases, and variation coefficients of Ponlai rice, Chailai rice, and upland rice.

Table 20. Yields and Variation Coefficients of Ponlai, Chailai and Upland Rice (Second Crop)

	Average Yield (kg.)			Annual Yield Increase (kg.)			Variaton Index (%)		
	1902 -14	1914 -24	1924 -38	1902 -14	1914 -24	1924 -38	1902 -14	1914 -24	1924 -38
Chailai	1,615.7	1,728.3	2,139.1	1.67	0.30	26.70	8.67	7.49	3.77
Upland	1,189.1	1,181.6	1,524.1	0.38	0.52	1.43	20.55	8.94	10.59
Ponlai	—	—	2,551.7			57.34			5.02

Source: Kawano Shigeto "Rice Economy of Taiwan" Yuhi Kaku Book Co., Tokyo

1902-14 was the period before the great improvements in rice production were made. 1914-24 saw the eliminating process of Chailai varieties. In 1924-38 irrigation development made great strides. From the above table, we can see that (1) the yield of paddy rice exceeded that of upland rice; (2) the annual yield increase of paddy rice was faster than that of upland rice, except in 1914-24; (3) the variation coefficients of paddy rice were smaller than those of upland rice through all the years, indicating more steady harvest.

The regression and multiple correlation among the yield of rice (Y), amount of fertilizer applied (F), irrigated area (I), and the price of rice (P) are shown as follows:

1922-38: $Y=9.6196 + 0.2595F + 0.6232I + 0.03759P$

$S_{bf}=0.1240 \quad S_{bi}=0.27735 \quad S_{bp}=0.1109$

$R^2=0.9063 \quad S=5.3643$

1950-60: $Y=-186.5523 + 0.4971F + 2.4786I - 0.0047P$

$S_{bf}=0.7273 \quad S_{bi}=0.6880 \quad S_{bp}=0.0036$

$R^2=0.97 \quad S=2.4918$

An increase in the irrigated acreage affected the rice yield more than did the amount of fertilizers used and high price of rice. One percent increase in the irrigated acreage resulted in 0.6% increase in the rice yield in 1922-38, and in 2.48% increase in 1950-60.

As shown in Table 21 above, the correlation coefficient between the increase in irrigated acreage and the increase in multiple cropping index was 0.84, with the regression equation being $Y=129.71+1.164X$ indicating that the cropping index without irrigation was 130 and that 1% increase in the irrigated acreage would result in 1.164% increase in the cropping index. If all cultivated lands in Taiwan were irrigated, the overall cropping index would be 246. Further analysis of the correlation between the cropping index and the total value of agricultural products has shown that 1% increase in the cropping index means NT$100 million (US 10 million) increase in the value of agricultural products (in 1950-52 value). Hence, 1% increase in the irrigated acreage means NT$116 million increase in the value of agricultural products. The importance of the role played by irrigation in agricultural development in Taiwan is obvious.

Table 21. Correlation between Irrigated Acreage and Multiple Cropping Index

County	Acreage of Cultivatd Land (ha.) (I)	Acreage of Irrigated Land (ha.) (II)	Irrigated Ratio (II)/(I)	Multiple Cropping Index (%)
Taipei	50,950	21,497	42.19	165
Ilan	27,949	23,122	82.73	190
Taoyuan	54,842	32,998	60.17	193
Hsinchu	42,440	10,616	25.01	164
Miaoli	41,415	16,076	38.82	187
Taichung	46,331	38,781	83.70	232
Changhua	76,070	59,908	78.75	233
Nantou	46,228	19,190	41.51	143
Yunlin	86,441	20,730	23.98	195
Chiayi Tainan	71,685 96,945	149,333	34.31	159
Kaohsiung	53,803	24,001	44.61	187
Pingtung	77,820	41,154	52.88	196
Hwalien	31,818	10,673	33.54	167
Taitung	30,612	8,572	28.00	147
Penghu	7,283	—	—	132

Source: See footnote of Table 14.

B. Improvement and Standardization of Crop Varieties [6]

The stories of improving and standardizing the varieties of rice and sugar cane will exemplify the general technological innovation in this respect in Taiwan.

Rice

In the early days of Taiwan, the rice varieties were mostly of the indica type and the total number was ever counted as 1,197. During the Japanese occupation, orders were issued by the Government General to restrict the number of varieties allowed to be planted, and to eliminate inferior varieties. In addition selections had been made in the experimental stations to improve this kind of native rice. As a result of both administrative and technological efforts made along the line as indicated, the number of rice varieties planted reduced to 390 in the period from 1909 to 1920 and their pedigrees were classified into 175 varieties according to experimental plantation.

[6] Thanks are due to Messrs. C. H. Huang and C. Chen, Sr. Specialists of JCRR, Plant Industry Division for their comments and contribution on the statements relating to rice and sugarcane varietal improvement work in this section.

In the beginning of starting native rice improvement, many japonica varieties of Japanese rice had been also introduced into this Island. In the process of building the introduced rice varieties of japonica type more adaptable to the subtropical condition of this Island, selections from introduced Japanese varieties or breeding crosses of japonica varieties and intervarietal crosses between japonica and indica varieties were successfully tried and brought forth the so-called "ponlai rice" varieties. The name of "ponlai rice" was made public on May 5, 1926. Ecological experimentations for the establishment of this kind of rice were then carried out in various counties. The planting area of ponlai rice was gradually expanded from foothill paddy land down to plains, and from Northern Taiwan to Central and Southern Taiwan, and from one crop a year to two crops a year. Since 1926, the Governor-Generals' Office had subsidized the counties and County Farmers' Associations in distributing ponlai seeds to selected farmers or farmers' associations who multiplied them and further distributed them among ordinary farmers for planting. This promotion and distribution system continued through the years, and greatly helped expand the planting of ponlai rice to every corner of the island.

In the overall program of improving rice variety and increasing rice production, not only that ponlai rice gradually replaced native rice in planting acreage, but also that the number of total ponlai varieties and native varieties greatly diminished.

The following table shows the percentages of total planting acreage taken by the most widely planted varieties of ponlai and native rice in 1938.

Table 22. Percentages of Planting Acreages of Major Ponlai and Native Varieties (1938)

Order of Varieties	Ponlai		Native	
	1st Crop	2nd Crop	1st Crop	2nd Crop
	%	%	%	%
1st	85.6	84.9	12.6	16.3
2nd	5.2	3.3	12.4	9.3
3rd	2.7	2.8	8.8	5.2
4th	1.9	2.2	6.0	5.0
5th	1.6	1.6	3.8	4.4
Total of 1-5	97.0	94.8	43.6	40.2
Total of 1-10	99.5	98.9	59.6	56.4
Total No. of varieties	29	25	77	109
Total acreage (ha.)	167,400	143,321	107,155	148,015
Average acreage of each variety	5,772	5,733	1,392	1,358

Source: "Rice Statistics of Taiwan" 1939, The Taiwan Governor-General's Office

After World War II, Taiwan was again returned to China. Under the strenuous efforts of the various agricultural experiment stations, new ponlai rice varieties have been incessantly developed to replace the old varieties and a total of 62 varieties were officially registered from 1946 to 1964. Among them, 9 varieties together with 4 old varieties were grown over 10,000 ha. in 1963. The following table is showing the percentage of total planting acreage taken by several of these most promising ponlai and native rice varieties in 1963.

Table 23. Percentage of Planting Acreage of Most Promising Rice Varieties in 1963

Order of Varieties	Ponlai Rice		Native Rice	
	1st Crop	2nd Crop	1st Crop	2nd Crop
	%	%	%	%
1st	19.5	28.2	47.9	18.0
2nd	13.9	9.5	6.8	12.7
3rd	11.4	9.1	6.7	9.7
4th	9.3	5.3	5.6	8.5
5th	4.3	4.7	3.9	5.5
6th	4.1	4.0	3.1	3.6
7th	2.9	2.8	2.8	2.5
Total	65.4	63.6	76.8	60.5
Total planting acreage (ha.)	196,809	284,837	111,850	128,939

Since the pre-war period and throughout the post-war period, a major emphasis of rice improvement has been made on the ponlai rice. However, viewing the fact that Taiwan native varieties still occupied about one-third of the total rice planting acreage, further improvement of native rice was considered important and necessary for the rice production in Taiwan. The improvement work on native rice was started in 1949. Many crosses were made between the local breeding stocks by various agricultural experiment stations. In 1957, a new promising rice variety, Taichung Native No. 1, was developed. Differing from other indica varieties in Taiwan, it is non-sensitive to photoperiod, so it can be successfully planted in both the first and second crops. It is of short stiff straw, responsive to fertilizer application and also giving good yield. The planting acreage of this variety was 53,589 ha. in the first crop and 23,109 ha. in the second crop, which occupied the total planted acreage of native rice for the respective crop season about 47.9% and 18.0%.

In summarizing the recent progress made in rice improvement in Taiwan, it may be stated that the popular ponlai rice varieties released in the early period have been largely replaced by varieties developed in the post-war period. For instance, the percentage of the planting acreage of the first leading variety "Taichung No. 65" in 1938 was 85.6% for the first crop and 84.9% for the second crop, which declined to 11.4% and 9.5% respectively in 1963. Furthermore, much progresses have been made to develop ponlai rice varieties adaptable to intensive crop systems of growing other cash crops between two rice crops within a year in the same piece of land. The new varieties to be developed in this need are of early maturity with fair yielding capacity, of short and sturdy straw resistant to lodging and tolerant to heavy fertilization, and of resistance to most prevalent diseases. In the overall program of improving native rice varieties, efforts have been made to develop varieties with such desirable characters as non-sensitiveness to day-length non-lodging, and responsiveness to fertilizers.

Sugar Cane

The technological innovation of sugar cane in Taiwan is of a different pattern from that of rice. Sugar industry is so-called a green house product of Taiwan, bred under the protection of the Taiwan Governor-General's Office and the various private sugar companies.

At the time when Taiwan was ceded to Japan in 1895, the predominant sugar cane variety under cultivation was a diminutive Chinese cane (Saccharum sinensis) variety called Tekcha (literally translated Bamboo Cane) which was believed to have been brought in from South China around 1610, and had remained as a leading variety in support of an artisan sugar industry for nearly three hundred years with an average yield of about 2 M.T. per hectare. The Japanese colonial administration lost no time to press for varietal improvement in sugar cane as an essential measure for implementing a long-range sugar development program, and a noble cane (S. officinarum) variety Rose Bamboo was immediately introduced from Hawaii in 1896 and released in 1902 for general planting. Being superior to Tekcha both in unit yield and in sucrose content, Rose Bamboo spread quickly and became an exclusive variety around 1912, but as it is highly susceptible to wind damage, successive heavy typhoons in the early 1910's brought about its rapid downfall and necessitated the impor-

tation of several hardy thin-stalk hybrids from Java (notably POJ161 and POJ105) to take its place. These varieties had a short period of peak extension in 1922-26, and because of their weakness in mosaic resistance was again replaced by a few thick-stalk varieties from Java including POJ2725 and POJ2878. POJ2725 was found to be particularly adaptable to the local conditions and gained temporary predominance in 1930-35, then rapidly succumbed to the attacks of red-rot and cane borers, and had to give way to POJ2883 ond a locally-bred variety F108 when the Second World War broke out.

After the retrocession of Taiwan to China in 1945 the war-battered sugar industry was quickly restored to normal operation despite seemingly unsurmountable difficulties. This time it was to produce sugar for the people of whole China instead of for Japan. But in less than four years after the war ended, China Mainland was completely lost to the communists, and all of a sudden the newly-consolidated sugar enterprise in Taiwan found itself in direct competition with all other sugar-producing countries for a share in the world market. In a desperate effort to boost the sugar yield and reduce production costs, a new local breed F134 was released in 1950 to replace the deteriorating varieties POJ2883 and F108 inherited from the pre-war period. Success was temporary and incomplete, though, because with all its good yield, high sugar content and early maturity, F134 is by nature a soft cane and can hardly stand the roughness of a heavy typhoon which is almost an annual occurence here. Very fortunately N:Co310, a 1947 introduction from Natsl, South Africa which had been put through years of vigorous testing was by then fully recognized as possessing most if not all of the desirable characters needed to meet the local requirements. It is favored with (1) an excellent yielding capacity and (2) a sugar content higher than any other variety ever planted here; it has (3) an extensive and efficient root system that provides remarkable tolerance to drought, salinity and poor soil conditions, (4) elastic stalks and narrow leaves that contribute to ample resistance to wind damage, (5) profuse tillers that allows for labor-saving easy culture as well as good ratooning capacity and delayed elongation adaptable to intercropping with other crops, and lastly (6) a genetic heritage that underlies strong resistance to most of the major cane diseases found here, including downy mildew, red rot, leaf scortch and mosaic. Immediately after its large-scale extension average sugar yield for the whole crop

jumped from around eight tons up to about ten tons of sugar per hectare. In addition, ratooning of sugar cane was for the first time established as a regular practice thereby bringing down the average growing period (of all new plantings and ratoons) from 18 months to about 14 months; cultural practices were greatly simplified; lower grades of land could now be used for growing sugar cane; and intercropping became acceptable as a profitable system with little effect on cane yield. Moreover, because of a marked increase in the number of stalks that can be produced per unit area, more seed pieces were cut and there was a saving of over 10,000 hectares of land needed for seed production each year. All these added up to a considerable reduction in production costs in addition to a substantial increase in yield, and as a result the Taiwan sugar industry was saved from inevitable collapse in those dark years.

As seen in the following table, progresses in sugar production through the years in Taiwan are largely accountable by the successive strides made in varietal improvement, but above all the introduction and rapid extension of N:Co310 can justly be claimed as one of the most significant agricultural developments in the post-war period.

Table 24. Varietal Changes of Sugar Cane in Taiwan

Period	Representative variety	Peak years	% of extension	Average cane yield per ha. (M.T.)	Average sugar yield per ha. (M.T.)
Period of Chinese cane	Tekcha	1902—06	97	28	2.1
Period of noble cane	Rose Bamboo	1910—17	95	29	2.9
Period of thin Java canes	POJ161	1922—26	84	43	4.3
Period of thick Java canes	POJ2725	1930—35	78	67	8.8
	POJ2883	1941—42	38	66	7.4
Period of F108	F108	1947—50	53	67	7.6
Period of F134	F134	1953—54	24	71	9.7
Period of N:Co310	N:Co310	since 1956	94	76	10.3

Obviously, the history of technological innovation of sugar cane in Taiwan has been a continued development of new varieties for the purpose of increasing yield.1/

1/ "Taiwan's Agricultural Economy in Japanese Period" Bank of Taiwan, Research Series, 1958.

C. Chemical Fercilizers*

Besides variety improvements, increased application of chemical fertilizers has also contributed greatly to increased yields of rice and sugar cane and other crops . It has also made highly intensive cultivation possible, and the consumption per unit area has shown an increasing trend as the size of farm is limited. Therefore, heavy fertilization is stressed by national program as well as individual farmers as a sure means to increase agricultural production.

The development of sugar industry in Taiwan has pioneered heavy fertilization on this island. Before the Japanese occupation of Taiwan, farmers on this island knew nothing about chemical fertilizers. To teach the farmers of Taiwan to accept the idea of chemical fertilization was then a big step towards the development of sugar industry in Taiwan.

First, chemical fertilizers were distributed to sugar cane farmers free of charge by the sugar companies, because they could not convince the farmers to buy such fertilizers. In 1903, the sugar companies stopped free distribution of fertilizers but subsidized farmers in their purchase of fertilizers. In 1904 all imports of fertilizers were coordinated by the Taiwan Governor-General's Office. In 1916 fertilizer subsidies to sugar cane farmers were discontinued. The idea and practice of chemical fertilization soon were diffused to farmers to other crops. The Taiwan Governor-General Office's efforts in improving fertilization practices in rice field were less vigorous. In 1908, model green manure fields were set up in many places of the island for demonstrative purpose. In 1918 green manure demonstration was discontinued, but technicians were dispatched to all counties to handle distribution of seeds and fertilizers and to extend improved culture technique. In 1920, construction of hog sties and compost house were subsidized to encourage the use of manure and compost. During this period, farmers were more or less left to themselves to supply their own fertilizers with some technical assistance from the government. This was also the period native (Chailai) rice varieties were being selected and japonica type being introduced.

After 1926, Ponlai rice was rapidly extended in Taiwan and heavy chemical fertilization in rice field began. Taiwan then shared the prosperities of Japan, prompted by World War I.

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* Thanks are due to Mr. C. M. Wong, Specialist of JCRR Plant Industry Division for his comments and contribution on the statement in this section.

The fertilizer consumption reached its peak in 1938 during the pre-war period while the average rice yield per unit area also broke its record over the past. The direct use of oil cakes which occupied more than 50% in 1931 had been gradually replaced by mixed fertilizers (NPK chemical fertilizers mixed with oil cakes), and the maximum use of such mixed fertilizers reached about 70% of the total consumption in 1941.

Table 25. Fertilizer Consumption by Different Types (1930 - 1943)

Year	Total gross consumption (M. T.)	Proportion of different types (%)			
		Oil cakes	Straight chemical fertilizers	Mixture of oil cakes & fertilizers	Others
1930	397,242	49.28	36.66	14.05	0.01
1931	387,331	51.52	35.19	13.23	0.06
1932	405,447	49.74	34.47	15.67	0.12
1933	431,449	47.94	30.16	21.60	0.30
1934	528,874	44.23	38.29	17.44	0.04
1935	534,924	41.46	38.91	19.50	0.13
1936	604,207	35.45	41.54	23.00	0.01
1937	622,109	28.23	41.55	30.20	0.02
1938	648,890	28.67	35.41	35.90	0.02
1939	585,149	30.89	20.90	48.20	0.01
1940	495,184	19.84	12.58	64.00	3.58
1941	449,567	18.25	11.57	70.00	0.18
1942	378,072	21.58	25.42	53.00	—
1943	325,702	14.30	34.44	51.20	0.06

After the restoration of Taiwan to China, supply of chemical fertilizers had been considered as one of the most important responsibilities of the Government. Rice and sugarcane production were listed at the top priorities to receive fertilizers and the distribution policies for rice were set in the following manner:

1. First stage (1946-1949): Since the supply of fertilizers was very short, a uniform distribution of fertilizers was adopted to guarantee a fair allocation to all rice growers.

2. Second stage (1949-1952): Fertilizer supply was fairly adequate, and the allocation was made on the basis of soil productivity. Areas where

the average yield were high received higher rates of fertilizer allocation and low-yielding areas and vice versa.

3. Third stage (1952—present): Allocation was decided according to the soil productivity and past distribution records, etc. Also, farmers are allowed to adjust their request within a range of 50% of the standard allocation rates. Additional PK-fertilizer and N-fertilizer other than ammonium sulphate are allowed to supply farmers at their request.

Rational fertilization of sugarcane with proper crop rotation based upon climatic and soil conditions is another example in the technical innovations of fertilizer use in Taiwan.

Tobacco has become one of the important crops in Taiwan after the war. Farmers tended to use heavy rate of N to increase the yield. Research studies have shown farmers to employ lower rate of N and high K fertilizer to limit the yield below 2,000 kg. per ha. with high quality of leaves, thus increasing the return to the farmers.

Pineapple is a crop mainly planted on acid soils low in plant nutrients and therefore heavy application of fertilizers is indispensable. Dense planting is a twin brother of effective pest control achieving revolutionary success in pineapple cultivation and it is only made possible by heavy rate of fertilizers.

The special features of fertilizer use in the post-war can be illustrated as follows:

1. Use of straight fertilizer materials: Since soybean cake could no longer be obtained at low cost after the war, use of chemical fertilizers was demonstrated to farmers with satisfactory results.

2. Acceptance of locally produced N-fertilizers: For years, Taiwan farmers have been accustomed to use ammonium sulphate which was mostly all imported product. In view of the availabilities of resources, manufacture of calcium cyanamide, nitrochalk, nitrophosphate and urea was considered more adequate by the industry authorities. To overcome the reluctance in accepting these types of fertilizers, series of fertilizer demonstrations and other educational programs were carried out. As a result, the production of these fertilizers has never been interrupted by the sluggish sale.

3. Importation of potash: Taiwan does not produce potash fertilizers. Numerous field experiments reveal that the application of potash can increase the crop yield and bring farmers a good return. In 1949, importation of potash fertilizers was first financed by U. S. Aid. After realizing the importance of potash to the crop production, the Government has included potash application in the regular program and the consumption reached 40,000 M.T. K_2O in 1964.

4. Stress of crop response and returns: N is the dominant factor in increasing the production of almost all crops in Taiwan. The crop responses to PK fertilizers are comparatively low. Therefore, the increasing use of N-fertilizer reflects the fact that Taiwan farmers are fully aware of the economic use of fertilizers in relation with the cost-return principle.

The increase of fertilizer use in Taiwan can be illustrated by the distribution figures (average of every 2 years) as shown in the following table:

Table 26. Fertilizer Distribution in Taiwan
(Unit: M. T.)
(Index: 1950-51=100)

Year	Fertilizer Distribution					
	N	Index	P_2O_5	Index	K_2O	Index
1948-49	24,838	46	7,991	63	254	5
1950-51	53,997	100	12,780	100	5,471	100
1952-53	69,542	129	23,612	185	13,796	252
1954-55	82,675	153	28,207	221	17,037	311
1956-57	93,845	174	31,324	245	21,535	394
1958-59	102,244	189	33,995	266	27,772	508
1960-61	101,744	188	30,551	239	29,229	534
1962-63	119,816	222	32,408	254	35,065	641
1964 (est.)	142,000	263	38,400	300	43,000	786

5. Extension of organic manures: During the war time and immediately after the war, the fertilizer supply was inadequate, and consequently, utilization of organic manures were highly encouraged. Compost consumption was recorded at 16.8 million tons in 1943. Construction and repair of compost shelters program was initiated in 1950 to encourage farmers in making compost of better quality. An average of 8-9 million tons of compost are being applied annually by farmers.

Use of green manures was highest in 1948 with 3.8 million tons. Introduction of astragalus (Chinese milk vetch) to utilize fallow field in winter season has been successful. The trial planting of Lana vetch in southern areas has also gained confidence among farmers. As more slope lands are being developed for growing fruits and other crops, extension of cover crops on slope land along with other soil conservation practices has become popular since 1960.

In order to strengthen the extension education on optimum fertilization, experiments on response of major crops to fertilizers and fertilizer demonstration on local fields have been undertaken in a large scale. About 961 field demonstrations on 216 townships are continuously undertaken by farmers' associations through the sponsorship of Provincial Food Bureau and other government agencies. These demonstrations have been successful in overcoming partly the farmers' dislike for calcium cyanamide and application of urea fertilizer. A more balanced application of N-P-K has also been proceeded and accepted by the farmers.

D. Improvement of Cultivation Technique*

Besides breeding improvement and chemical fertilization, many improvements have been made in the cultivation technique and pest and disease control.

In 1908, the Government promulgated the regulations governing the eradication and prevention of crop disease and pests. As to close planting, the number of rice seedlings planted in each Tsubo (6 x 6 feet) was raised from 37 to 49 in 1922 and later to 60, so as to increase yield. For this purpose, the Agricultural Experiment Station also invented a deep-plowing plow for extension among farmers. In 1924, weeding was officially encouraged by the agricultural agencies of the government. Cooperative planting of rice was promoted in Southern Taiwan among 500 farming groups.

After Taiwan was restored to China in 1945, intensified efforts have been made to improve the cultural practices on crop production in order to make effective use of limited land resource.

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* Comments received from Mr. H. S. Chang, Secretary-General of JCRR.

In early 1950's, the average yield of pineapple was 10 metric tons per hectare. In 1954, a preliminary study of planting density on pineapple was initiated and it was found that the unit yield could be significantly increased with increase in number of plants. A 50% increase in unit yield was obtained when the planting density increased from 18,000 to 40,000 plants per hectare. The unit yield of pineapple raised from 10 M. T. per hectare in 1950 to 18.27 M.T. per hectare in 1962.

The success in making synthetic compost from which mushroom makes its upright growth and the improvement in mushroom culture and the selection of desirable mushroom strains adaptable to the natural environment of Taiwan have made possible the development of rapidly growing mushroom industry and its export.

The demonstration project for the improvement of tea culture has brought about significant increase in unit yield and regenerating the vigor of tea bushes. The demonstration plots have shown a 80% increase in unit yield.

The integrated demonstration on improved rice cultivation combines all the improved techniques from land preparation to harvesting into a package treatment; and the yield from the demonstration plots has marked an increase by 18-53% over the check plots. It is believed that the integrated rice demonstration has paved the way for breaking through the bottleneck in increasing the rice yield.

The development and improvement of inter-cropping system and relay interplanting cultural practice have enabled farmers in Taiwan to grow more new crop in winter and the other crop seasons to increase further the index of multiple-cropping and more intensive use of limited land resource. Rotational cropping and rotational irrigation systems were also introduced into the agriculture.

Efficient use of fertilizers has been one of the main targets of the fertilizer program administered by the Chinese Government. Recent findings have revealed that split applications of nitrogenous fertilizers and potash on rice are more effective than one single basal dressing in increasing the grain yield. Recommendations on such practices are being made to the farmers for general adoption.

In the past two decades after the World War II, many new kinds of pesticides and small power tillers were introduced into Taiwan.

Losses of crops from disease and pest in Taiwan have been estimated at 18% of total agricultural production. The measures for preventing these losses were long time delayed by the short supply of efficient pesticides. With the rapid development of pesticide manufacturing industry since 1950, the work of plant protection has entered into a new era of agricultural technology. In 1960, a total consumption of pesticides amounted to more than NT$25 million. About 85% of the total farm families applied pesticides for various crops. For rice crop only, about NT$13 million of pesticides were applied. The most important items of pesticides include BHC, Warfarin, Parathion PM and Cerasan Lime. The successful controls of pineapple mealbug-wilt, citrus disease and fruitfly and soil pest are the outstanding examples contributing to the increase of farm production and export.

Besides the application of pesticides for crops, rats control with warfarin was also systematically carried out. In 1957, about NT$20 million of budget was provided by government with JCRR subsidy for carrying out this program.

The increasing use of weedkiller in recent period is a new direction. This trend is completely responsive to the complexity of crop pattern and labor saving in farming practices. The number of small power tillers used by Taiwan farmers raised from 7 sets in 1954 to over 6,600 sets in 1962 and about 10,000 sets in 1964, alleviating the labor shortage during farming peak seasons and generating both labor-saving and output-effect due to deep plowing and work performance on time. After several years' research and experimentation, a set of implements for sweet potato culture and a type of drying bin for artificial drying of grain crops have been developed for practical use for time-saving in sweet potato culture and drying harvested grains in the rainy season.

Chapter VII.

Institutional Frame for Agricultural Development

A. Agricultural Agencies

One of the important factors contributing to favorable agricultural development in Taiwan was the agricultural institutional reform and political measures. Policies and measures have been applied with flexibility and thoroughness. As weakness became evident in operation, legislation was quickly modified to ensure that the intended objectives were attained. The policy measures were applied on a scale and with an intensity commensurate with ends in view. To handle the agricultural development program, there were many public and private agencies and organizations which may be conveniently grouped under seven headings. These are: government agricultural agencies, public and private agricultural corporations, agricultural financial institutions, agricultural experimental and research organizations, agricultural colleges and vocational schools, professional farmers' organizations and local self-government of township offices.

The highest government office responsible for agricultural administration is the Department of Agriculture and Forestry under the Ministry of Economic Affairs of the Central Government.

On the provincial level, the Taiwan Provincial Department of Agriculture and Forestry has overall charge of administrative affairs relating to agriculture. The PDAF, as the Department is called, has under it a Forestry Bureau, a Fisheries Bureau and a Mountain Resources Development Bureau to take charge of forestry and fisheries administration and development, soil conservation and marginal slope land development, respectively.

Under the Taiwan Provincial Government there is a Food Bureau in charge of food production, collection and distribution and administration of food policy. A Land Administration Bureau was set up under the provincial Department of Civil Affairs, and the land reform program was carried out under the general supervision of this Bureau.

A Water Conservancy Bureau under the Provincial Department of Reconstruction has charge of all matters relating to water conservancy and water resource development in Taiwan.

Those government offices constitute the first group of agricultural institutions. The second group is composed of five corporate bodies, namely: the Taiwan Sugar Corporation, the Taiwan Pineapple Corporation, the Taiwan Agricultural and Forestry Development Corporation, the Taiwan Ta Shueh Shan Forestry Corporation, and the China Fisheries Corporation. Organized as business enterprises, each of these corporations plays an important part in the development of one sector of our agricultural economy.

The third group of agricultural institutions consists of financial organizations, of which there are two: the Land Bank of Taiwan and the Cooperative Bank of Taiwan. It was the Land Bank of Taiwan which handled the issuance of the land bonds in kind used for the purchase of lands from the landlord during the implementation of the Land-to-the-Tiller program in 1953. The main business of the Land Bank of Taiwan is to provide loans in terms of long and intermediate periods to farmers and their organizations. In addition to a variety of banking services to the farmers' associations and cooperatives, the Cooperative Bank of Taiwan lays special emphasis on extending various kinds of agricultural short-term credit to farmers, fishermen, and farmers' organizations.

The fourth group of agricultural institutions in Taiwan is composed of experimental and research organizations, of which there are some thirty odd. They include research institutes, experimental stations, improvement stations, multiplication stations, experimental farms, and breeding stations. Each of these experimental and research organizations is interested in the study of one particular crop or a group of several crops or one particular aspect of agriculture. Some are organized along regional lines, while others are province-wide in scope. Administratively, most of them belong to the Taiwan Agricultural Research Institute, the Taiwan Provincial Department of Agriculture and Forestry, and the Taiwan Sugar Corporation.

Two colleges of agriculture, the National Taiwan University at Taipei and the Provincial Chung Hsing University at Taichung are engaged in agricultural education as well as in agricultural research. In addition, there are a Provincial Junior College of Agriculture, a Provincial Maritime Junior College, 41 Senior and Junior agricultural vocational schools, three fishery vocational schools, and a Tea Vocational School. All these agricul-

part in agricultural development in Taiwan. JCRR in the last 14 years, has been providing both technical and financial assistance to various sponsoring and cooperating agencies and organizations on project basis for agricultural and rural development.

To further understand the contributions of those agricultural institutions to agricultural development, some analysis should be made on their financial allocations and activities. In this review four main categories of agricultural financing are classified as Table 27.

Table 27 is intended to give a general picture of agricultural financing in Taiwan for FY1961. Attention is drawn to the role played by different agencies. The JCRR's financial assistance in the overall agricultural financing is most noticeable. JCRR's FY1961 allocations contributing to agricultural capital formation are about three times as large as the total amount of funds put up for this purpose by the government of all

levels including provincial, prefecture/city and township governments or a little over 50% more than the total investment made by all agricultural public enterprises, such as Taiwan Sugar Corporation, Taiwan Food Bureau, Taiwan Forestry Bureau, etc., or about 25% more than the funds provided by all farmers organizations including farmers' associations, farm irrigation associations, marketing cooperatives, etc.

Of the total expenditure for various agricultural improvement projects, JCRR's appropriations were NT$111,137 thousands or about 43% of the total expenditure in the year under review. This amount is a little over 30% more than the funds furnished by governments of all levels for this purpose, or one and half times more than the amount put up by all public enterprises, or about seven times the amount provided by all farmers' organizations. An illustration of matching fund system in operation between JCRR and sponsoring or cooperating agencies is given below:

Table 28. An Illustration of Matching Fund for JCRR Supported Projects in FY1961
(Unit: NT$1,000)

Activities	JCRR Fund Allocations	Sponsor's Contributions: Prov. & Local Government	Sponsor's Contributions: Gov't Enterprises & Banks	Sponsor's Contributions: Farmers' Organizations	Sponsor's Contributions: Private Farms & Others	Total
1. Crop production	32,403	5,526	1,441	1,155	8,453	48,978
2. Livestook Production	24,019	2,400	—	—	23,000	49,419
3. Water Use and Control	227,017	37,304	—	172,925	—	437,246
4. Forestry and Soil Conservation	21,922	917	14,901	—	5,535	43,275
5. Rural Organization	14,893	6,368	—	6,729	—	27,990
6. Agri. Extension	21,096	8,261	—	12,754	265	42,376
7. Agri. Credit	80,972	—	10	70	—	81,052
8. Economic Research	5,722	1,415	279	—	—	7,416
9. Fisheries	28,500	14,302	—	2,661	31,534	76,997
10 Rural Health	20,228	17,669	—	—	200	38,097
11 Agri. Research & Education	15,538	—	—	—	—	15,538
12 Rural Electrification	5,800	—	—	—	—	5,800
13 Miscellaneous Projects	14,780	—	—	—	—	14,780
14 Administration	17,780	—	—	—	—	17,780
Total:	530,670*	94,162	16,631	196,294	68,987	906,744
Percentage	58.52%	10.38%	1.83%	21.65%	7.62%	100%
			41.48%			

Source: "Statistical Review of Agricultural Financing in Taiwan and JCRR Contributions" unpublished JCRR Report, Dec. 1961.

* 47.5% of the amount of NT$530,670,000 was used as grants-in-aid, and 52.5% as loans.

Table 28 illustrates the amounts of matching funds required of and provided by the sponsoring agencies in the operational projects initiated or jointly initiated by JCRR. It should be pointed out that most of JCRR's projects are aimed to provide the necessary initiative for new developmental operations and to stimulate the sponsoring agencies to furnish additional

budgets for such operations. As shown in Table 29, government budgets for FY 1961 spent for the agricultural improvement and development activities at different levels are 7.50% for provincial, 3.43% for prefecture/city and 6.76% for township. The scarcity of government fund for agricultural operations is evident from these figures. This fact indicates that JCRR's provision of funds for agricultural operation is quite significant in helping government to carry out the various agricultural projects. Such integrated development programs of agriculture through a close relationship between JCRR and governments were centered in the Four-year Agricultural Development Plan. Appropriation of funds for agricultural operation is more or less based on the priorities set up by planners and top officials. They include the following principles: (1) to ensure enough supply of foodstuff for domestic consumption to meet the need of increasing population; (2) to expand the agricultural exports to earn foreign exchange; (3) to develop the natural and human resources to increase agricultural productivity as well as providing more employment opportunities to rural people.[8/]

Table 29. Budget of Governments at Different Levels for FY1961 (Unit: NT$1,000)

Items	Provincial		Prefecture/City		Township		Total	
	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Overall Expenditure	1,902,800	100.00	2,368,407	100.00	636,875	100.00	4,908,082	100.00
1. Education	405,545	21.32	828,943	35.00	111,668	17.54	1,346,156	27.43
2. Economic Reconstruction	212,225	11.15	316,442	5.76	63,131	9.91	411,798	8.39
1) Agri. investment	45,533		46,334		17,997		109,864	
2) Agri. improvement	57,877	5.44	22,340	2.90	10,008	4.40	90,225	4.08
3) Agri. administration	39,209	2.06	12,535	0.53	15,000	2.36	66,744	1.36
Total for agri.	142,619	7.50	81,209	3.43	43,005	6.76	266,833	5.44
4) Other economic reconstruction	69,606	3.65	55,233	2.33	20,126	3.15	144,965	2.95
3. Health and Sanitation	68,343	3.59	102,057	4.31	32,314	5.07	202,714	4.13
4. Social Welfare & Relief	100,349	5,27	33,041	1.40	11,363	1.78	144,753	2.95
5. Other	1,116,338	58.67	1,267,924	53.53	418,399	65.70	2,802,661	57.10

Source: "Statistical Review of Agricultural Financing in Taiwan and JCRR Contributions" unpublished JCRR Report, December, 1961.

8/ T. H. Shen, "Agricultural Planning and Production", p. 24, Taipei, Taiwan, China, March 1958.

Basing upon the above principles, a large portion of government budget and JCRR fund is allocated to the investment in resource development programs, such as water resource, forestry and fishery production bases. Appropriation to agricultural research, extension and improvement stands at the next. Except the government agencies and JCRR, public enterprises, Farmers' Associations, Irrigation Associations and private farmers are also the important units contributing substantial investment for the agricultural development.

B. Farmers' Associations

The present organization of farmers' association in Taiwan was formed through the amalgamation of two different farmers' organizations, namely, the farmers' association and industrial cooperative.

The first unification of two organizations took place in January 1944 and separated again in 1946. The second unification was seen in 1949 when the first step of the land reform program started. In 1953, it was reorganized and became the multi-purpose cooperative to carry out a number of functions which include the promotion of farmers' interest, advancement of farming knowledge and skill, increase of their production, improvement of their living conditions and development of the rural economy.[9]

The first farmers' association in Taiwan was established at San-Ko-Yung of Taipei prefecture in September 1900. Little is know of this association's activities. Up to 1908, the sixteen farmers' associations were successfully established. They were organized by the administration under the local top officials in cooperation with landlords and community leaders. The purposes of these associations were aimed to improve farm practice, introducing new seeds and purchasing fertilizer. Before promulgation of "The Regulation Governing the Farmers' Associations in Taiwan" in 1908, they had had no legal basis of activities. After issuance of the regulation, only 12 farmers' associations were left, one each in prefectural level and their activity was emphasized in agricultural improvement and extension. The government started to effective control over their formation and activities. Compulsory recruiting of members and compulsory collection of dues and

[9] S. C. Hsieh, "Farmers' Organization in Taiwan and Their Trends of Development", Industry of Free China, December 1963

government subsidy were legally granted. In 1927, as a result of the re-adjustment of administrative territories, the number of farmers' association was limited to one each in the eight prefectures. This means that farmers' association is an associated unit of government administration serving an important transmission belt to introduce new technology into agriculture through its strategic link between the administrators and the farmers. Therefore, it was effectively organized with the strong government support and control. Agricultural improvement stations were established in each prefecture to supply the information of new technology to farmers' associations.

The annual expenditure for the associations which accounted for 273, 093 yen in 1908, increased to 703,610 yen in 1919 or by 1.6 times in 1931, the period of technological maturity in agriculture, the associations' annual budget amounted to 1,592,324 yen and the total number of agricultural technicians in the associations was 1,148. Their activities were also expanding gradually. It included warehousing, cooperative purchase of chemical fertilizers, rice improvement, extension of agricultural skill and practices, improvement of livestock and poultry, livestock insurance, improvement of sericulture and reforestation, farm survey and conducting of agricultural seminar.[10] Each association had its own crop and livestock experimental farms to test the new technology. To be affiliated with farmers' associations in prefectural level, there were small agricultural units in village level. In 1944, the year when the agricultural association organizations were amalgamated, the total number of small agricultural units reached 4,891. The agricultural units consisted of different kinds of units; such as small agricultural practical units, societies, companies, etc. The main activities of small agricultural units were to conduct the following common items; (1) extension of new agricultural practice, (2) arrangement of land rent dispute between landlord and tenant, (3) seed multiplication. (4) fertilizer distribution, (5) crop culture and growing, (6) animal raising, (7) irrigation, (8) agricultural contest, etc.[11]

According to the "Order Governing Farmers' Associations in Taiwan" which was issued by the government in 1937, the farmers' association was

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[10] "Yearbook of Farmers' Association", Provincial Government General, 1931

[11] Min-hsioh Kwoh "Farmers' Associations and Their Contributions toward Agricultural and Rural Development in Taiwan" JCRR October 1963.

reorganized to the two-level systems; provincial and prefectural. The branch offices were organized in every township, and local committees were appointed at every village for coordinating their activities. After reorganization of farmers' associations in 1937, the integrated system for implementing government agricultural adjustment plan was completely established.

The movement of industrial cooperative in rural area was quite different from that of farmers' association. It was completely based on the general principles of cooperative society. Before promulgation of "The Regulation Governing the Industrial Cooperative in Taiwan" in 1913, 16 cooperatives had been established, of which were almost located in cities and towns. The major purposes of these cooperative societies were to finance the small business and firms. With the rapid industrial development in this period, financing problem was felt very difficult for small business and firms.

Financial discrimination of bank to those small business and firms even worsened the general financial situation. With the consideration to this financial difficulty, government had encouraged the establishment of Credit Cooperative under the special amendment to the civil law. After promulgation of the cooperative regulation in 1937, the total number of cooperative societies expanded very rapidly in urban and rural areas. It reached 251 units in 1920, and 500 in 1940. The total membership was 2,760 in 1913, and increased to 609,817 in 1940, about one half of the total number of families in Taiwan. [1] However, in spite of a big cooperative movement at township level, the establishment of federal organization was prohibited until 1942 when the regulations were revised and the Taiwan federation of industrial cooperative was established. The major activity of industrial cooperative in rural area was credit service in the early period. The activities of purchasing, marketing, utility service were undertaken later. In 1933, the warehousing service was added, the multi-purpose cooperatives were completed. The activities of industrial cooperatives and farmers' association were different at the starting point, but they gradually intermingled each other and came out some confusion and duplication between the two organizations. The sharp competition of two organizations in their business activities was felt necessary to be adjusted to the coordinat-

[1] Min-hsioh Kwoh "Farmers' Associations and Their Contributions toward Agricultural and Rural Development in Taiwan," JCRR, October 1963.

ed way to meet the requirement of national economic mobilization. This situation motivated the unification of farmers' organization and industrial cooperatives in 1943, resulting in a single and unified agricultural association. The newly unified agricultural association was set up at the three levels: province, prefecture and township. The activities performed by the farmers' association, livestock industrial association, specified single cooperatives, such as credit cooperative, purchase and supply cooperatives were amalgamated into agricultural association. Besides the provincial agricultural association, an Industrial Cooperative Bank was established as the central coordination unit of credit sections of township agricultural associations. The small agricultural units were reorganized to the agricultural practical units and considered as the basic bodies of township agricultural association.

The chairmanship of agricultural association at the three levels were opened for the governor and the heads of local government. The directors and counselors were nominated by the chairman and appointed by the government. The agricultural association became like a branch of government agency to help its economic mobilization to achieve the war purpose.

In the post-war period, agricultural association was retained by the Chinese government for a time. In 1946, reorganization program for agricultural associations was undertaken to separate it into two systems - - farmers' association and cooperative. Basing on the Chinese regulations for two organizations, separation of the old agricultural association into two units has led the farmers' association to the non-active organization. This could no longer meet the government programs for agricultural recovery from war-damage and needs of farmers. Reunification of two organizations on the different basis had been broadly recognized. More specifically, such movement in reorganization of farmers' association was accelerated by another social and institutional transformation of Land-to-the-Tiller program in rural area. The first reorganization thus was undertaken in 1949 when land rent reduction program was completed, and the second reorganization was undertaken in 1953, when Land-to-the-Tiller program was successfully started.

Through the reorganizations in 1949 and 1953, farmers' associations of Taiwan have the specific functions and forms which were not ever seen in Taiwan, China mainland and other countries. A great difference between

the present farmers' association and the pre-war agricultural association is that real membership is limited to the farmers and organization was governed in autonomous way. This is quite in accordance with the purpose of land reform program in helping farmers to increase farm productivity, and to raise farmers' income and their social status.

At the present time farmers' associations are organized at three levels: 317 associations at the township level, 22 associations at the prefecture and city level, and one association at the provincial level. Each association has a board of directors and a board of supervisors, both directors and supervisors being elected by the representatives' meeting. A general manager is employed by the board of directors to be responsible for managing the business of the association according to the decisions and policies of the board of directors.

Under each township farmers' association there are three business operational sections in charge, respectively, of marketing and purchasing, credit, and extension.

There are two categories of members in a farmers' association, namely: farmer members and non-farmer associate members. All farmer members have the right to elect officers and to be elected to any office of the association.

A farmers' association performs such services and offers such facilities as cooperative marketing and processing of farm products, purchasing of farm supplies, extension of farm loans and acceptance of farmers' deposits, collection of rice for the Government, distribution of fertilizer to the farmer, and the sponsoring of agricultural extension service and various rural welfare services.

The farmers' associations in Taiwan have successfully carried out agricultural extension work in close coordination with governments of all levels, agricultural research institutes, agricultural improvement stations, and other interested agencies.

Agricultural extension work undertaken by farmers' association includes three phases: farm extension among adult farmers, 4-H club work among rural boys and girls, and home economics extension among farm women.

The farm extension program has been conducted on the basic policy in dealing with the whole farm operation, instead of with individual projects. By 1961, the program had been adopted by 277 townships. A total of 527 township farm advisers, under the direction of county supervisors and the Provincial Farmers' Association, work with adult farmers to familiarize them with new farm practices, organize group discussions, and hold demonstration on selected farms.

The 4-H club phase of the extension program trains rural young people to become better farmers and home makers by teaching them improved farm and home practices, and to become better citizens by training them to develop self-reliance, self-discipline and industry.

Each member of a 4-H club carries out his own project such as growing rice, vegetables, or sweet potatoes, raising pigs, poultry or rabbits, or improving the home. He follows the instructions of the township adviser and keeps a complete record of his project. In addition to carrying out individual projects, 4-H club members also receive training in democracy and leadership by conducting club meetings, giving talks, and making demonstrations. They engage in community services, such as vaccinating poultry, planting roadside trees, and exterminating rats.

Home economics extension helps to improve the living conditions of the farmers in Taiwan. A total of 10,735 4-H club girls have enrolled in 856 home economics and 4-H clubs, and 14,616 farm women have enrolled in 1,185 home improvement clubs to learn how to use more home-grown food, how to plan healthful and inexpensive meals with limited funds, and how to cook rice and vegetables to preserve their nutritional value.

The agricultural extension program in Taiwan has several distinguishing characteristics:

First, it is a cooperative program. Many resources of the Government, farmers' associations, and JCRR are joined together in common.

Secondly, advisory committees at the provincial, county, township, and village levels bring together representatives of the coordinating agencies and of the farm people to help determine policies and programs that meet the needs of the farm people and the objectives and goals of government agencies.

Thirdly, there is a comprehensive pre-service and in-service training program for extension workers covering both subject matter and teaching methods.

Fourthly, local leaders are trained and used in all three phases of the agricultural extension work.

Lastly, information services support and assist the extension program in addition to carrying on many activities on an independent basis.

It is the goal of the agricultural extension program in Taiwan so to develop it as to meet the needs of the rural people and to be financed and supported entirely from local resources.

C. Irrigation Association

Elaborate systems of irrigation and drainage have been constructed in Taiwan. For the maintenance and operation of the irrigation canals, as we have already noted in a previous connection, irrigation associations were organized on a regional basis. The first irrigation association was established in 1922. Though they have been reorganized three times in response to the readjustment of water system, their guiding principles and functions almost remained unchanged. The legal phase of association is the semi-autonomous and public-nature body.

The last reorganization was undertaken in 1955 in order to meet the change of membership after Land-to-the-Tiller program. The functions of the irrigation associations are emphasized on the following points:
(1) implementation, improvement, operation and management of the irrigation and drainage engineering projects; (2) water regulating and control among canals and pumps under their jurisdictions and settlement of disputes; (3) land improvement including wind, sand in their control and soil and water conservation; (4) prevention and elimination of practices destructure or harmful to irrigation system; (5) operation and management of its own properties; (6) to take up and assist in matters coordinated to the government planning for regional irrigation projects contiguous to the Associations' jurisdictional areas: (7) preparing plans for hydraulic engineering work in the jurisdictional area; (8) to take up related jurisdictional matters assigned by the superior organizations and other matters coming under its jurisdictions according to legal stipulations. The irrigation asso-

ciations will separately draw up working measures pertaining to the above functions to be approved by their superior organizations. [1]

The membership of the irrigation association includes all beneficiaries of irrigation facilities in the respective area. They may enjoy all the irrigation and drainage facilities in the area and have the right of electing representatives to the council and the duty of paying membership fees. There are at present 26 associations covering a total irrigation and drainage area of about 490 thousand hectares. About 528,000 hectares of paddy fields out of a total of 872,000 hectares of cultivated land in Taiwan are irrigated more or less with water from the irrigation canals.

The annual revenue of the irrigation association comes from the ordinary membership fees collection which is governed by "The Regulation for Collection of the Membership Fees". The budget is drawn up annually to meet the needs of administration expenses, maintenance and urgent repairing needs. The membership fees are therefore different from association to association, but some limits of maximum and minimum are fixed officially and approved by the member-representative meeting. The special water fees are generally collected from farmers in the benefited areas to repay the construction loans.

Of the total annual revenue, a 58.34% is spent on maintenance, 16.13% on damage repairs and 7.42% on irrigation management. Besides some reserve funds paying off from annual membership fees, surcharge fund are also collected for damage repairs and contingent expenditures by 26 irrigation associations. Under the principle of self-financing and mutual cooperation, the joint revolving funds are pooled and managed by a special revolving fund committee to meet the urgent needs of individual irrigation associations. For this purpose, 5.5% of interest rate is paid to the depositing associations and 6% against the borrowing of using associations.

The operation of water use and control by the irrigation associations are governed by the Water Law and other regulations. A water right of using surface water, ground water or surplus water for any agencies should be registered. But some priority of water use is manifested in

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[1] K. T. Chang, Tsuei-Yuan Tsai, and S. T. Hsu, "Operation and Maintenance of Irrigation in Taiwan" Far East Regional Irrigation Seminar pp. 360-369 May 1-12, 1961, Taipei, Taiwan, China.

the Water Law for adjusting the conflicts between different water use and water allocation in the irrigation association. When the water supply is short, top priority is to be given to the first registered users.

Maintenance work of irrigation facilities is divided into four categories, regular maintenance, annual up-keep, flood control and special repairs. Every year, the irrigation association conducts an over-all inspection of irrigation facilities and works out a plan for carrying out annual repairs to these facilities and repair of important projects. If local labor is desirable for these repairing works, labor should be provided by the benefited farmers during slack season. ₩

Irrigation has been improved in recent years through canal lining, land consolidation, rotational irrigation, and ground water development. As a result of using concrete lining, the loss of water through seepage which had been estimated to be as much as 40 per cent in the case of the Chianan Canal before lining, can be stopped and much water saved. By means of land consolidation, small plots of land are grouped together into units of eight to 12 hectares each, and five or six such group units with a total area of 50 hectares form a "rotational area" which will receive water according to a prescribed schedule. By means of rotational irrigation, not only water can be saved, but also an increase of production can be obtained. The saving of water through rotational irrigation is especially needed in regions where the area of irrigation is to be expanded or where there is an inevitable shortage of water. By the end of 1961, 302 deep wells had been constructed in the Yunlin-Changhua area where ground water is abundant. Ground water development resulted in a very high benefit-cost ratio, because the supplementing of surface flow with ground water made it unnecessary to construct extensive canal systems and control structures.

The development of irrigation in Taiwan has brought many advantages to the farmer and to the farm economy as a whole. First, it increases the intensive use of land. It converts dry land into paddy fields, which can then be planted to two or three crops a year under a multiple cropping system. Secondly, it stabilizes per unit yield and even increases it. Thirdly, it makes possible for the superior varieties, the fertilizer and other culture

₩ K. T. Chang, Tsuei-Yuan Tsai, and S. T. Hsu, "Operation and Maintenance of Irrigation in Taiwan." Far East Regional Irrigation Seminar pp. 360-369, May 1 - 12, 1961, Taipei, Taiwan, China.

techniques and practices to produce the best results.

In Taiwan, the problem is not only just to provide water for irrigation, but also the enforcement of controlled irrigation for economic and efficient use of water. By controlling the irrigation, it is possible to adjust the flow of water to the demand for it, adjust it to the needs of particular crops, and control the volume of water as well as the time of its inflow. These are the new functions of the irrigation associations of which operations should be emphasized in the future.

D. Human Factors

The human factor has played a very important role in agricultural development in the last 50 years. Two colleges of agriculture, and one junior college of agriculture are engaged in agricultural education as well as in agricultural research. In addition, there are agricultural vocational schools, fishery vocational schools and a tea vocational school for education and training of lower level of agricultural technicians working at the township and county levels. All these colleges and schools have trained a large number of agricultural workers and technicians to meet the increasing demand for such personnel in the province. The abundance of technical personnel and the high quality of their performance have contributed materially to the successful implementation of the numerous measures and programs for the improvement of both the quantity and quality of agricultural products. The following table indicates that 77% of graduates from College of Agriculture, National Taiwan University during the period of 1949-1959 was engaged in the agricultural education, research and agricultural corporations. This fact implies that the large number of technicians educated in colleges and vocational schools are working in their own special fields of agriculture.

Table 30. Job Distribution of College Graduates

Type of Job	Number of persons	Percentage %
Agricultural Education	208	28.1
Agricultural Research	209	28.3
Public Enterprise of Agriculture	152	20.6
Private Enterprise	73	9.9
Agriculture and Business	17	2.3
Others	41	5.5
Unknown	39	5.3
Total	739	100.0

Another important human factor contributing to agricultural development in Taiwan is, without doubt, the intelligence, skill, and receptivity of the farmers themselves. The 1960 Agricultural Census shows that 50% of farmers have received more than primary education. However, their literacy exceeds more than 60%. Being able to read and write, they are eager to learn new techniques and methods. They are receptive to new ideas and willing to undertake new experiments. They will gladly try out new varieties or pesticides. The 1960 Agricultural Census also reported that more than 40% of farm families adopted new techniques of crop cultivation and kept farm record. About 18% of total farm families participated in the agricultural training and seminar courses held by farmers' associations.

The farmer in Taiwan has other good qualities to command himself. One of these is the spirit of self-help, which expresses itself in the form of local initiative and desire for progress. Another is his active participation in all agricultural development programs, without which no agricultural operational program can be smoothly and effectively carried out. A further characteristic is the farmer's law-abiding spirit and political consciousness. He knows the importance of cooperating with the administrative authorities by strictly following the rules and regulations promulgated by the Government for the implementation of specific programs. This sense of civic responsibility on the part of the farmer has made it easy for the Government to introduce new measures for agricultural development which will command popular support.

All agricultural development projects have been undertaken with the hope that the local governments or organizations will eventually take over the responsibility of sponsoring and executing all long-term reconstruction projects, so that they may be carried on without interruption and become a permanent part of the activities of the rural community.

At this point it is important to emphasize that all agricultural development programs in Taiwan have originated in the farmers' felt needs and geared to the national policy of increasing agricultural production on the one hand and improving the farmer's standard of living on the other.

E. Land Reform

The agriculture of Taiwan, before implementation of the land reform program in 1949, had been faced with certain basic problems. Among these the

scarcity of farm land had long been the most serious. With the increasing agricultural population the farmers had to cultivate their small plots of land in the face of an underemployed labor force and a shortage of capital. Under these conditions there had developed an irrational system of land tenure under which serious disputes between landlord and tenant often arose. The average farm rental rate was fixed at approximately 50 percent of the total annual main crop yield; in extreme cases it was as high as 70 percent. In addition to the high rent the tenant often had to pay the landlord "key money" for the renewal of the lease. Further, the lease had no definite period and might be terminated by the landlord at any time. Most contracts were made verbally, and only in exceptional cases were they put into written form. With the limited farm land and the irrational tenure system, rural underemployment presented a serious problem. The cash income of tenants from farming was often insufficient to cover living expenses and farmers and farm labourers depended on additional income from off-farm employment. Low income, low capital input, surplus labor and the small size of farms constituted the major obstacles to the introduction of modern techniques in agriculture in Taiwan.[1]

In order to seek a solution to some of the above problems and lay the foundation for future agricultural development, the government in 1949 set out to implement the rent reduction and the Land-to-the-Tiller programs. They were aimed at terminating the traditional land tenure system and raising the farmer's standard of living.

Farm rent reduction was carried out in 1949. The program called for the compulsory reduction of all farm rental rates from an average of 50 per cent to a maximum rate of 37.5 per cent of the annual main crop yield. A total of 260,000 hectares of tenanted lands was affected by the program, and about 300,000 tenant families were benefited thereby.

The sale of public lands to their incumbent tenants was begun in 1952. By the end of 1961, a total of 96,000 hectares of public land had been sold by the government at a price 2.5 times its annual crop yield. More than 200,000 tenant families have acquired land ownership under this program.

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[1] H. S. Tang and S. C. Hsieh, "Land Reform and Agricultural Development in Taiwan". The Malayan Economic Reveiw Vol. VI. No. 1, April 1961.

The Land - to - the - Tiller program began in February 1953. Under this program the Government compulsorily purchased all private tenanted holdings exceeding three hectares of paddy land or six hectares of dry land from the landlord and resold them to their tenant cultivators. Both the purchase and the resale prices were fixed at 2.5 times the annual crop yield. The tenant - purchasers paid the purchase price to the Government in 20 semi - annual installments spread over a period of ten years. The Government compensated the landlord for his land by paying him 70 per cent of the land price with land bonds redeemable in kind and 30 per cent with stock shares of four government enterprises. About 140,000 hectares, or 60 per cent of the total private tenanted land, were purchased by the Government and resold to 200,000 tenant families who, as a result of this program, have become independent owner-operators.

Some important changes were seen in the agrarian structure as the result of this government land policy.

Changes in tenancy: Before 1949, 39 per cent of the total farm families in Taiwan were tenant farmers. They were reduced to only 17 per cent of the total in 1957. Changes in the number of owner farmers were also accompanied by a change in the acreage of owner cultivated land. Of a total area of 680,000 hectares of private cultivated land, the proportion cultivated by owner farmers was increased from 61 per cent to 85 percent.

Changes in size of land holding: Another important changes is in the size of individual land holdings. Those who had less than three hectares of land were increased from 58 per cent to 77 per cent of the total private farm land, while those who had three hectares and above were reduced from 42 per cent to 23 per cent. The above trend can also be noted in the figures for landowner (including owner farmer) families. In 1952 there were only 610,000 landowner families; 93 per cent owned land under three hectares. In 1955 the number of landowner families increased to 790,000 families, of which 96 per cent owned land under three hectares. [1]

As the transfer of land ownership under the Land - to - the - Tiller program in Taiwan has not involved very much the split of large land holding into small land unit as in the cases of land reform in other countries, and

[1] H. S. Tang and S. C. Hsieh, "Land Reform and Agricultural Development in Taiwan". The Malayan Economic Review Vol. VI, No. 1, April 1961.

as the tenant farmers had assumed managerial responsibility of their farm operation even before the land reform, the implementation of the program produced neutral effect on the operation unit of the farm size and the farm management and organization. It has also resulted in the adoption of multiple-cropping farming and subsequently rapid growth of land productivity. It also provided increasing working opportunities to utilize the surplus labor in agriculture. Under the serious shortage of land resource and high pressure of population in agriculture, the implementation of land reform has brought the new owner cultivators incentive to engage in the labor intensive and diversified farming.

Total agricultural production increased by about 21 per cent during the period of 1950-1955. Total crop production increased by 15 per cent and livestock production by over 90 per cent. With respect to crop production, there were substantial increases in the output of rice and other cash crops. An important contributing factor was the rapid increases in labor input and working capital, indicating 7 per cent and 75 per cent respectively. Although it is difficult for us to separate the effects of land reform program and other factors on agricultural production at the present time, it is reasonable to conceive that a large share of increase in agricultural productivity has been motivated by the land reform program.

F. Rural Health and Nutrition*

Rural health in Taiwan before its retrocession to China was only rudimentary. At the time of retrocession, even such rudiments as there were disintegrated. Rural health in Taiwan is therefore considered a recent achievement of the Chinese Government, particularly after 1949 when the US, UN and other foreign aid agencies started to play their important roles in its promotion.

At the time of retrocession, the health condition in Taiwan was bad. Hospitals supported by the government and charity organizations were few, all in dilapidated conditions and located exclusively in major cities. There

* Reference is made to "Major Achievements in Health Program and Its Impact on Socio-Economic Development in Taiwan" by Dr. S. C. Hsu, Chief of JCRR Rural Health Division, February, 1965, and "Agricultural Development on Taiwan Since World War II", Chapter 19; Rural Population and Health, by Dr. T. H. Shen, Chairman of JCRR, published by the Cornell University Press, 1964.

were no health organizations in either urban and rural areas. Malaria and other major communicable diseases such as smallpox, the plague, cholera, and rabies were rampant. Environmental sanitation was backward and most of the waterworks were either out of function or inadequate to meet the needs of the people. Food was scarce. The caloric intake of the people was low and nutritional deficiency diseases were common. Life expectancy was low and death rate high.

The measures taken by the government to overcome these difficulties were control of diseases, establishment of a network of province-wide rural health units, improvement of environmental sanitation, nutrition program, etc.

With US aid for equipment, building and advanced training, a modern serum and vaccine laboratory was established by amalgamating early in 1950 the two biological units of the National Taiwan University and the Provincial Health Department. Ever since the laboratory has been providing all the biologicals that are up to international standards to meet the local needs. Smallpox, the plague and cholera broke out on the island during the first few years after retrocession. They were soon brought under complete control, although there was a transient recurrence of paracholera in 1962.

Malaria control deserves special mention. There were estimated to have been 1.2 million cases of malaria annually out of 6.5-8.1 million people prior to 1952. As a result of the vigorous control program supported jointly by US aid and WHO, the disease is now eradicated.

The Chinese Government has also carried out active control programs against tuberculosis, venereal diseases, trachoma, diphtheria-pertussis and poliomyelitis. With encouraging results the tuberculosis mortality has dropped from 285.2 in 1946 to 37.2 per 100,000 people at present. Positive serological tests of blood specimens of adults for syphilis were 13.4 percent in 1954 and 3.86 percent in 1960. Trachoma incidence of new entrants of primary schools was 42.6 percent in 1956 and 17.9 percent in 1963. The number of cases and deaths from diphtheria were respectively 2,040 and 516 in 1959 to 170 and 66 in 1963.

The number of rural health stations increased fast, from one at the

time of restoration, to 56 in 1949 which were established in old buildings and poorly equipped, and to 361 at present, one in each township and district plus 12 in salt fields. With JCRR assistance all these health stations were strengthened or established in early 1950 by local communities. Since 1952 they have become county-municipal government supported organizations. Beginning from 1962, they have been financed and controlled by the township governments.

For the improvement of environmental sanitation, emphasis has been laid on the construction of waterworks, sanitary wells, standard latrines, drainage ditches, composting, fly control, etc. In 1949, out of 127 waterworks in Taiwan, 18 were in good condition, 32 irreparable and 77 needed immediate rehabilitation. Now there are 252 waterworks. The number of people having potable running water has increased from 17.9 percent in 1949 to 32.7 percent at present. Altogether 8,600 new sanitary wells with hand pump, 4,129 public and private latrines, 154,091 meters of drainage ditches in 86 villages have been constructed over the past years. The number of primary schools having piped water has likewise increased from 316 in 1951 to 811 at present which represent 40.3 percent of primary schools and benefit 37.2 percent of the school population. New standard latrines have been constructed in 889 schools.

Since 1956 a per capita consumption survey of basic food has been regularly carried out by the Provincial Food Bureau. During 1962 a province-wide weighed dietary survey was also done. JCRR compiles annual Taiwan food balance sheet. A comparison of the average per caput daily nutrient availabilities in 1945 and 1963 shows great improvement: calories from 1,277 to 2,297, total protein from 24.31 to 58.75 grams, animal protein from 3.23 to 16.81 grams, fat from 11.01 to 42.07 grams, calcium from 130.69 to 279.01 mg, iron from 4.52 to 9.45 mg., and proportional increases in vitamins. Since September 1964, with US aid the government has extended the school lunch program to 267 primary schools benefiting 200,000 pupils in indigent areas or 10 percent of the total primary school population in Taiwan. In addition, 100 primary schools and 236 villages have a milk drinking program with the milk powder provided by the UNICEF and Protestant and Catholic Welfare Associations.

The remarkable improvements in rural health conditions and rural nutrition made in the past decade have contributed to the increase of the

efficiency and productivity of agricultural labor and to the improvement of the general health of farmers in Taiwan. All these constitute one of the important factors contributing favorably to the increase of farm output and improvement of the human factor in agricultural development.

Chapter VIII.

Agricultural Development and Economic Growth

In the preceding section, the salient features of agricultural development in Taiwan have been pointed out in the analysis of the five phases of the development process. There were many factors affecting the growth of agriculture in the different stages. They included both internal and external forces. In this section, the external forces will be examined in the light of the relations between agricultural and other economic sectors. In the process of overall development, the growth of the agricultural sector was closely related to that of other sectors in a mutually benefiting way. Therefore, it is the purpose of this section to show that the rapid growth of the economy of Taiwan came as a result of the interrelation between agricultural and non-agricultural sectors.

The economy of Taiwan developed at an average annual growth rate of 3.0% during the entire period from 1911-15 to 1956-60. While the growth rate averaged annually 4.1% in the prewar period from 1911-15 to 1936-40, it was 9.6% in the postwar period from 1946-50 to 1956-60. Despite the downward trend of net national product in the period of 1940-45 due to the ravages of war, the economy of the island still expanded steadily so far as the entire period was concerned. The relative importance of the agricultural sector in the national economy was different in the periods before and after the war.

Table 31. Net National Product by Industrial Origin
(1935-37 constant price T$1,000)

Period	Total	Primary industry	Secondary industry	Tertiary industry
1911—1915	293,660(100.0)	140,599(100.0)	78,220(100.0)	74,841(100.0)
1916—1920	336,547(114.6)	123,086(87.5)	126,953(162.3)	86,508(115.6)
1921—1925	399,143(135.9)	159,353(113.3)	109,524(140.0)	130,266(174.0)
1926—1930	560,175(190.8)	218,002(155.1)	149,258(190.8)	192,915(257.8)
1931—1935	706,218(240.5)	248,623(176.8)	209,302(267.6)	248,293(331.7)
1936—1940	796,749(271.3)	280,371(199.4)	269,784(344.9)	246,594(329.5)
1946—1950	402,859(100.0)	162,118(100.0)	77,617(100.0)	163,124(100.0)
1951—1955	728,797(180.9)	255,606(157.7)	170,156(219.2)	303,035(185.8)
1956—1960	1,010,076(250.7)	325,984(201.1)	264,945(341.4)	419,147(257.0)

Source: See Appendix Table 1

It can be seen from Table 31 that the primary industry played the principal role in national economy in the prewar period, while in the postwar period the secondary and tertiary industries were of greater importance, indicating that Taiwan has experienced a transformation in its economic structure, from agricultural to industrial economy. The latter period also witnessed a higher growth rate for secondary and tertiary industries.

Although it required outside capital and technological innovations to break the economic stagnation in the early stage and in the period immediately after the war, the contribution of agricultural development to the overall economic growth was significant. In analysis, agriculture had three special functions in this respect.

Firstly, agriculture met successfully the increased demand for agricultural commodities associated with the expansion of general economy. In the initial stage of development, Taiwan was reorganized as a part of the Japanese Empire, and its economy was purely colonial in nature. The expanded trade then developed between Taiwan and Japan, and the perennial food shortage in the latter called for the supply from Taiwan, in growing quantities, of such commodities as rice, sugar and other food items. This rising trend of export continued until 1940. After the war, the rapid increase in population caused the domestic demand for food to grow, while agricultural export dropped to a low level due to the temporary cutting off of the economic and political relations between China and Japan early in the postwar period.

Population growth is directly connected with the demand for agricultural goods. The rate of population growth in Taiwan averaged annually 1.1% in the period of 1916-20 and increased to 2.75% and 4.61% in 1936-40 and 1951-55, respectively. Since 1951-55, it has dropped slightly but has remained one of the highest in the world.

Throughout the process of economic development, the increased demand for agricultural goods either due to the expansion of foreign market or due to population explosion generated a great impact on agricultural development.

Table 32. Food Balance Sheet of Taiwan
(at 1935-37 constant price)

Period	Total Supply of Food (1)	Domestic Food Consumption (2)	Net Export of Food	(2)/(1)%	Population Growth%
1911—15	158,246,546	133,313,863	24,932,683	84.24	—
1916—20	182,875,548	146,178,513	36,697,035	79.93	1.09
1921—25	216,777,415	167,350,267	49,427,148	77.20	1.65
1926—30	270,524,798	195,891,673	74,633,125	72.41	2.35
1931—35	333,445,998	208,100,553	125,345,445	62.41	2.75
1936—40	374,180,942	218,755,658	155,425,284	58.46	2.75
1941—45	296,557,632	221,520,548	75,037,084	74.70	1.53
1946—50	290,715,774	268,753,554	21,962,220	92.45	2.57
1951—55	429,984,656	404,536,427	25,448,229	94.08	4.61
1956—60	534,118,728	505,395,616	28,723,112	94.62	3.82

Source: computed by Rural Economics Division, JCRR

As shown above, Taiwan's agriculture was able to supply enough food to meet the needs of both increased population and expanded export trade. With the rate of population growth at 1.1-3.8%, income elasticity of demand for food at 0.5-0.6, and the increase in per capita income at 3-5%, the supply of agricultural goods still kept pace with the aggregate demand for food in the entire period. This balanced growth of agricultural and non-agricultural sectors reflected the long-run stability of agricultural price ratio. There had been no price inflation caused by food shortage in the past 50 years, with the exception of the short-run monetary inflation shortly after World War II. The effects of the available food supply to the nation on labor mobility and wage rate, which are worthy of a further examination, will be discussed later.

The second function of the agricultural sector in connection with its contribution to general economic development was the supply of labor to industry and other economic sectors. In the initial period of economic development, more than 60% of the population was rural and more than 70% of labor force worked on farms. After that, the percentage of agricultural labor in the total labor force decreased, although both labor forces continued to expand steadily. It should be noted that only a small part of the increase in agricultural labor force had migrated to cities. The process of the supply of labor industry and urban areas in Taiwan was different from that in other countries, mainly because of the abnormally high rate of population growth in both rural and urban areas here.[17]

[17] S. C. Hsieh "Agricultural Development and Small Farm System in Taiwan", Industry of Free China, Nov. 1962.

The third function of agriculture in contributing to the economy as a whole was the provision of capital. In Taiwan, however, the supply of capital from agriculture came in a somewhat indirect way, as capital resources from Japan in the initial stage and those from U. S. aid after the war played a major role in economic activities and in the investment in infra-structure on the island. Although the political systems in the prewar and postwar periods were different, the mechanism to channel farmers' savings into investment was about the same. In the former period, the Japanese colonial government, in order to create conditions that would encourage private investment largely from Japanese capitalists, had remodeled agricultural and economic systems so that land and labor would become more productive and the previously idle resources would be utilized. Consequently, it became necessary for the government to create a large budget surplus through land tax reform and the establishment of the monopoly bureaus. The specific feature of the mechanism which induced a substantial part of the increment of output into public investment was that it was provided on a pay-as-you-go basis[18] In the postwar period, the siphoning off of the agricultural surplus to public investment was accomplished through the paddy-fertilizer barter system and the compulsory purchase of paddy rice from land owners at a lower-market price. Rada and Lee estimated that the rice-money profits collected by the Provincial Food Bureau amounted to NT$1,200 million for rice collection each year and to NT $423 million as earnings from imported fertilizer. These profits were used to subsidize the rice rationing program for military and govenment employees and the infant fertilizer industries.[19] The payment of rents by tenant farmers and the levy of land taxes by the government were the principal instruments to siphon off a surplus from the small farmers. The resources mobilized in this way were undoubtedly considerable, and it was a way similar to that in the initial stage of economic development under Japanese colonial rule. The qualitative aspects were also of significance. Resources obtained by the government through the collection of land taxes were applied to economic development including the provision of services and

[18] Chang Han-yu and Ramon H. Myers, "Japanese Colonial Development Policy in Taiwan, 1895-1906: A Case of Bureaucratic Entrepreneurship", The Journal of Asian Studies, Vol. 22, No. 4, Aug. 1963.

[19] E. L. Rada and T. H. Lee "Irrigation Investment in Taiwan--An Economic Analysis of Feasibility, Priority and Repayability Criteria", Chinese-American Joint Commission on Rural Reconstruction, Economic Digest Series No. 15, February 1963 P. 30

facilities to the agricultural sector. As mentioned in the preceding section, the mechanism of inducing savings from small farmers was in operation at a time when agricultural productivity was rising.

Dr. Chang Han-yu, Professor of Economics at the National Taiwan University, says in his paper "Evolution of Taiwan's Economy During the Period of Japanese Rule" that although farmers' income and consumption were improved to some extent, the rates of their increase were much lower than that of the growth of productivity.[20] The levy of land taxes which took away partly farmers' surplus actually did not discourage them from increasing production and adopting new technology. The paddy-fertilizer barter system started in the postwar period when there was inflation and a shortage of chemical fertilizers was apparently also useful in encouraging farmers to raise their production on the one hand and in providing the Government with a revenue on the other.

Besides the role of the government in public investment, landlords also participated in the investment in irrigation and land improvement and in industry, especially during 1911-40, the period of continued agricultural development. But large-scale productive investment of savings for the most part was made by Japanese capitalists in the prewar period and by the Government, U. S. economic aid through JCRR and private capitalists in the postwar period.

The Land-to-the-Tiller program undertaken in 1952 brought about a change in the system of obtaining capital from agriculture. Under the program, the Government gave landlords land bonds in kind and stocks of government enterprises in return for the lands compulsorily purchased from them and resold to tenant farmers who, on their part, paid the land price in kind to the Government by semi-annual installments over a period of ten years. 70% of the land price payment was used for paying off the land bonds and 30% for compensating for the government enterprises turned over to landlords. The total face value of the stocks of government enterprises thus disposed of was NT$657,660,820 or US$35,019,213 at the 1954 exchange rate. In physical terms, the value of land bonds issued to landlords was 1,448,809 metric tons of paddy rice and 495,757 metric tons of sweet potato.

[20] Chang Han-yu aud Ramon H. Myers, "Japanese Colonial Development Policy in Taiwan, 1895-1906: A. Case of Bureaucratic Entrepreneurship", The Journal of Asian Studies, Vol. 22, No. 4. Aug. 1963.

The annual payment of land price by the newly created owner-cultivators was about 6% of the total rice production on the island, and in terms of money value it amounted to NT $538,396,000 according to the 1962 prices of rice and sweet potato. A sample economic survey revealed that among the landlords, most of the small holders spent the compensation received under the land reform program on living and investment in small businesses; the medium holders used a large part of it for investment in businesses and industry; and most of the large holders used it for investment in industry, fishery and forestry. In analysis, of the total amount of compensation to landlords, about 22% was used for consumption purposes, 42% for investment purposes and the balance held in land bonds. The land reform program had not only raised farmers' social and economic status, but also improved the system of securing surplus funds from agriculture for public investment. Its impact on industrial expansion was great.[2]

However, the agricultural and other sectors of the economy in its development were mutually related. Agriculture contributed to the growth of other sectors by providing them with labor, capital and agricultural goods, while the expansion of other sectors stimulated the growth of agriculture by raising the demand for agricultural products and by providing agriculture with the benefits of technological progress. This interrelation was especially marked during 1934-40 and 1950-60 when Taiwan's economy was undergoing a structural change with industry expanding rapidly from food processing to other manufacturing branches relating to chemical fertilizers, textile, machinery, etc. These new industries required the support from the agricultural sector in the form of increased demand for their products. By the end of these periods, farmers' income and agricultural productivity had been sufficiently raised to consume the increased output of industrial consumer goods and production goods. While agricultural development led to increased demand for industrial products, industrial growth, e. g., the fertilizer industry, also contributed to agricultural technological advancement. The rapid expansion of the fertilizer industry in the postwar period had gradually made the island self-sufficient in chemical fertilizers. Other industries which produced farm machinery, insecticides and other chemicals also promoted agricultural development. Moreover, the provision of communication facilities, roads, electricity,

[2] H. S. Tang and S. C. Hsieh, "Land Reform and Agricultural Development in Taiwan", published in "Land Tenure, Industrialization and Social Stability", The Marquette University Press, Milwaukee 3, Wis., USA, 1961.

etc. was particularly significant in the latter stage of technological maturity of agriculture.

With regard to capital accumulation by private enterprises and its contribution to the rapid rate of economic growth in Taiwan, it is necessary to examine how agricultural development had affected the economic structure. This question is related to the technology involving labor use adopted in both agriculture and industry. Taiwan is in need of a rapid rate of expansion in non-agricultural sectors of the economy to absorb the increment in labor force resulting from population growth. But no actual reduction in agricultural labor force has been realized up to the present, implying that there can not be any radical departure from the small-scale system of farming in Taiwan, and that efforts should be made to develop industries with labor-intensive techniques of production. The present pattern of economic development has a great deal to do with population growth, and the most important elements to support this pattern are low wage rate and cheap food prices.

The rate of population growth in Taiwan was 1.09% annually in the initial period of development. It reached the highest point of 4.61% in 1951-55, then declined to 3.82% in 1956-60, and remains at 3.2% at present. The average annual growth rate in the whole period was 2.38% which was higher than those in other developing and developed countries undergoing the process of economic transformation. The fact itself meant that a faster economic growth was needed in Taiwan to create more job opportunities for the increased labor force. The rate of increase in labor force was 1.52% in the whole period, which was below the average annual growth rate of population in the same period. On the other hand, agricultural labor force increased at the rate of 0.97% annually in the same period.

Table 33 Annual Growth Rates of Population and Employment

Period	Total Population		Total Employment		Agri. Employment	
	No. of persons	Growth Rate %	No. of persons	Growth Rate %	No. of persons	Growth Rate %
1911—1915	3,486,162	—	1,614,572	—	1,188,012	—
1916—1920	3,677,012	1.09	1,600,021	-0.18	1,155,313	-0.55
1921—1925	3,981,153	1.65	1,634,905	0.44	1,156,804	0.03
1926—1930	4,448,932	2.35	1,745,532	1.35	1,218,749	1.07
1931—1935	5,061,013	2.75	1,945,009	2.29	1,318,190	1.63
1936—1940	5,756,241	2.75	2,165,809	2.27	1,407,914	1.36
1946—1950	6,868,685	—	2,619,742	—	1,712,614	—
1951—1955	8,452,486	4.61	2,959,204	2.59	1,802,232	1.05
1956—1960	10,068,722	3.82	3,183,768	1.52	1,831,958	0.33
1911—1960 average	—	2.38	—	1.52	—	0.97

Source: computed by Rural Economics Division, JCRR

The majority of the population in Taiwan was agricultural in the early stage of economic development. With continued rapid growth of population in both rural and urban areas, it was difficult for the expansion of non-agricultural sectors to absorb the increment in the working population or to prevent the size of rural labor force from further growing. In many countries in Asia today, population is expanding at a rate comparable to that in Taiwan. They obviously need also a rapid expansion in non-agricultural sectors of their economies in order to overcome the problems of unemployment and underemployment. But if they should choose to establish in urban areas large-scale industries requiring heavy capital investment as a solution, there would happen the waste of scarce capital and worsen the employment problem. In this connection. Taiwan's experience in economic development may have its special significance.

The following table indicates that the industrial sector absorbed more labor than capital investment in terms of their growth rates:

Table 34. Capital Investment, Employment and Gross Output of Manufacturing Industries in Taiwan*

Period	Capital Investment (T$ 1,000)	No. of** Factories (Unit)	Total No. of Labor Workers Employed (person)	Gross Output (T$ 1,000)
1914	59,648(100.00)	1,309(100.00)	21,859(100.00)	45,723(100.00)
1919	128,885(216.08)	2,424(185.18)	40,727(186.31)	129,851(283.90)
1924	214,275(100.00)	3,462(100.00)	43,633(100.00)	191,783(100.00)
1929	202,083(94.31)	5,870(169.55)	62,877(144.10)	246,751(128.66)
1934	200,308(93.48)	6,776(195.72)	66,559(152.54)	215,639(112.43)
1936	268,040(125.09)	7,881(227.64)	81,589(186.98)	310,000(161.64)

* Source: "Statistics of Commerce and Industry in Taiwan", annual report published by the Taiwan Governor's Office

** Including only factories employing five or more labor workers.

Before 1919, both capital investment in manufacturing industries and the number of factories increased at a fast pace. The former increase was due largely to the construction of modern sugar manufacturing plants financed by Japanese capitalists through the encouragement of the colonial government. From 1919 until 1936, the structure of the industrial sector was characterized more or less by a dual system, under which small-scale factories thrived. The number of factories classified by the number of workers employed is shown in Table 35 below.

Table 35. Distribution of Factories by Number of Labor Employees, 1935

Total No. of Factories	Less than 5 persons	5-29 persons	30-99 persons	More than 100 persons
7,032	4,166	2,538	224	104
100%	59.2	36.1	3.2	1.5

Source: "The Statistical Report of Industry", Vol. 15, Taiwan Governor's Office, 1936

Low capital-labor ratio, low capital-output ratio and low labor productivity were the salient features of small factories. One of the main reasons that accounted for the increased investment in small factories was high capital return. The system of dual industrial structure was shaped in the pre-war period of 1930-40 and has been continued since then. Under it, large modern factories have also grown gradually. The following table shows the economic status of the dual structure of industry in Taiwan.

Table 36. Profit, Share of Labor Income and Capital-Output Ratio of Industries Classified by Size, 1960

Capital Scale	Profit Rate(%)	Labor's Share of Income(%)	Capital-Output Ratio
Less than NT $100,000	5.11	74.4	1.97
NT $100,000–1,000,000	5.61	72.5	2.52
NT $1,000,000–10,000,000	5.54	49.8	3.26
NT $10,000,000–100,000,000	3.04	38.6	3.66
More than NT $100,000,000	1.69	31.4	4.46

Source: "The Report on Industrial Survey, 1960", No. 2, Ministry of Economic Affairs, 1961

Another distinct feature of industrial development in Taiwan was that most of the important industries were located in rural areas. Some of them depended on local supply of materials for their operation, as in the case of food processing industries, but there were a variety of reasons for others. In 1943, more than 80% of all factories were in rural districts. By 1960 the percentage had dropped to 70%, but these factories doubtlessly had a great impact on the situation of rural employment. Some degree of wage differential was maintained between agricultural labor and industrial skilled labor during the process of economic development.

Table 37. Wage Differential between Agricultural Labor and Industrial Skilled Labor

Period	Daily Wage of Industrial Labor(T$) (A)	Daily Wage of Agri. Labor (T$) (B)	$1-\frac{B}{A}$(%)
1911—1915	0.70	0.40	43
1916—1920	1.32	0.67	49
1921—1925	1.45	0.60	58
1926—1930	1.55	0.75	52
1931—1935	1.30	0.60	54
1936—1940	1.50	0.70	53

Source: computed by Rural Economics Division JCRR

The wage differential between the two sectors enlarged from 43% in 1911-1915 to 54% in 1931-1935, but dropped to 53% in 1936-1940. In the post-war

period, the differential remained around 50%. The relatively high industrial labor productivity and elastic supply of labor in rural areas were the main reasons for the differential. However, the increase rate of industrial wage still lagged behind that of industrial net output. The share of labor income in industrial net output was about 47% in 1911-1915, 36% in 1931-1935 and 36% in 1956-1960. On the other hand, the rate of capital accumulation in industry was 18-35% during 1930-40. As a result of the development of labor-intensive technology in both agricultural and non-agricultural sectors, the capital-output ratio of the economy as a whole was low in 1916-35 and higher in 1936-40. The building of large, more capital-intensive industries and the heavy investments made in communications and transportation systems and in power generation in postwar period had caused capital-output ratio to grow further recently.

Table 38. Capital-Output Ratio

Period	Additional Net National Product($1,000)	Net Capital Formation ($1,000)	Marginal Capital-Output Ratio	Economic Growth Rate*
1916—20①	42,887	47,346	1.10	2.92
1921—25	62,596	65,612	1.04	3.72
1926—30	161,031	143,924	0.90	8.07
1931—35	146,043	170,433	1.17	5.21
1936—40	90,531	138,169	1.52	2.56
1953—56②	1,327,000	2,274,000	1.71	17.19**
1957—60	1,517,000	3,249,000	2.14	7.29

① 1935-37 value of T$ for the period from 1916-20 to 1936-40

② 1953 value of NT$ for 1953-56 and 1957-60

* Computation of economic growth rate is based on the average ratio of the average annual increase in net national product in one period to the average annual net national product in the preceding period. For example, the economic growth rate of the period 1916-20 was calculated by taking into account the average annual net national product in 1911-15.

** The economic growth rate of the period 1953-56 based on a comparison of the relevant data in the period with those in 1945-52. However, for lack of data on net capital formation in 1945-52, the additional net national product for 1953-56 was recalculated in order to coincide with the statistical series of net capital formation. As a result, the computed growth rates of 1953-56 and 1957-60 in this table are slightly different from those in Table 1 of the appendix.

From the relationship between capital-output ratio and economic growth rate, it can be seen that the high growth rate of Taiwan's economy in the past was due largely to the low capital-output ratio or, in other words, the use of capital-saving technology in the dual structure of the economy.

In short, the remarkable achievements in overall economic development on the island resulted partly from the raising of the productivity in the agricultural sector, which made possible: 1) fuller utilization of the under-employed agricultural labor to increase total output, and 2) creation of more agricultural surplus for industrial expansion through the systems of government purchase, price manipulation and taxation.

Chapter IX.

*The Unique Aspects of Taiwan's Agricultural Development**

After reviewing agricultural development and its contributions to economic growth in Taiwan in the preceding sections, it is obvious that though Taiwan has made important achievements in agricultural productivity and economic transformation, it is still in a transitional period from the stage of labor using techniques to the stage of capital intensive techniques. Of course, there are many problems confronting the future progress of Taiwan's agriculture. The record of agricultural development in Taiwan should prove to be valuable in many respects to developing countries in Asia.

Two concepts are useful in appraising the applicability of Taiwan's achievements to other Asian countries. First, the achievements add up to expanding the power of society to supply its members with increasing quantities of goods and services, a process commonly called economic development. Put in another way, such development is the growing capacity of a people to carry on an increasingly successful conquest of nature - - the transformation of physical materials and forces into an ever faster flow of goods and services per person. Second, this conquest centers in two fundamentally distinct components. One is technological - - the increasingly productive technologies, the hardware, knowledge and related skills that increase people's capacity for manipulating physical forces and materials - - transforming resources into outputs. The other component of economic development is organizational - - the regrouping of people under new rules (structures) of mutually helpful behaviors that enable them to generate and put to widespread use the increasingly productive technologies.

1. Improved soils, plant varieties, animal breeds, fertilizers, pesticides, irrigation facilities, tillage equipment - - all these are examples of the technological component of development.

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* Special thanks are due to Dr. John M. Brewster of Economic Research Service of USDA for his criticisms and suggestions which are included in the revision of this chapter.

2. Farmers' associations, credit systems, irrigation associations, public school systems, well staffed experiment stations and educational service systems, rules defining property rights, and above all a progress-oriented stable government - - all these and more are typical examples of the organizational (institutional) requirements of the increasingly effective technologies which have enabled the people of Taiwan over the past half century to turn their physical and biological world into steadily increasing quantities of needed goods and services per capita,

In keeping with both the technological and organizational components of development, three aspects of the Taiwan experience deserve special attention in assessing its usefulness to other countries seeking to accelerate their own growth activities.

1. First, Taiwan has met the requirements of both components within the context of rates of population growth which are approximately as rapid as those of other countries in Southeast Asia - - rates which are appreciably faster than those of the relatively more economically advanced western nations. This means that Taiwan's record disproves the commonly held generalization that decelerating currently rapid rates of population growth is a necessary pre-condition for accelerating economic development in the various countries of Southeast Asia. This does not mean that decelerating the rates of population growth would not facilitate achieving faster increases in output per capita. But it does have the encouraging meaning that this achievement is not doomed until the rate of population increase is first slowed down.

2. Second, Taiwan has also met the organization requirements of increasingly productive technologies within the framework of small farm sizes which approximately coincides with the framework of most of the other countries in Southeast Asia. This fact disproves the widespread generalization that wholesale reorganization of farms into substantially larger sizes is a pre-condition of very substantial increases in total farm output for years to come.

In the experience of Taiwan's agricultural development, land productivity was raised rapidly mainly through the application of more working capital inputs, such as fertilizers, insecticides, improved seeds and labor. Fixed capital investment, such as irrigation, farm machineries and farm build-

ings, also contributed to the improvement of land productivity by providing and facilitating a broader and better base in agriculture for the effective use of working capital inputs to raise land productivity. To pay off such investment, price supporting measures were not adopted as governmental policy. Low-interest and long-term loans together with subsidies were granted for irrigation development. Short-term working capital was supplied by well organized rural credit cooperatives or farmers' associations. This capital pay-off system should be carefully considered by most of the rice-producing countries of Asia which suffer from unfavorable terms of trade against the rice crop. In the case of Taiwan, the terms of trade against rice had been only 80% for fifty years. The capital pay-off system which has been changed as a result of the increase of agricultural productivity and the implementation of land reform may be of some help to increase the farmer's repayment ability in the developing countries.

3. A third feature of the Taiwan record bears upon its significance for other developing countries. This feature is the fact that economic development in Taiwan has maintained a close interrelationship between agricultural and non-agricultural sectors. In our analysis of agricultural development and economic growth, we found that the early stage of the economy was absolutely based on agriculture. Food processing and chemicals were the main industries in the initial stage. Most of the resources needed for these industries came from agriculture. Two advantages were derived from the close interrelationship between agriculture and non-agriculture. First, capital-saving techniques led to high efficiency of capital, or low capital-output ratio. Secondly, successful advance in agricultural exports was achieved by low production cost with cheap labor wage.

In addition, economic development in Taiwan was promoted by the increase of agricultural productivity. Consequently, as industry developed, it was able to provide first the fertilizers and, later, the pesticides, farm machinery and other necessities to agriculture. In the process of such well-balanced growth between agriculture and non-agriculture, capital flow and allocation between the two sectors were effective in Taiwan. Farmers' credit cooperative activity and public investment played a leading part in the financial arrangement. In the later period, the method of allocating the U.S. Aid funds between agriculture and non-agriculture is worthy of special study.

This fact brings to clear focus a further feature of the Taiwan record which bears on the nature and extent of its instructiveness to other countries. That feature is this: The most strategic component of the island's economic development has not been the capacity of its people to generate new farm and non-farm technologies, but their capacity to construct new organizational rules for linking together their economic behaviors so as to more effectively help each other create and put to widespread use the improved technologies which in turn increase their power to manipulate their physical and biological environment more in line with their needs and aspirations. Otherwise expressed, the main secret of Taiwan's development is not merely her ability to meet the technological requirements for increasingly productive gadgets, but her ability to meet the organizational requirements of new combinations and mechanization of mutually helpful human behavior necessary to achieve the gadgets of progress.

Consider a typical example. Today there are no flies in Taiwan. The new technological requirement for this achievement was very simple: A small spray gun and some DDT power,which most children can operate. But the organizational requirement for using this technology in conquering the flies of Taiwan was the ability to construct an island-wide health stations which, among other things, linked together the scientific behaviors of a few physicians with laymen behaviors of households of the whole island through the intermediate activities of a small number of specialized nurses working with thousands of village nurses at the country levels, who in turn worked with hundreds of thousands of individual families all over the island, pumping DDT onto flies with their spray guns.

The same principle applies at every step in the island's increasing agricultural productivity. As previously explained, Taiwan's steady increase in farm output is the direct outcome of increasingly effective high-labor, rather than high-capital using technologies. But the more strategic fact is that achieving even the simpliest of these technical improvements has been possible only through new organizational (institutional) rules which combined in mutually helpful ways the behaviors of far greater numbers of people than are contained in extended families and clans, which were the dominant units of collective actions on the island prior to the time (about 1895) any economic development got way on the island.

The really tough part of economic development is not fabricating improved technologies, but rather the organizational task of recombining human behaviors under new rules that enable more people to help each other in creating and putting to widespread use the more effective technologies. Here is why. Unlike physical materials and forces, the rules that combine behaviors into mutually helpful ways of living and making a living are not lifeless affairs. They are very much alive because, at least, the most important ones are interlocked with deep-seated convictions (beliefs) which people hold concerning the kind of rules which deserves their respect and allegiance, and the kind that merits their distrust and opposition.

For this reason it may be quite true such and such revisions in long established ways (rules) of life and work may enable people to help each other achieve improved technologies for increasing their physical ease and comfort. But such proposed revisions induce stubborn resistance if they run counter to people's long shared convictions concerning the kind of behaviors they owe each other. For example, as previously explained, even the simplest improved farm technologies on Taiwan would not have been possible except for the prior achievement of rules that combined into mutually helpful ways the behaviors for greater numbers of persons that are contained in any village or primary group such as the extended family, clan or tribe. This means that in some societies the relatively large scale organizational requirements of Taiwan farm technologies might well be blocked by the sense of mutual fear and distrust that is evoked by the equation of helping hands with one's kin, clan or tribe, and outsiders with exploiters. In similar fashion, people's long standing sense of fair and just uses of rule-making power may impel them to reject the organizational realignment of claims to property, incomes and status positions which are often required for recombining behaviors into ways that enable people to achieve the continually improved technologies which in turn enable them to make steady increases in their output per capita.

Economic development is thus far more than a mere technological or physical transformation of inputs into increasing outputs; it is more fundamentally an organizational transformation of old ways of life and work into new rules of interpersonal behaviors. And this in turn is possible only to the extent that people are able to make revisions in their

heritage of basic convictions concerning the kinds of interpersonal rules which do and do not deserve their respect and support.

In reference to this distinctly humanistic (cultural) requirement of economic development, two observations bear on the transferability of the Taiwan record. First, for centuries Chinese traditions have inculcated the strong feeling that household heads owe it to their ancestors to work as diligently as they can so as to achieve the means necessary for rearing their children well, and in this way pass on the family line from generation to generation. Second, there is in Taiwan a progress-oriented stable government. By this we mean a government with the technical capacity and resolution to use its power and leadership capabilities in continually transforming old rules of interpersonal behaviors into new ones that enable Taiwan people to be more effective in assisting one another in creating and putting to widespread use increasingly productive technologies, and in this way more fully meet their age-old sense of obligations to improve without limit the economic and status positions of their individual families.

Three final conclusions emerge from the foregoing observations. First, as previously explained, Taiwan's distinctive record in increasing agricultural productivity has been accomplished within a framework of small farms and rapid rates of population growth, both of which are similar to those of other countries in Southeast Asia. Second, when viewed solely from the standpoint of the technological requirement of economic development, these facts suggest a ready easy transfer of the Taiwan experience to many other countries. Third, this suggestion, however, is subject to severe qualifications when the Taiwan record is viewed from the standpoint of the organizational requirement of the technological component of progress. For when viewed from this standpoint, the Taiwan record clearly would have been impossible except for a stable government guided by a strong commitment to use its power in meeting the organizational requirements of technological advance, and also an island of people guided by a long heritage of felt obligations to be as productive as they can for the sake of improving the income and status positions of their families from generation to generation.

Thus while the technologies of the Taiwan achievement may be physically transferred elsewhere, their actual transfer may be severely limited. For

th eheritage of basic convictions in other countries might be quite incompatible with the organizational rules of interpersonal behaviors required by the widespread use of Taiwan technologies. This does not mean that the Taiwan record is not of immense instructional value to other developing societies. But it does mean that the utility of the Taiwan record must be closely scrutinized by people of other cultures with a sharp eye to which particular Taiwan practices, if any, can be fitted into their own heritage of belief systems concerning the kinds of interpersonal claims most deserve allegiance and support.

Appendix Table 1. Real Net National Output, by Industrial Origin
(1935-37 value of T$1,000)

Period	Total		Primary industry		Secondary industry		Tertiary industry	
	Amount	Growth rate	Amount	Growth rate	Amount	Growth rate	Amount	Growth rate
	T$	%	T$	%	T$	%	T$	%
1911—1915	293,660	—	140,599	—	78,220	—	74,841	—
1916—1920	336,547	2.92	123,086	—2.49	126,953	12.46	86,508	3.12
1921—1925	399,143	3.72	159,353	5.89	109,524	—2.76	130,266	10.12
1926—1930	560,175	8.07	218,002	7.36	149,258	7.26	192,915	9.62
1931—1935	706,218	5.21	248,623	2.81	209,302	8.05	248,293	5.74
1936—1940	796,749	2.56	280,371	2.55	269,784	5.78	246,594	—0.14
1946—1950	402,859	—	162,118	—	77,617	—	163,124	—
1951—1955	728,797	16.18	255,606	11.53	170,156	23.85	303,035	17.15
1956—1960	1,010,076	7.72	325,984	5.51	264,945	11.14	419,147	7.66
1961	1,251,830	8.15	396,828	0.43	331,908	11.53	523,094	12.56
1962	1,325,545	5.89	391,211	—1.42	363,472	9.51	570,862	9.13
1963	1,420,923	7.20	384,805	—1.64	424,934	16.91	611,184	7.06

Source: Figures, 1911 to 1950, estimated by Rural Economics Division, JCRR. 1951 to 1963, Computed by Directorate-General of Budgets, Accounts and Statistics, Executive Yuan, "National Income of The Republic of China"

Table 2. Population and Employment

(Unit: 1,000 persons)

Period	Population [1]		Employment [2]							
			Total		Primary industry		Secondary industry		Tertiary industry	
	No.	Growth rate	No.	Growth rate	No.	Growth rate	No.	Growth rate	No.	Growth rate
		%		%		%		%		%
1911—1915	3,486	—	1,615	—	1,188	—	138	—	289	—
1916—1920	3,677	1.09	1,600	—0.18	1,155	—0.55	153	2.30	291	0.16
1921—1925	3,981	1.65	1,635	0.44	1,156	0.03	162	1.11	316	1.71
1926—1930	4,449	2.35	1,746	1.35	1,219	1.07	172	1.26	355	2.44
1931—1935	5,061	2.75	1,945	2.29	1,318	1.63	203	3.59	424	3.90
1936—1940	5,756	2.75	2,166	2.27	1,408	1.36	247	4.36	511	4.10
1946—1950	6,879	—	2,620	—	1,713	—	189	—	718	—
1951—1955	8,452	4.61	2,959	2.59	1,802	1.05	274	8.98	883	4.59
1956—1960	10,069	3.82	3,184	1.52	1,832	0.33	341	4.91	1,011	2.89
1961	11,149	3.31	3,429	2.54	1,912	1.86	387	2.65	1,130	3.67
1962	11,512	3.26	3,504	2.19	1,936	1.26	404	4.39	1,164	3.01
1963	11,884	3.23	3,616	3.20	1,972	1.86	424	4.95	1,220	4.81

[1] Provincial Department of Accounting and Statistics, "The Fifty Years' Statistics of Taiwan" 1946.
1946 to 1963, from Provincial Department of Civil Affairs "Annual Population Statistics of Taiwan"

[2] Figures 1911-1946, estimated by Rural Economics Division, JCRR.
1946 to 1963, from Provincial Department of Civil Affairs "Annual Population Statistics of Taiwan"

Table 3. Per Capita Real Product of Labor, by Industrial Origin
(1935-37 Constant value)

Period	Total		Primary industry		Secondary industry		Tertiary industry	
	Amount	Growth rate	Amount	Growth rate	Amount	Growth rate	Amount	Growth rate
	T$	%	T$	%	T$	%	T$	%
1911—1915	182	—	118	—	569	—	259	—
1916—1920	210	3.08	107	—1.87	828	9.10	297	2.93
1921—1925	244	3.24	138	5.79	676	—3.67	412	7.74
1926—1930	321	6.31	179	5.94	867	5.65	544	6.41
1931—1935	363	2.62	189	1.12	1,031	3.78	586	1.54
1936—1940	368	0.28	199	1.06	1,091	1.16	483	—3.52
1946—1950	154	—	95	—	390	—	230	—
1951—1955	246	11.95	142	9.89	621	10.22	343	10.22
1956—1960	317	5.77	178	5.07	777	5.02	415	4.20
1961	365	5.49	208	—1.42	858	8.75	463	8.69
1962	378	3.56	202	—2.89	900	4.90	490	5.83
1963	393	3.97	195	—3.47	1,002	11.33	501	2.24

Table 4. Agricultural Production Index

1935-37=100

Period	Crops	Livestock	Forestry	Fishery
1911—1915	43.63	48.78	—	21.45
1916—1920	50.20	56.62	—	31.21
1921—1925	59.03	61.54	73.34	43.87
1926—1930	73.15	74.28	71.21	67.15
1931—1935	89.94	87.30	82.67	86.88
1936—1940	102.11	96.72	109.92	105.59
1941—1945	83.50	60.80	190.12	54.65
1946—1950	82.36	54.56	70.21	88.10
1951—1955	118.97	122.61	133.30	164.70
1956—1960	144.70	181.97	201.62	268.57
1961	159.89	207.42	262.57	366.23
1962	160.90	216.83	264.55	379.34
1963	157.55	215.03	257.77	406.29

Source: Computed by Rural Economics Division, JCRR.
Original figures based on "Agricultural Year Book"
Department of Agriculture and Forestry.

Table 5. Indices of Agricultural Output and Input, 1911-1963

(Five years average)
Base year: 1935-37

Period	Agricultural gross output (A)	Agricultural input	Output per unit of input
1911—1915	44.24	66.84	66.19
1916—1920	50.96	73.16	69.66
1921—1925	59.33	78.70	75.39
1926—1930	73.28	88.42	82.88
1931—1935	89.63	94.32	95.03
1936—1940	101.47	100.57	100.89
1941—1945	80.80	90.12	89.66
1946—1950	79.06	89.93	87.91
1951—1955	119.40	111.04	107.53
1956—1960	149.13	123.11	121.14
1961	165.54	127.67	129.66
1962	167.55	129.51	129.37
1963	164.38	132.57	123.99

Source: Computed by Rural Economics Division, JCRR

Table 6. Increase in Land and Labor Productivity

(1935-37 constant price)

Period	Land Productivity (Gross output/arable land)1/		Labor Productivity (Gross output/labor force)	
	Amount	Index	Amount	Index
1911—1915	244	100	146	100
1916—1920	267	109	174	119
1921—1925	300	123	202	138
1926—1930	336	138	227	155
1931—1935	419	172	267	183
1936—1940	454	186	283	194
1941—1945	371	152	—	—
1946—1950	355	145	183	125
1951—1955	523	214	263	180
1956—1960	652	267	331	227
1961	727	298	356	244
1962	736	302	356	244
1963	722	296	343	235

Source: Computed by Rural Economics Division

1/ Gross output including crops and livestock production.

Table 7. Indices of Crop Yield and Multiple-Cropping

Period	Crop yield	Multiple-Cropping
1911—1915	100	100
1916—1920	110	102
1921—1925	122	104
1926—1930	140	105
1931—1935	157	114
1936—1940	165	115
1941—1945	136	113
1946—1950	125	130
1951—1955	156	148
1956—1960	184	155
1961	200	160
1962	199	159
1963	200	159

Source: Computed by Rural Economics Division, JCRR. Original figures based on "Agricultural Year Book" Provincial Department of Agriculture and Forestry.

Table 8. National Income and Food Consumption

Period	National Income (A)	Food Expenditure (B)	B/A
1911—1915	281,287	141,865	50.40
1916—1920	324,956	158,839	48.88
1921—1925	360,282	186,080	51.65
1926—1930	491,635	221,898	45.13
1931—1935	634,499	240,778	37.95
1936—1940	734,519	257,883	35.11
1941—1945	724,298	270,886	37.40
1951—1955	836,301	455,318	54.44
1956—1960	1,139,868	573,222	50.29
1961	1,250,079	665,510	53.24
1962	1,322,780	662,776	50.10
1963	1,417,815	711,937	50.21

Source: Computed by Rural Economics Division, JCRR

Table 9. Change of per Capita Consumption Pattern

Period	Rice and wheat	Beans	Miscel-laneous	Vege-table oil	Fruits	Vege-tables	Meat	Milk
1911—1915	100	100	100	100	100	100	100	100
1916—1920	99	81	131	87	149	351	115	107
1921—1925	100	93	158	92	255	802	119	133
1926—1930	101	96	206	102	291	1,068	130	207
1931—1935	86	91	207	90	334	1,222	134	267
1936—1940	77	82	205	58	368	1,141	131	293
1941—1945	86	47	197	37	360	854	63	167
1946—1950	99	34	219	96	312	1,159	44	160
1951—1955	117	108	224	156	240	1,222	112	473
1956—1960	121	96	234	188	262	1,159	142	440
1961	127	112	233	265	258	1,115	147	760
1962	121	78	218	258	295	971	154	813
1963	129	101	226	221	295	1,132	148	867

Source: Computed by Rural Economics Division, JCRR

Table 10. Cultivated Land Area and Labor Input

Period	No. of farm households	Agricultural population	Farm[2]/ workers	Cultivated land area	Crop area	Cultivated land area per agr. labor	Crop area per agr. labor	Working days per cultivated area	Working days per labor
		person	person	ha.	ha.	ha.	ha.	day/ha.	day
1911—1915	338,000[1]/	2,199,468	1,154,602	692,272	806,282	0.60	0.70	195	117
1916—1920	363,000[1]/	2,288,288	1,123,734	731,288	865,561	0.65	0.77	206	134
1921—1925	388,354	2,270,968	1,126,158	758,538	920,177	0.67	0.82	210	141
1926—1930	403,865	2,452,155	1,187,719	802,222	982,261	0.68	0.83	211	143
1931—1935	411,384	2,657,765	1,286,033	820,304	1,079,004	0 64	0.84	220	140
1936—1940	427,697	2,908,116	1,374,130	856,108	1,138,520	0.62	0.83	228	142
1941—1945	469,250	3,242,383	—	837,015	1,098,007	—	—	223	—
1946—1950	587,319	3,751,752	1,658,152	852,911	1,288,308	0.51	0.78	223	115
1951—1955	698,467	4,378,293	1,741,569	873,962	1,501,891	0.50	0.86	276	138
1956—1960	768,294	4,943,625	1,725,285	875,897	1,575,849	0.51	0.91	305	155
1961	800,835	5,467,445	1,780,910	871,759	1,620,604	0.49	0.91	313	153
1962	809,917	5,530,832	1,800,379	871,858	1,612,458	0.48	0.90	316	153
1963	824,560	5,611,356	1,833,463	872,208	1,612,099	0.48	0.88	322	153

[1]/ Figure estimated, 1921 to 1963 quoted from "Agricultural Year Book" Provincial Department of Agriculture and Forestry.

[2]/ Including only farm workers.

Table 11. Changes of Prices of Agricultural Production Goods and Service

(1935—37 constant price)

Period	Fertilizer T$/M.T.	Soybean cake T$/M.T.	Wage rate T$ per day	Interest rate % monthly rate
1911—1915	86.92	79.79	0.62	0.738
1916—1920	92.16	71.69	0.56	0.687
1921—1925	82.35	71.01	0.52	0.816
1926—1930	89.68	70.55	0.71	0.693
1931—1935	77.38	61.97	0.69	0.630
1936—1940	81.71	74.03	0.91	0.477
1941—1945	51.19	51.16	0.76	0.409
1946—1950	130.22	133.28	0.51	4.944
1951—1955	65.43	117.83	0.62	2.901
1956—1960	66.93	126.79	0.69	1.590
1961	69.56	127.99	0.86	1.425
1962	65.50	133.90	0.88	1.338
1963	62.54	126.86	0.83	1.245

Source: Computed by Rural Economics Division, JCRR

Table 12. Farm Household Numbers by Farm Size

	1929	1939	1949	1955	1960
Less than 0.5 ha.	93,423	108,754	163,521	224,277	274,314
0.5—1.0 ha.	77,477	88,976	158,518	198,671	218,215
1.0—2.0 ha.	99,129	112,555	157,446	198,245	195,183
2.0—3.0 ha.	51,710	57,404	54,197	86,053	65,916
3.0—5.0 ha.	40,007	41,711	25,641	21,078	36,695
5.0—10.0 ha.	18,763	19,057	6,293	13,060	14,123
10.0—20 ha.	3,190	2,796	561	2,544	3,154
more than 20 ha.	453	531	93		
Total	384,152	431,784	566,270	743,928	807,600

Source: Figure of 1929 quoted from "The Basic Agricultural Survey" 1929 Provincial Government. 1939, 1949 quoted from "Agricultural Year Book" 1952 edition Provincial Department of Agriculture and Forestry. 1955, 1960 quoted from "Agricultural Censuses" made in 1955, 1960.

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