Volume Title: The Role of Agriculture in Economic Development

Volume Author/Editor: Erik Thorbecke, ed.

Volume Publisher: UMI

Volume ISBN: 0-87014-203-8

Volume URL: http://www.nber.org/books/thor70-1

Publication Date: 1970

Chapter Title: The Transferability of the Japanese Pattern of Modernizing Traditional Agriculture

Chapter Author: Kazushi Ohkawa, Bruce F. Johnston

Chapter URL: http://www.nber.org/chapters/c3368

Chapter pages in book: (p. 277 - 310)

The Transferability of the Japanese Pattern of Modernizing Traditional Agriculture

KAZUSHI OHKAWA

HITOTSUBASHI UNIVERSITY

AND

BRUCE F. JOHNSTON

STANFORD UNIVERSITY

INTRODUCTION

To what extent can the factors and conditions that made the transformation of Japanese agriculture possible be reproduced elsewhere? The attempt to identify unique as well as transferable factors, particularly in terms of development strategies, has been made on several occasions by the present writers as well as other authors.

A consensus seems to have emerged concerning the characteristics of the "Japanese model." Of these characteristics we will emphasize three. First, agricultural output has been increased within the unchanged organizational framework of the existing small-scale farming system. This was possible because of increases in the productivity of the existing on-farm resources of land and labor, and was associated with remarkably small demands on the critically scarce resources of capital and foreign exchange, at least during the long prewar period. Second, the

bulk of the nation's farmers have been involved in increases in agricultural productivity associated with the use of improved varieties, fertilizers, and other current inputs; and technological progress of this type has continuously been the driving force in increasing agricultural productivity. This is still true for the postwar agriculture in which small-scale mechanization has developed throughout the country. Third, agricultural and industrial development went forward together in a process of "concurrent" growth. Expansion in the nonagricultural sectors has, of course, proceeded a good deal more rapidly than in agriculture, so that the overwhelmingly agrarian character of the economy has gradually been transformed. But throughout the process of modern economic growth, the interactions between agriculture and the rest of the economy that have been associated with this structural transformation, have had profound implications for growth in both sectors. In particular, the raising of factor productivity in agriculture was a necessary condition for the important net contribution that the rural sector made to financing the expansion of the nonfarm sectors of the economy.

These are mutually interrelated phenomena, and only a comprehensive framework can clarify the mechanisms that produced this pattern of growth. The attempt to formulate such a framework is beyond the scope of this short paper. The present treatment is intended to focus attention on problems relating to the type and speed of technical progress, questions that we believe are of crucial importance in determining the efficient strategy for agricultural development. In pursuing this partial approach we are mainly concerned with the first and second characteristics mentioned above, leaving the third almost untouched.

A comprehensive framework of analysis would provide a basis for identifying the variables and parameters that are most important in assessing the relevance of the Japanese experience to contemporary developing countries. In our partial analysis, which considers this question primarily in relation to other Asian countries, we postulate that the Japanese pattern of development was conditioned by three initial factors that have parallels in Asian countries today, and a fourth factor that points up an important difference. The factors that are similar are: first, an economic structure characterized by the dominant position of agriculture (representing some 75 per cent of the total labor force in the early Meiji period and similar fractions in most of the Asian countries today); second, the dwindling of uncultivated arable land, with the consequent growth of dependence on increase in output per unit area; and third, an organizational framework characterized by small-scale farming systems.

The fourth factor relates to the wide disparity between the growth rates of population and total labor force in contemporary less developed countries and in Japan. The fact that these are much higher in the former countries is very significant. But the impact of these high rates of growth of population and labor force on the development problems and prospects of the Asian nations today accentuates the importance of the three similarities with the Japanese experience. Given the initial conditions—the fact that agriculture weighs so heavily in the total labor force—and given the rapid growth of total population and labor force, the "arithmetic of structural transformation" is such that the absolute size of the farm population will continue to increase for some decades.[1] Hence, even in those countries where the arable frontier is still of considerable importance, the availability of unused land of satisfactory quality is being reduced quite rapidly. And the average farm size, already small (though not as small as in Japan), can be expected to undergo considerable further decrease before the trend is ultimately reversed by a reduction in the absolute size of the farm labor force.

The unchanged organizational framework of the small-scale farming system in Japan and the participation of the bulk of the nation's farmers in the increase of agricultural productivity—these two facts would require explanations in some detail from both an historical and an institutional point of view. The evolution of the initial conditions from which the transformation of agriculture started; the early changes in the land tenure system, among others—these are particularly relevant to the discussions that follow. Again, these matters would deserve separate treatment rather than a hasty, superficial description. We believe, however, that a partial treatment along the lines defined above can be carried out effectively enough. In this paper the conventional input-output approach is applied on a more comprehensive scale than before to the analysis of Japanese agricultural development. The aim is to link the results with the strategy of technological development in agriculture. Regarding the approach, two points seem particularly to deserve mention.

First, much more consistent quantitative data than were previously available are used to test our hypothesis. To investigate the problem stated at the outset of this paper, we believe that a consistent interpretation of the historical experience, though not easily achieved, is an essential requirement. This interpretation in turn depends upon long-term

[1] See the Appendix Note to this paper by John Cownie, and also B. F. Johnston, "Agriculture and Economic Development: The Relevance of the Japanese Experience," *Food Research Institute Studies*, Vol. VI, No. 3, 1966, pp. 267–73.

economic statistics of agriculture estimated within a systematic framework consistent with those of the rest of the economy. The new volume by M. Umemura and others meets this requirement although there are still some important areas of uncertainty and ignorance. (See Table 1 below for the citation.) We will begin by presenting a very compact summary of these data in terms of our phase hypothesis.[2]

Second, in approaching the problem of identification of transferable factors or patterns (i.e., certain combinations of factors), an attempt is made to present them in concrete terms, not only as derived from the experience of advanced economies (Japan in this case), but also with due consideration to the the situation of the presently developing countries. Regarding the latter, the specific focus is East Asia. Owing to the paucity of available data, we resort to a certain amount of speculation in order to identify the factors and patterns required for efficient development of agriculture. This will be described after presenting an interpretation of Japan's experience.

Our conceptual framework is built on two basic ideas: one relates to the historical phases that condition the process of agricultural development, and the other concerns the characteristics of technology in agriculture, particularly Asian agriculture. The former is formulated in terms of the historical pattern of labor force distribution between the agricultural and nonagricultural sectors and is closely related to the thesis of a "turning point." [3] The latter stresses the significance of an agricultural technology in which new inputs of a biological and chemical nature are crucial, and its economic interpretation will be developed so as to be linked with the general thesis of "borrowed technology."

LONG-RANGE GROWTH PATTERN OF JAPANESE AGRICULTURE: STATISTICAL FINDINGS AND INTERPRETATION

To what extent can the experts agree in recognizing and appraising the growth pattern of Japan's agriculture in the hundred years since

[2] The phase hypothesis and supporting data are examined in greater detail in Kazushi Ohkawa, "Phases of Agricultural Development and Economic Growth," in Kazushi Ohkawa, B. F. Johnston, and Hiromitsu Kaneda (ed.), *Agriculture and Economic Development: A Symposium on Japan's Experience* (forthcoming).

[3] See Kazushi Ohkawa, "Agriculture and Turning-Points in Economic Growth," *The Developing Economies*, December 1965.

the Meiji Restoration? With some exceptions, especially in regard to the early period, we have the impression that the data presented in Table 1 command a large measure of agreement among students of Japan's economic history.

The table is prepared to show in a concise way the long-range growth pattern of Japanese agriculture since 1885; for the earlier years available data seem to be rather dubious. Estimates of the average annual compound rates of change in output, inputs, and various input-output relationships and ratios are shown. The estimates are explained in the notes to the table, but the conceptual frame underlying Table 1 needs a brief explanation. It is composed of two dimensions: first, a time dimension that is examined in terms of three periods and second, an input dimension based on a two-way classification of inputs. The time periods—1885–1919, 1919–54, and 1954–61 are based on our observations concerning the pattern of major swings in inputs and output which will not be discussed here. The initial discussion is in terms of those three periods, but later a distinction is made between Phase I, which comprises Periods 1 and 2, and Phase II which refers to the period since 1954. For the most part the estimates for Period 3 (1954–61) are used to characterize Phase II, but in some instances reference is also made to data for more recent years. The average rates in the table do not necessarily reveal their acceleration or deceleration during the demarcated periods. When necessary, timing of acceleration or deceleration will be made the subjects of supplementary comments. For the input dimension a dichotomy is made between inputs of nonagricultural or external origin and those of agricultural or internal origin. Because of data limitations, land and labor are shown in terms of a stock rather than a flow concept.

Let us start with the output performance. Its rate of increase shows sizable differences among the three periods: biggest in 1954–61(Period 3), smallest in 1919–54 (Period 2), and intermediate for 1885–1919 (Period 1). This is true irrespective of whether we choose an output index or a value-added series. One might wonder whether such a big variation is a statistical illusion, perhaps a result of the method of artificially demarcating the periods. The answer is no. The following trend measures, including the earlier years before 1885, and based on the value added estimates, give the following rates (percentage):

1877–1919:1.80	1919–38:0.46	1877–1938:1.39
1919–60:0.51	1877–1960:1.17	

TABLE 1

Average Annual Percentage Changes In Output, Input, and Productivity of Japanese Agriculture, 1885-1961
(except where specified, seven year moving averages centered on years indicated)

	Item	Phase I Period 1 1885–1919	Phase I Period 2 1919–54	Phase II Period 3 1954–61
	A. Total			
A1	Total output index[a]	1.96	0.70	4.26
A2	Total input index[a]	0.49	0.56	2.13
A3	Total productivity index (A1 ÷ A2)[b]	1.47	0.14	2.51
	Gross added value			
A4(1)	Using linked deflators	1.60	0.31	2.13
A4(2)	Valued at 1934–36 prices	1.69	0.17	2.46
	Current input			
A5	Total	1.76	3.47	8.16
A6	External	3.47	3.22	9.55
A7	Internal	0.29	0.68	1.90
	B. Land and Labor			
B1	Arable land area	0.62	0	0.30[c]
B2	Labor force (number)	-0.03	0.25	-2.74[c]
B3	Land-labor ratio	0.65	-0.25	2.44[c]
	Partial productivity of land			
B4(1)	A4(1) ÷ B1[b]	1.34	0.70	3.96[c]
B4(2)	A4(2) ÷ B1[b]	1.07	0.17	2.16[c]
	Partial productivity of labor			
B5(1)	A4(1) ÷ B2[b]	1.99	0.45	7.00[c]
B5(2)	A4(2) ÷ B2[b]	1.72	-0.08	5.20[c]

(continued)

TABLE 1 (continued)

	Item	Phase I Period 1 1885–1919	Phase I Period 2 1919–54	Phase II Period 3 1954–61
	C. Capital[d]			
C1	Total gross capital stock[e]	0.54	0.54	3.18
C2	Livestock[e]	0.52	1.38	3.52
C3	Trees and shrubs	2.17	0.83	5.25
C4	Equipment	1.45	1.48	8.63
C5	Capital-labor ratio (C1 ÷ B2)[b]	0.57	0.29	5.92
C6	Capital-land ratio (C1 ÷ B1)[b]	-0.08	0.54	2.88
	D. Other Ratios and Indexes			
	Capital-output ratio[e]			
D1	Total	3.40–2.30[f]	2.30–2.63[f]	2.63–2.91[f]
D2	Excluding buildings	1.05–1.00[f]	1.00–1.19[f]	1.19–1.60[f]
	Relative price index of output			
D3	to current input[g]	2.06	1.01	4.08
	Ratios[h]: agricultural to manufacturing			
D4	Wages[i]	69.9–73.7[f]	73.7–37.3[f]	37.3–42.0[f]
D5	Partial labor productivity	50.0–44.8[f]	44.8–28.1[f]	28.1–19.9[f]

Sources: Except as specified hereafter all the original data are from Part 3 of Mataji Umemura and others, *Noringyo* [*Agriculture and Forestry*] (Vol. 9 of Kazushi Ohkawa, Miyohei Shinohara, and Mataji Umemura, eds., *Estimates of Long-Term Economic Statistics of Japan Since 1868*, Toyo Keizai Shinposha, Tokyo, 1966). This thirteen-volume series is a revised and enlarged version of Kazushi Ohkawa et al, (eds.), *The Growth Rate of the Japanese Economy Since 1878*, Toyko, 1958.

The original data for total gross capital stock in C are from Kazushi Ohkawa and others, *Shihon Sutokku* [*Capital Stock*] (Vol. 3 of the above series) Tokyo, 1966. The ratios of wages and productivities in D are reproduced from Tables 4 and 5 in Kazushi Ohkawa and Henry Rosovsky, "Postwar Japanese Growth in Historical Perspective," in *Proceedings of the Tokyo Conference on Economic Growth, September, 1966* (Forthcoming).

(continued)

TABLE 1 (concluded)

[a]Indexes with different weights have been linked; valued at constant 1934–36 prices.

[b]Indicated computation refers to the original data, not to the percentage increases shown.

[c]A five-year average centered on 1961.

[d]Five-year moving averages are used for all series in all years. Residential buildings are excluded.

[e]In terms of 1934–36 prices.

[f]Initial and final ratios based on five-year average centered on years shown.

[g]The relative price index is obtained by dividing the index of prices received by farmers by the index of prices of inputs of nonagricultural origin. Both are linked indexes with 1934–36 = 100.

[h]Agriculture, in the computation of these ratios, includes forestry and fisheries.

[i]For agriculture, average daily wage rates; estimated values of payments in kind are not included.

It is clear that the Japanese experience over almost a century presents not only a period of a high rate of growth (an accelerated process), but also a period of a low rate of growth (or a decelerated process). This suggests that considerable changes must have taken place in the operation of the factors and conditions that determined the growth of output.

Of the complex and interrelated factors and conditions that were operative, only the performance of conventional inputs is shown in the table. And yet these can, we believe, provide a broad indication of the causes of the above-mentioned differences.

As noted in the Introduction, we periodize agricultural development in terms of historical and analytical phases based on the distribution of the labor force between agriculture and nonagriculture. To be more concrete, the turning point of agriculture is placed at the period at which the absolute size of the labor force engaged in agriculture begins to decrease as a trend. The basic reason for this demarcation is that the nature and structure of agricultural production and the character of its changes should differ basically between the period before that point and the period after that point. The former period is called Earlyphasia or Phase I and the latter Middlephasia or Phase II.[4] With this demarcation

[4] In introducing these terms, Johnston used the terms Earlyphasia and Middlephasia to describe two hypothetical countries for which fifty-year projections of the growth path of total, agricultural, and nonagricultural labor force were presented based on alternative assumptions with respect to the rates of growth of the total labor force and nonfarm employment. See Johnston, *op. cit.*, pp. 267–70. The Earlyphasia situation assumed that initially 80 per cent of the total labor

in mind we would like first to examine the differences between Period 3 on one hand and Periods 1 and 2 combined on the other, ignoring the differences between the latter two for the time being.

The labor force in agriculture tended to decrease appreciably during Period 3 for the first time in Japan's economic history. A number of repatriated people from the overseas territories contributed to an abnormal increase in the agricultural labor force after the war, so that the real turning point may be found a bit later than 1954. Until this time, even with its high rate of industrialization (top level by international comparison), and with its moderate rate of population increase (some 1.0 to 1.5 per cent), Japan could not decrease its farm population (see B-2 in Table 1). A theoretical definition of turning point along the lines of the Lewis two-sector model would require a test of the equality of labor's marginal productivity as between the self-employed sector, essentially agricultural, and the enterprise sector, of which manufacturing is representative. Here we do not claim identity of the turning point historically identified with regard to agriculture and the theoretical turning point. However, the performance of the wage ratio shown in D-4 can be construed as giving some support to such an interpretation. The ratio of the agricultural to manufacturing wage rate has continued to increase since 1961, reaching 48.6 per cent in 1964. This indicates that agricultural wages are catching up fast. (We are not concerned with the level difference itself.)

Phase II has not run for long enough to make a full comparison of its characteristics with those of Phase I. Furthermore, the period 1954–61 marks the postwar investment spurt in Japan, with its unprecedentedly high rate of output growth of the nonagricultural sector, a growth from whose "induced effects," agriculture must have grown rapidly. With these qualifications, it seems legitimate to call attention to the following characteristics. The much higher rate of output growth in Phase II was to a great extent a reflection of the much higher rate of increase in total inputs (see A-2). This is true with respect to both current and capital inputs (see A-5 and C-1). It is particularly notable in

force was in agriculture whereas in Middlephasia only 50 per cent of the total labor force was in agriculture at the beginning of the fifty-year period. The turning point, as defined in the text in terms of the onset of a decline in the absolute size of the farm labor force, may occur either before or after its percentage share has declined to fifty. For the special case in which the nonagricultural and total labor forces grow at constant rates, with the rate of growth in the former twice that in the latter, the turning point thus defined is reached when the farm labor force has declined to fifty per cent of the total. The appendix note prepared by Cownie clarifies the influence of various factors on the time required to reach the turning point.

the case of current inputs of nonagricultural origin (A-6) and of the equipment category of capital (C-4). The output effects of these enormously rapid increases should be clarified by detailed analysis, but here it is sufficient to note the following points. In Phase II, there are two conditions not present in Phase I beginning to manifest themselves: one is the substitution of material inputs for labor, and the other a renewal in the process of extending the availability of agricultural technology.

The increase in current inputs of external origin was promoted by the introduction of chemicals of new types (e.g., insecticides and herbicides) as well as by the increased use of conventional fertilizers and imported feed. These inputs, which were complementary to a renewed progress in cultivating technology and diffusion of improved seed varieties, undoubtedly contributed to raising output. Some of the inputs, for example chemicals for weed control, had the effect of substituting for labor. However, most of the substitution effects were introduced by means of capital investment, particularly in small-scale mechanization. The unprecedentedly high rate of expansion of capital equipment (C-4) has already been noted and also the rapid increase of agricultural wages (D-4). An econometric analysis by Tsuchiya has clarified the substitution effect of power tillers in rice cultivation, but the output effects have not yet been adequately studied.[5]

Although the capital-output ratio is a simplified and partial measure, it provides a convenient basis for examining the relation between capital increase and output growth by industrial sector. During Phase II, even with its very high rate of output growth, the capital-output ratio tended to increase (D-2). Excluding farm buildings, thereby obtaining a better measure for our present purpose, the rate of increase in the capital-output ratio was substantial and it reached a level much higher than in Phase I.

The last point is, we believe, very important in characterizing the pattern of agricultural development in Phase II. The measurement of agricultural capital is confined to private farms, excluding public investment. We know that the postwar government investment in land improvement and the like was extremely high as compared to prewar outlays. Therefore, the above findings do not mean a substitution of private for public capital formation. We do not mean to suggest that the trend of an increasing capital-output ratio will continue unchanged in the future. We do wish to emphasize, however, that a considerable increase

[5] See, for example, Keizo Tsuchiya, "Economics of Mechanization in Small Scale Agriculture," in Ohkawa, Johnston, and Kaneda, *op. cit.*

of capital use per unit of output is inevitable in Phase II, whereas during Phase I the per unit capital requirement was kept almost unchanged; the relatively high ratio in 1885 shown in D-1 seems to be somewhat exaggerated.

Thus it is our view that the leading role in increasing the postwar rate of output growth has been played by technology, embodying advanced knowledge of a biological and chemical nature. The significance of the enormous increase in fixed capital appears to lie in its substitution for labor, which has come to be in increasingly short supply in rural districts.

Now we turn to Phase I. The year 1919 is taken to demarcate two distinct time segments in terms of output-input relations: Period 1 (1885–1919) and Period 2 (1919–54). This demarcation was prompted by two considerations: first, the factors and conditions that determined the agricultural growth pattern are different enough to be distinguished; and second, throughout each interval they seem to work continuously and distinctively. Period 2 covers the war and the postwar rehabilitation, and the extent to which those abnormal episodes affected the period is open to debate. However, the basic characteristics were apparent in the 1920's as well as in the later years of the period.

Period 1 is characterized by a fairly high rate of output growth with a moderate rate of increase in total inputs (A-2); whereas for Period 2 we see moderate rates for both. This makes a big difference in the increases in productivity and value added (A-3, A-4) in both periods.

Regarding the composition of inputs of Period 1, we note two features: the highest rate of increase was in current inputs of nonagricultural origin (A-6), and the rate of increase in fixed capital was very slow (C-1). The former represented the introduction of new inputs that were complementary with the diffusion of improved varieties and cultivating techniques. Those familiar with Japan's agricultural development have long argued that the combined effect of those changes on farm output was very substantial, and the interesting attempt by Hayami and Yamada to test their importance statistically has confirmed that view.[6] With respect to the second feature, several points may be noted in addition to the decrease in the capital-output ratio. Trees and shrubs showed a notable increase (C-3) as a result of the expansion of tea cultivation and sericulture; and this expansion was supported by notable technological progress, especially in the various aspects of sericulture. The

[6] Yujiro Hayami and Saburo Yamada, "Agricultural Productivity at the Beginning of Industrialization," in Ohkawa, Johnston, and Kaneda, *op. cit.*

capital-land ratio was kept almost unchanged (C-6); the area of arable land expanded to a certain extent (B-1) and the increase of capital stock (at just above 0.5 per cent) was at a slightly slower rate.

It must be admitted that two very important quantitative indicators are missing in Table 1: one concerns expenditures for the construction of infrastructure, particularly facilities for irrigation and drainage, and the other is data concerning the rate of utilization of farm land. The historical research now under way on these points will not be completed for some time, and therefore we are obliged to offer some speculations based on scattered data in order to complete our interpretation.

It has often been insisted that the agricultural infrastructure had been built primarily during the pre-modern epoch and that at the beginning of its period of modern economic growth Japan's agriculture inherited these stocks, thus avoiding the need for sizable investments in infrastructure. We are skeptical of this argument, and we propose the hypothesis that the capital formation in land improvement and in water control facilities must have been carried out at an appreciably more rapid pace than during the pre-modern period. It is true that the official record of irrigation and drainage works of large-scale areas (i.e., covering over 500 hectares) does not show us such a pattern. A large number of small-scale works, however, were carried out by farmers and landlords. A great amount of labor input, involving the use of considerable materials (mostly of internal origin), also seems to have been required for the repair and improvement of facilities built in the long past.

With respect to changes in the rate of utilization of farm land, things are less obscure. Meadows and pastures are of little significance in Japanese farming, so that the figures in B-1 are reliable for such changes except that they do not reflect changes in multiple cropping. This is significant because the extent of double cropping of paddy fields is particularly important as an indicator of farmers' attitude toward farming. From 1889, when the statistical recording of the practice began, double cropping increased until 1919, when it began to decrease. The decline, continuing during the 1920's, indicates a change in the attitude of farmers between the two periods.

The last supplementary interpretation of the statistical findings concerns labor input. The figures in Table 1 (B-2) and other related figures do not indicate changes in the actual input of labor. On the basis of such evidence as is available, we judge that the rate of utilization of labor must have been intensified during Period 1. To mention a few items: the expansion of double cropping, the spread of sericulture (and of the technique of producing an autumn as well as a spring crop of cocoons),

and the on-farm production of more manures, all point in that direction. It is of interest to note that there are indications that the response of farm households to the conditions of Period 1 involved fuller utilization of the labor time of family members, but unfortunately no systematic knowledge is available at present.

We conclude that the major factors responsible for the fairly high rate of output growth during Period 1 were the increased productivity and fuller utilization of existing land and labor. This was made possible by scientific progress and diffusion of technology of a biological and chemical nature, with only minimum requirements for capital equipment and with modest requirements for infrastructure, especially in terms of public expenditures. The result can be described as capital-saving measured simply in terms of the movement of the capital-output ratio.

Why did the picture change so drastically during Period 2? It is clear that the answer cannot be found in a decrease in total inputs. The rate of increase in fixed capital was maintained at more or less the same level as in the previous period, although its composition changed (C-1, 2, 3, 4). Arable land area did not increase. But the rate of increase in total current inputs was higher, and inputs of external origin now weighed more heavily in the total (A-5, 6, 7). In terms of the input-output relationship, this represented a decreasing return to the increase of inputs, compared with the previous period. We will try to find the explanation for this in differences between conditions in this period and the previous one, although a completely satisfactory empirical test is not possible.

First, the relative prices for farmers were less favorable. The ratio of farm output prices to prices of current inputs moved favorably in Period 1 and it became even more favorable in Period 3 (D-3). Increased imports of rice from Korea and Formosa prevented the rise in the price of domestic rice that might have occurred if the shortage of domestic supplies had not been offset by these cheap imports. Undoubtedly this had an adverse effect on farmer incentives. Second, potentials for technological advance became less promising, perhaps because of two reasons. Technical innovations relevant to the system of cultivation became less accessible, resulting in a tendency toward decreasing returns to increases in inputs. And this worked in combination with the traditional landlordism that now turned out to be an institutional barrier to technological advance instead of a positive factor as in Period 1. Third, the deflationary conditions that prevailed in Japan during much of the 1920's and the early 1930's, together with other factors slowed the rate of increase in nonfarm employment opportunities. Hence the farm labor force did not decline in Period 2 as might have been expected. The weight

of agriculture in the total labor force had declined sufficiently by 1919 so that the absolute size of the farm labor force would have declined at an increasing rate if nonfarm employment had increased at the high rate of Period 1 or at the even higher rate of Period 3. The prospect for increasing total factor productivity in agriculture would have been considerably improved if labor inputs had been declining, because such decline would have enlarged the scope for substitution of capital for labor.

To be complete in our historical coverage, we have to say at least a few words concerning the earliest period, 1868–85. Although we take the view that the "transformation" of traditional agriculture became a national objective from the beginning of the Meiji Restoration in 1868, we hesitate to treat this first twenty years in detail for two reasons: first, the quantitative data are still not sufficiently reliable. Second, qualitatively this is the transition period of Japan's modern economic growth, and interpretation of the agricultural changes during that period demand special consideration particularly from the institutional point of view. Here we touch upon a few points that relate directly to changes in farmers' behavior and attitudes and to the diffusion of technical knowledge.

The social and institutional reforms carried out during the transitional period gave a strong impetus to the development of agriculture by striking down feudal restrictions such as those on the sale and cropping of land and on the choice of occupation. In particular, the removal of the Tokugawa restrictions on the movement of goods and people and the creation of a unified nation with a "national" economy had a great influence on farmers' attitudes towards modernization. It accelerated the spread of technological knowledge and spurred the adoption of better traditional varieties. In facilitating the diffusion of the considerable backlog of technical knowledge accumulated during the Tokugawa Era both the central and local governments played an important role, thereby making an undoubted contribution to the initial breakthrough and subsequent development of agriculture in Period 1.

EAST ASIAN AGRICULTURAL DEVELOPMENT: A POSSIBLE PATTERN

Let us begin by posing the problem broadly as follows. The required increase in the current rate of growth in agricultural output must take place within the framework of basic economic conditions. The most influential of these are: first, a fairly serious limitation on further expansion of the arable land area; second, a high rate of increase in the labor

force; third, severe limitations on the supply of capital—limitations that stem not only from its over-all scarcity, but also from the competitive demand for use in industrial expansion.

The extent to which the current rate of output growth should be increased differs of course from one country to another. However, the general consensus is that the difference or gap between the rate that should be realized in the future and the rate realized in the past is not small for most countries in the region. On the contrary, it is sizable, indicating a need for a transformation of the traditional agriculture, a transformation whose effects go beyond the sort of acceleration attainable by the methods through which output increases have been achieved in the past. What is needed are changes in the basic structure of input-output relationships. The seriousness of the limitation on further expansion of cultivation differs among countries, but in general, the most promising strategy for increasing output is to raise per acre yields—this is the pattern that has been evident in Japan, particularly in the case of rice cultivation.

It is generally considered that the effects of the recent population explosion will be felt for at least several decades to come. A 2–3 per cent rate of annual increase in the total labor force is so high as to have no parallel in the experience of the developed countries, including Japan. Even with the most optimistic expectation as to the future increases in employment in the nonagricultural sectors, a trend of absolute increase in the employment of labor in agriculture would seem to be unavoidable in all countries in which the farm labor force still bulks large in the total; and this is true of virtually all of the Asian countries other than Japan. And the magnitude of this increase will be greater than that ever experienced in the modern period of economic growth in the advanced countries.

The "concurrent" growth of agriculture and industry is a particular requirement for countries characterized by economic backwardness. For these late-developing countries both sectors must grow side by side. Agricultural development cannot be a precondition for industrialization in the historical sequence that characterized most of the advanced Western nations. As touched upon briefly in the Introduction, this concurrent development is a particularly relevant feature of Japan's pattern of growth. The well-known problem of the competition for limited resources, especially capital and foreign exchange, between agriculture and industry is thus a serious one. It is generally recognized that the transformation of a traditional agriculture requires an enormous amount of capital, especially for building up infrastructure. But from an economic point of view,

it is highly unrealistic to ignore a limited availability of capital resources. Therefore, such limitation should be considered as an important given condition for determining a new input-output pattern, and this pattern should be determined for a sustained expansion for agricultural output, not for a once-and-for-all effect.

With these given conditions, in what direction should the traditional pattern of input-output relations be changed? "Towards a more productive and fuller utilization of land and labor," seems to be the reasonable answer in a broad context. The critical need is for accelerated technical progress that is both labor-using and yield-increasing. Taking this as a hypothetical proposal, let us examine the factors and conditions that make it possible to change the present input-output relations in that direction. We are directly concerned with two factors: the type of technological progress and the attitude and behavior of farmers. Both, in our view, can in principle be examined, at least in a preliminary manner, through measurable indicators of input-output relationships.

Let us begin by describing briefly the past and present pattern of agricultural production in terms of three features: the area of arable land, the land area per farm household, and the yield or farm output per unit of land.

First, the arable land under cultivation, particularly for major crops, tended to expand in most cases. In some cases the expansion has been very rapid, as for land in rice in the Philippines and Thailand. In the former country the average annual rate of increase is calculated as 2.7 per cent for the period 1900–60; in the latter it is calculated at 3.0 per cent for 1910–60.[7] If these statistical records are even fairly reliable, the pattern is quite different from that of Phase I in Japanese agriculture. (During the Tokugawa Era, a sizable expansion of cultivated area took place in Japan.) Second, the cultivated area per farm household is on the average much larger in East Asian countries than in Japan—roughly two to three times as large. This generalization is affected, of course, by differences in family size among countries, as well as by differences in cultivated area; and we should be careful to note exceptional cases such as Indonesia. But, by and large, this feature is notable. With respect to the third feature, fairly reliable data are available for crop yields of individual crops, especially for rice. Japan's present rice yield, for example, is a little more than four times as high as the national average yield in the Philippines and more than three times the yield in Thailand, Burma,

[7] S. C. Hsieh and V. W. Ruttan, "Environmental, Technological, and Institutional Factors in the Growth of Rice Production: Philippines, Thailand, and Taiwan," *Food Research Institute Studies,* Vol. VII, No. 3, 1967.

India, and Pakistan. It is much more difficult to compare total farm output per unit of land, but it can be safely assumed that the differences in land productivity are fairly similar to the differences in rice yields.

With respect to agricultural inputs, the available data are extremely limited, making it difficult to compile time trends. Therefore the "irrigation ratio" is often used as a representative indicator. This is sometimes misleading. We badly need further knowledge on the performance of other inputs. The following comparison (from a study by Professor Ishikawa) is based on 1956–57 data for India and the 1956 national average for Japan.[8]

	Gross Crop Income (paddy equivalent in tons per hectare)	Labor Input (working days per hectare)	Total Fixed Capital Excluding Land (paddy equivalent in tons per hectare)
West Bengal	1.79	109	3.21
Madras	1.31	115	2.92
Japan	5.39	543	7.69

The most notable fact is that the labor input per unit area in India is only about a fifth of that in Japan—an enormous difference. Since the difference in gross crop income between the two countries is less than that, the partial gross labor productivity is higher in India than in Japan although the total annual income per farm worker is much lower in India. Although there is no assurance that these data for India are representative of other East Asian countries, we believe that this order of difference can be accepted as reasonable. As noted previously, time series data concerning actual labor input in Japan are not available so that we cannot make a comparison with Phase I. Our guess, however, is that the postwar figure, even in 1956, may be less than the prewar one. Therefore, the above-mentioned difference is the more decisive; and we believe that it is crucial to understanding the factors and conditions which differ from Japan's case.

A comparison of capital per hectare must be less accurate because of measurement difficulties such as the valuation of capital and the allocation of residential buildings, but it reveals the striking fact that the capital stock per labor input is roughly twice as large in India as in Japan. The same is true of the capital-output ratio, India's ratio being much higher than Japan's. Undoubtedly a big difference in the rate of utilization is the explanation.

[8] The price of crops at the farm level was used in estimating the gross crop income in paddy equivalent. For details see Shigeru Ishikawa, *Economic Development in Asian Perspective*, Tokyo, 1967, Table 3-2, p. 226.

How about current inputs? No data are available corresponding to the comparison made above based on farm accounts data, but with regard to rice cultivation Ishikawa presents suggestive material for the same districts in India.[9] The findings are: (1) the average amount of current inputs differs greatly between irrigated districts and nonirrigated districts (the former being four to five times larger than the latter) but is still very small, only some 10 to 15 per cent of the value of output; (2) according to a comparison, by farm household, with labor input per unit area, the current input has a fairly close association in the former district, whereas in the latter almost no association is seen; (3) paddy yields, however, show a surprisingly small difference between the two districts (1.9 to 2.6 vs. 1.5 to 1.8 tons per hectare).

These findings, though based on limited evidence, suggest important characteristics with regard to the input-output relationships. We interpret them as follows. There seems to be close technical complementarity between current inputs, labor input, and irrigation facilities, so that we can expect that an extremely low level of both labor and current inputs per unit area will be associated with a low level of infrastructure. At the same time, however, increased capital inputs for irrigation facilities and increases in other inputs may have a very small marginal product (increase in yield) under the present technology. The data cited above show that despite moderate difference of various inputs between the irrigated districts of Madras and Japan, a big difference does exist in the rice yields.

This pattern of rather rapid expansion of area, fairly large farm units, and moderately high labor input productivity associated with a very low level of labor input per unit area constitutes a set of input-output relationships that we would like to describe as the "extensive" type of Asian traditional farming. These relationships represent a rational adaptation to the given traditional conditions. The required evolution towards fuller utilization of labor and land demands a breakthrough in the direction of an "intensive" type of farming, represented by historical changes in input-output relationships as described in the previous section on Japan. The traditional extensive type, as seen from the development point of view, implies the existence of rich potentials for intensification. If the very low level of yield, for instance, were associated with a very large labor input and accordingly were accompanied by a very low level of labor productivity, then there would be much less potential for intensification. But the real situation appears to be the opposite of this in most, if not all, countries in East Asia. In particular, we would like to stress the signifi-

[9] *Ibid.*, pp. 219–21.

cance of the fact that the output per unit of labor input under the traditional type of farming shows, under a rather conservative interpretation, no substantial difference as compared with the intensive farming in Japan. This suggests that the low yield may not be the result of decreasing returns, but rather the result of a low rate of utilization of resources, particularly labor and land.

How is the rate of utilization of labor and land to be raised? To answer this question the possible pattern of future growth of farm output in the countries of extensive type of farming should be considered. The labor force engaged in agriculture will increase. Therefore under a given land area, the average labor-land ratio will also increase. The distribution of land-holding and land-cultivated area per farm household or the land-labor ratio of farm-households will in most cases decrease. If this pattern should materialize, the magnitude of the changes involved will surpass anything ever experienced in Asian agriculture. The development of industries of a labor-intensive type to absorb the increased labor force, as was done in Japan, should to some extent moderate this trend.[10] However, the previous discussions reveal that the transformation of agriculture, enabling it to employ more labor and to use it productively, might be possible under certain conditions. The principal conditions favorable to fuller utilization of labor and land are basically two: progress in relevant technology and the existence of economic incentives to induce farmers to take advantage of it.

Japan's experience does not exhibit an agricultural development associated with an increasing farm labor force, and in this sense probably even its Phase I differs from the future path of other Asian countries. It goes without saying that Japan's Phase II, though we can see only its beginning, is completely different in its nature. However, as economic history tells us, one country's experience cannot be reproduced in its entirety. We believe that the relevance of Japan's approach, in its broadest context, is that it demonstrates the potential that exists for increasing farm output within the framework of a small-scale, labor-intensive Asian agriculture. More analytically the following are particularly relevant in both a positive and negative sense in the broad context mentioned in the Introduction.

First, the historical process of increasing agricultural productivity asso-

[10] This important issue requires far more attention than it has received to date. It has been examined in a preliminary way by the present authors: Kazushi Ohkawa, in "Agriculture and Turning-Points in Economic Growth," *The Developing Economies,* December 1965; and B. F. Johnston in "Agriculture and Economic Development: The Relevance of the Japanese Experience," *Food Research Institute Studies,* Vol. VI, No. 3, 1966, pp. 274–79.

ciated with use of improved varieties, fertilizers, and other current inputs —an advance in technology based on new inputs of a biological and chemical nature—represents an enormously important potential for the contemporary underdeveloped countries.

Second, capital intensification, particularly in terms of mechanization of field operations, is effective mainly in substituting for labor. Therefore the limited capital available to the agricultural sector should be used instead chiefly for building up the infrastructure to the extent that its technical complementarity is essential to the successful introduction of technology of the type mentioned above.

Third, economic conditions, particularly the trend of relative farm product prices as related to inputs, have a great effect on farmers' attitudes toward intensification. Japan's experience during Period 2 deserves special attention as indicative of a pattern to be avoided.

A STRATEGY FOR TECHNOLOGICAL PROGRESS

Taking up the positive factors among the three just mentioned, we turn now to the theoretical discussion of their detailed implications, particularly with respect to the strategy for accelerating technological progress. Generalizations with respect to the choice of an efficient strategy are obviously hazardous because of the great variation among countries lumped together as "underdeveloped." This variation stems in part from the extreme diversity that characterizes agricultural production, conditioned as it is by particular combinations of climate, soil, and topography, in part from the differences in the educational levels and attitudes of the farm population, and in part from the differing degree to which existing institutions impede or foster the capacity to absorb the international backlog of technological knowledge.

Thus it is essential to frame strategies for technological progress in terms of the unique characteristics of the farm economy of a particular country—and of the various farming regions within it. But this does not mean that each country must approach the task of choosing an efficient strategy on a purely *ad hoc* basis. That would be a counsel of despair because of the complexity of the process. It is critical to an efficient strategy of agricultural development that it generate new production possibilities characterized by a specific type of technological progress, rather than by technological progress in general. In this context, despite the dissimilarities mentioned above, in the countries characterized by technological

backwardness there is a common need for strategies that emphasize borrowing modern—but labor-using—technologies from advanced countries.

It is a widely accepted view that the greatest advantage for developing manufacturing in the economically backward countries lies in the possibility of borrowing the technologies from advanced countries at a relatively low cost and without much difficulty. However, at the same time, the view seems widely accepted that in the case of agriculture this is most difficult because of the different conditions that affect the borrowing of advanced technologies. We do not share the latter view, however, and would emphasize that the advantage of borrowed technology is the key factor for accelerating the rate of growth of all industries in follower countries. Most of the difficulties in the international transfer of agricultural technology do not prevent implementation of the strategy of borrowing advanced technologies, they only modify it.

Even in the case of manufacturing, most of the success stories tell us that an important feature of the process is the choice and modification of foreign technologies in order to fit them into the domestic economic situation, particularly in terms of the structure of factor prices. When a country has achieved this, it has built an appropriate system for developing its own technology. The situation is the same for agriculture. What is important is first to identify the unique nature of agriculture in each of the follower countries and, second, to find the criteria for the choice and the necessary modification of the advanced technologies so that they may be fitted into the desirable pattern of agricultural transformation in each country. Admittedly, agriculture, compared with manufacturing or other industries, poses particular difficulties, because of its wider range of variation in respect to the conditions mentioned above as well as the very nature of its technologies. On the other hand, agriculture has some advantages if the choice of strategy is appropriate. This and two other related points deserve attention.

First, the flexible nature of agricultural production in terms of factor proportions and input divisibility can be counted as a favorable element for borrowing advanced technologies in agriculture. In manufacturing, the more rigid factor proportions that are technically required often operate as a decisive factor. Thus technologies of a capital-using type must often be adopted even though they are out of keeping with the economic situation of follower countries where labor supplies are extremely flexible. But in agriculture, the current inputs, such as seeds, fertilizers, and insecticides, are all highly divisible; they can be used with different scales of farm operations without differences in efficiency. Thus they do not demand radical changes in farm organization. Furthermore, as previously

observed, use of these inputs can be increased efficiently with a complementary increase in the labor input per unit of land. If the above interpretation of the thesis of borrowed technology is accepted for the case of agriculture, it offers theoretical support for the proposition that the positive aspects of Japan's experience can be reproduced in other East Asian countries.

The second point to be emphasized is that the term "reproduction" should not be taken to mean that technologies are borrowed outright without modification. Rather the term implies that the foreign experience becomes the basis for guidelines in the choice of an appropriate strategy. As suggested above, this also requires invention and adaptation on the part of follower countries. In this connection, Japan's experience is again relevant in both a positive and negative sense. In the transition period at the beginning of the Meiji Era, the government made an attempt to introduce "western" advanced methods of large-scale farming. Agricultural machinery, implements, and crop varieties were imported to Japan. The strategy was exactly to take full advantage of borrowed technologies developed in advanced countries. This was a failure, except in Hokkaido where farming conditions are more or less similar to those in Western countries. Thereafter efforts were concentrated on increasing the efficiency of the prevailing system of small-scale farming. The so-called "Meiji technology" that was evolved, has been aptly described as a "combination of indigenous know-how and very selective borrowing from the West." Intimate knowledge of the best of traditional farming methods was thus the starting point for agricultural research and extension activities. In general, it is to be noted that appropriate borrowed technology in combination with indigenous achievements can be expected to contribute a great deal to establishing a country's own new system of improved technologies for transforming its traditional agriculture.

The third observation concerns the rich international backlog of technological knowledge that is becoming more promising to farming in the tropical and subtropical regions that are of predominant importance in the contemporary underdeveloped countries. The advances in agricultural science and research techniques provide the basis for rapid technical progress in these regions, but until recently the resources devoted to research directly relevant to the tropics and subtropics have been extremely meager. The large increases in yield and productivity that have been realized for oil palm, cocoa, and other export crops have demonstrated, however, that the potential for technical advance is great. And for the three major food crops that have received considerable attention

in recent years—maize, rice, and wheat—the prospects range from good to spectacular. The international backlog of technical knowledge is also of great importance in ensuring the availability at low cost of the key complementary inputs—chemical fertilizers and pesticides. Technical innovations that are continuing to reduce the real cost of nitrogen fertilizers are particularly significant, because this item is likely to bulk large as intensification leads to increased use of purchased inputs.

In a number of Asian countries, the extent to which productivity and output can be increased by exploiting the international backlog of technological knowledge will be influenced strongly by the measures taken to improve control over water supplies. It was, of course, for that reason that we have argued that the limited capital available to the agricultural sector should be used chiefly for expansion and improvement of irrigation and drainage works to the extent that these are essential to increase crop yields. Although satisfactory data on the magnitude of the outlays for irrigation and other infrastructure investments in Meiji Japan are not available, it seems clear that the rural sector made a highly significant net contribution to financing capital formation in infrastructure and in industry and that to a considerable extent this was made possible by the significant increase in factor productivity in Japanese agriculture. Vernon Ruttan has advanced the view that for contemporary underdeveloped countries, a net transfer of resources *into* agriculture is likely to be required because of the massive investment which must be made in irrigation and drainage facilities.[11] We have left aside this important and difficult issue in the present paper. It may be noted in these concluding remarks, however, that the implications of the viewpoint expressed by Ruttan are somber indeed. Rapid population growth not only accentuates the problems of food supply in an underdeveloped country, but also increases the requirements for capital to bring about the transformation of the economic structure that is a necessary condition for sustained growth.

Regardless of one's view with respect to the net flow of resources between agriculture and the rest of the economy, it is clear that the contemporary developing countries in Asia have a great stake in a strategy for technological progress that can achieve the required expansion of agricultural output mainly through more productive and fuller utilization of the on-farm (internal) resources of labor and land. The Japanese

[11] V. W. Ruttan, "Considerations in the Design of a Strategy for Increasing Rice Production in South East Asia," paper prepared for presentation at the Pacific Science Congress session on Modernization of Rural Areas, Tokyo, Aug. 27, 1966; see also Ishikawa, *op. cit.*, Chapter 4.

experience demonstrates that the intensification that will make this possible requires a substantial increase in current inputs and will in most instances depend on sizable investments in expanded and improved water control facilities. But this simply emphasizes the great importance of a strategy that leads to a path of expansion involving the lowest possible capital-output ratio. Hence the great importance, in the early phase of development, of fostering "minor" irrigation works for whose construction and maintenance local funds and underutilized farm labor can be mobilized through the inducement effect of central government outlays.[12] Similarly, the Japanese experience underscores the importance of simultaneous efforts to promote yield-increasing innovations so that the return to investment in infrastructure is augmented by the intensification of farming which it facilitates.

APPENDIX NOTE

JOHN COWNIE

In the foregoing paper an economy is said to reach a "turning point" in its transition from agriculture-dependence (Earlyphasia) to a more balanced state (Middlephasia) when the absolute size of the agricultural labor force begins to decline. If certain assumptions are made about the initial distribution of the economy's labor force and about the growth rates of the total and of the nonagricultural labor forces, then the time required to reach the turning point is easily determined.

The following notation will be used:

L	labor force
t	time
T, N, A	subscripts to denote "total," "nonagricultural," and "agricultural" respectively
prime ($'$)	denotes the annual growth rate of the primed variable

The growth rate of the total labor force at any given time is the weighted average of the growth rates of its components:

$$L'_T = \frac{L_A}{L_T} L'_A + \frac{L_N}{L_T} L'_N \tag{1}$$

[12] See Ishikawa, *op. cit.*, pp. 137–53 for an excellent discussion of the choice between major and minor water control facilities and of the workings of the "investment-inducement effect" of central government subsidies or low-interest loans.

The turning point is defined by the condition $L'_A = 0$. Therefore at the turning point

$$\frac{L'_T}{L'_N} = \frac{L_N}{L_T} \tag{2}$$

Although L'_T and L'_N are not likely to remain constant over extended periods of time, it is useful here to assume that they are fixed and to calculate the time, t_1, which would be required to reach the turning point given this assumption. This procedure provides a relatively simple expression for t_1, and it delimits the ranges within which the solutions for more complicated growth paths would lie.

If L'_T and L'_N are constant over time,

$$\frac{L_N}{L_T} = \left(\frac{L_N}{L_T}\right)_{t=0} \cdot \left(\frac{1 + L'_N}{1 + L'_T}\right)^t \tag{3}$$

Combining this expression with (2) shows that at the turning point

$$\frac{L'_T}{L'_N} = \left(\frac{L_N}{L_T}\right)_{t=0} \cdot \left(\frac{1 + L'_N}{1 + L'_T}\right)^{t_1} \tag{4}$$

Therefore,

$$t_1 = \frac{\log\left(\frac{L'_T}{L'_N}\right) - \log\left(\frac{L_N}{L_T}\right)_{t=0}}{\log(1 + L'_N) - \log(1 + L'_T)} \tag{5}$$

It is interesting to compare t_1 with the time t_2 required for the economy to reach the point at which the fraction of the labor force in agriculture has declined to one-half of the total. When $(L_A/L_T) = \frac{1}{2}$, $(L_N/L_T) = \frac{1}{2}$ also. Therefore, again assuming that L'_T and L'_N are constant over time,

$$L_N = \frac{1}{2} L_T \tag{6}$$

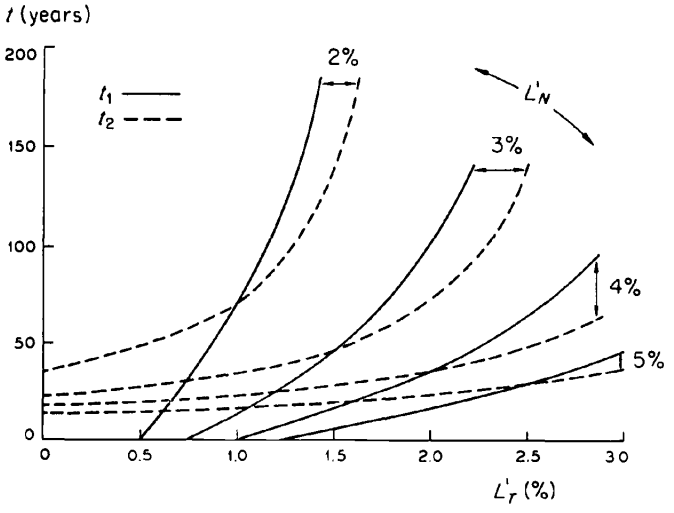
$$(L_N)_{t=0} \cdot (1 + L'_N)^{t_2} = \frac{1}{2} (L_T)_{t=0} \cdot (1 + L'_T)^{t_2} \tag{7}$$

Therefore,

$$t_2 = \frac{\log\left(\frac{1}{2}\right) - \log\left(\frac{L_N}{L_T}\right)_{t=0}}{\log(1 + L'_N) - \log(1 + L'_T)} \tag{8}$$

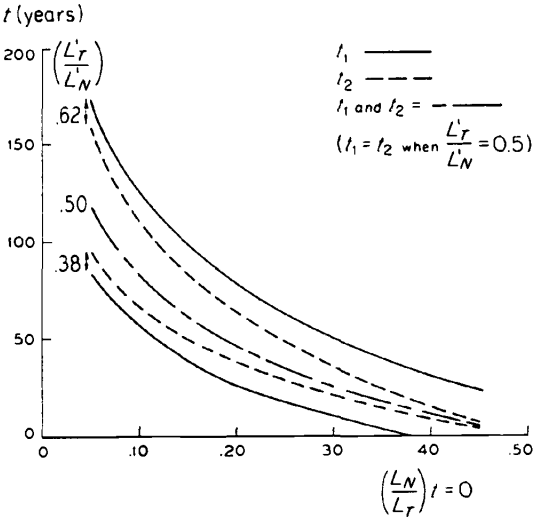
Figure 1

Growth Rates and Changes in Composition of the Labor Force



Note: t_1 is the time required to reach the "turning point" at which the agricultural labor force begins to decline in absolute numbers. t_2 is the time required for the agricultural labor force to decline to 50 per cent of the total labor force. In upper diagram t_1 and t_2 are functions of the growth rates L'_N and L'_T, given the initial condition $\left(\frac{L_N}{L_T}\right)_{t=0} = .25$

In the lower diagram t_1 and t_2 are functions of the initial composition of the labor force $\left(\frac{L_N}{L_T}\right)_{t=0}$ and $\left(\frac{L'_T}{L'_N}\right)$, given $L'_N = 4$ per cent.



Comparison of 8 with 5 shows that t_2 differs from t_1 only in the first term in the numerator. Thus, for the special case in which L_N is growing at exactly twice the rate of L_T ($L'_T/L'_N = \frac{1}{2}$), the economy reaches the turning point ($L'_A = 0$, with L_A beginning to decline) at the same time that L_A/L_T declines to one half, and $t_1 = t_2$. If the nonagricultural labor force is growing more than twice as fast as the total labor force ($L'_T/L'_N < \frac{1}{2}$), the economy reaches the turning point before the fraction of the labor force in agriculture declines to one half ($t_1 < t_2$). If L_N is growing less than twice as fast as L_T ($L'_T/L'_N > \frac{1}{2}$), the turning point is not reached until after L_A/L_T has declined to one half ($t_1 > t_2$).

Figure 1 illustrates the general nature of these relationships. In the upper panel the assumption is that 25 per cent of the total labor force is in the nonagricultural sector at time zero, and the dependence of t_1 and t_2 on L'_T is illustrated for different values of L'_N. The lower panel assumes a value of 4 per cent for L'_N, and shows the dependence of t_1 and t_2 upon $(L_N/L_T)_{t=0}$ for different values of (L'_T/L'_N).

Comment

T. H. LEE, CORNELL UNIVERSITY

The paper submitted by Professors Ohkawa and Johnston is an excellent and opportune work. With their high professional competence and rich experience in this field, the authors are in an unusually good position to write on the subject. The paper consists of three main parts: (a) a review of the input-output relationship in the long-run pattern of agricultural development in Japan; (b) the identification of the determinants of the possible pattern and direction of agricultural development for the East Asian countries in the future; and (c) the selection of strategies for accelerating the growth of agriculture in these areas in the light of the Japanese experience. The emphasis of the paper is placed on the significant progress of Japan's agriculture within a small-scale farming system and its transferability. Its basic concept, as mentioned by Johnston in another report, is that the growth pattern of Japan's agriculture reveals the importance of the opportunity to exploit the potential of increasing crop yields at a relatively low cost in terms

of scarce capital and foreign exchange. The contemporary developing countries have to find such opportunity as Japan has demonstrated before.[1] I have little dissent from this viewpoint. My comments on the transferability of the Japanese model are related to the following unanswered questions posed by the authors in their paper. First, what is a feasible pattern of technological relationships for the East Asian countries to adhere to in transforming their traditional agriculture? Second, what limitations on transferability are imposed by differences in indigenous organizational patterns and beliefs between Japan and these countries? My basic view concerning these two questions is that the contemporary developing countries suffer from their inability to transform traditional agriculture and bring about the major and continuous change in productivity associated with a technologically dynamic agriculture. The crucial fact, as Mellor pointed out, is that introduction of single change in farming practice in such a transitional agriculture will produce small effects on productivity.[2] Several empirical studies on Southeast Asia indicate that within the framework of traditional agriculture, increasing production or crop yields through added labor input seems unlikely to succeed.[3] Considering the available land resource and high population pressure in the contemporary East Asian countries, the possible pattern of land-man ratio in these areas will continue to vary in the future. Japan's experience does not exhibit a path of agricultural development associated with a varying land-man ratio. This implies that the input-output relationships as presented in the paper for any historical period of Japanese agriculture and for the equivalent historical period in the agricultural development of an East Asian country may differ in many respects—even when the period compared is Phase I, and regardless of whether the country undergoes the comparable period now or in the future. Taiwan is broadly thought of as a successful case of the application of the Japanese model to the transformation of traditional agriculture under different initial conditions. The implications of Taiwan's agricultural growth will be useful in suggesting an answer to the above two questions in relation to the modification of the Japanese model.

(1) Theoretically, increase in labor productivity is the most economically efficient way to free a nation's economy of its long-run stagnation and to embark on sustained growth. If we call net output of

[1] Bruce F. Johnston, *Agriculture and Economic Development in Japan: Its Relevance to Developing Countries,* Stanford University, Discussion paper No. 67–3, 1967, pp. 43–44.

[2] John W. Mellor, *The Economics of Agricultural Development,* 1966, chapter 12, pp. 214–19.

[3] *Ibid.,* pp. 136–54.

agriculture Y, the input of labor (man-unit) L, the input of cultivated land D, and the input of capital stock K; then labor productivity, land productivity and the output-capital ratio can be interpreted as $\frac{Y}{L}$, $\frac{Y}{D}$ and $\frac{Y}{K}$, respectively. The following definitional equations can be specified to show that labor productivity is determined by land productivity and per capita land area of labor and that land productivity is determined by capital intensity and the output-capital ratio:

$$\frac{Y}{L} = \frac{Y}{D} \cdot \frac{D}{L} \tag{1}$$

$$\frac{Y}{D} = \frac{Y}{K} \cdot \frac{K}{D} \tag{2}$$

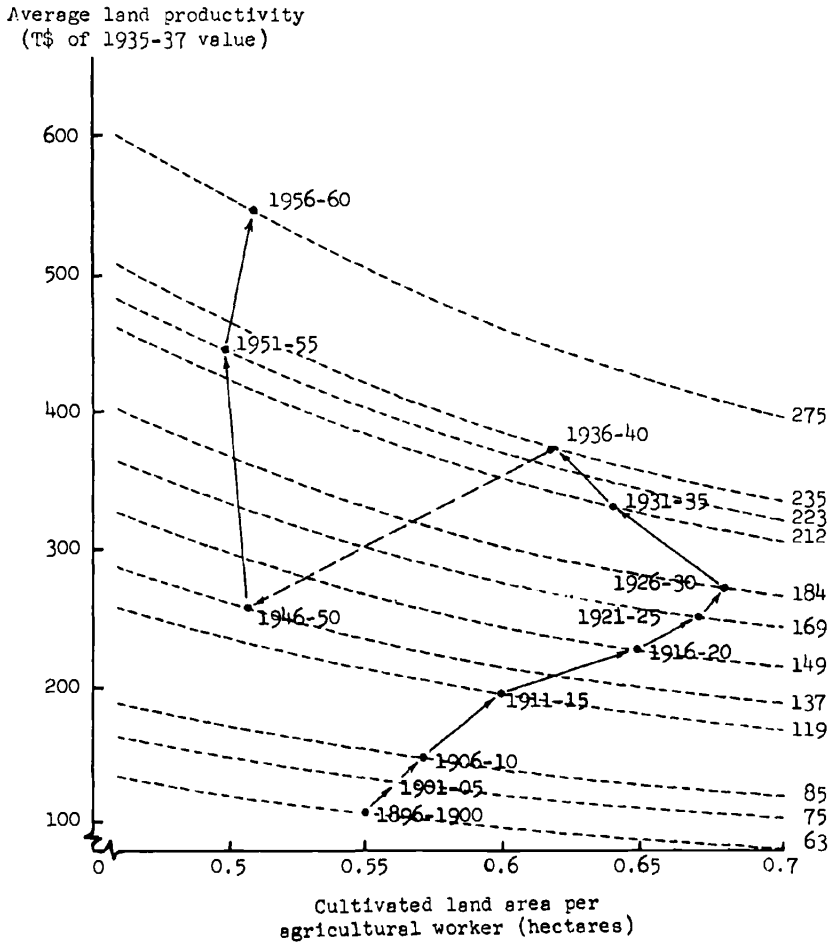
Technological progress and more investment in agriculture are considered to raise land productivity in densely populated areas. Labor productivity in turn, will be raised by the increase in both land productivity and the per capita land-labor ratio or through a sufficiently rapid increase in land productivity under constant or decreasing trends in per capita land area.

The historical growth path of agricultural productivity in terms of labor can thus be defined by the coordinates of land productivity on the vertical axis and per capita land area on the horizontal axis (see Figure 1). Figure 1 shows Taiwan's agricultural development, 1895–1960, in terms of changes in these coordinates. Contour lines through each point indicate iso-labor productivity curves. The direction of the historical path reflects changes in resource endowment, and the level of the iso-labor productivity curves presents the magnitudes of labor productivity in agriculture. Emphasis is not on the presentation of the historical path of agricultural development in Taiwan, but rather on the identification of the strategic factors which raised per capita income or labor productivity.

We have classified the whole growth path, shown in Figure 1, into four cases: (a) the traditional (1895 to 1926–30), (b) the developing (1926–30 to 1936–40), (c) the Malthusian (1936–40 to 1945–50), and (d) the Japanese (from 1945–50). According to our definition, case (a) is apparently the phase of extensive farming in traditional agriculture, the cases (b) and (d) correspond to the phase of intensive farming. Case (d), the Japanese, indicates a relatively constant labor force in agriculture under a constant land area, the experience of Japan in its entire prewar development period. Cases (a) and (b) are the

Figure 1

Growth of Labor Productivity in Taiwan's Agriculture, 1895–1960



Note: Figure indicates relationship between average productivity per hectare $\left(\frac{Y}{D}\right)$ and cultivated land area per agricultural worker $\left(\frac{D}{L}\right)$. The product of these two ratios is equal to labor productivity per agricultural worker, i.e. $\frac{Y}{D} \times \frac{D}{L} = \frac{Y}{L}$. For each observation in the figure the corresponding value of $\frac{Y}{L}$ can be read off from the isolabor-productivity curve.

Source: T. H. Lee, *Intersectoral Capital Flows in Economic Development of Taiwan*, 1895–1960, unpublished thesis, Cornell University, 1967, Chapter 5.

specific cases that Japan has never experienced. The data in Table 1 are from a recent study by this author.[4]

According to Vanek's classification, case (a) stands for technological change, which is capital-using, while the other cases are of a capital-saving nature.[5] The rate of technological change in terms of land, as seen from column five above, amounted to 0.46 per cent per annum for case (a) and 1.52 per cent and 2.40 per cent per annum respectively for cases (b) and (d). The implications of the case study of Taiwan are twofold: first, a comparatively high elasticity of substitution in case (a) can be thought of as a "big push" investment prior to the transformation of traditional agriculture under the high man-land ratio starting in the late 1920's. This fact tends to disprove the conventional viewpoint on capital allocation, i.e., that agricultural investment should be made complementary to labor input in the pretransformation period. The empirical facts show that heavy investment in land reclamation and irrigation was accompanied by the simultaneous introduction of a new variety of seeds and by technical changes in farming practice. Second, the negative efficiency of capital growth in case (a) has the potential to slow down the growth rate of the national economy as a whole. The heavy investment in irrigation in Taiwan involved large inputs of labor and agricultural materials relative to industrial capital goods inputs.

My comment on the first question is that the technological relationships in the Japanese model are quite different from those of Taiwan and also probably from those of East Asian countries in cases (a) and (b). The strategic heavy investment in irrigation and land improvement experienced by Taiwan will be necessary in the East Asian countries to transform agriculture in the transitional period between the extensive farming and the intensive farming stages.

(2) When viewed solely from the standpoint of the technological requirements of agricultural development; e.g., application of chemical fertilizer, new variety of seeds, etc., Japan's experience is, with some modification, readily transferable to the East Asian countries. However, this statement is subject to severe qualification when Japan's record is reviewed from the standpoint of institutional or organizational requirements for the technological progress. The adoption of new techniques in agriculture generally involves a number of institutional changes. It is

[4] T. H. Lee, *Intersectoral Capital Flows in Economic Development of Taiwan, 1895–1960*, unpublished thesis at Cornell University, Chapter 5.

[5] Jaroslav Vanek, "Towards a More General Theory of Growth with Technological Change," *The Economic Journal*, December 1966.

TABLE 1

Taiwan: Summary of Input-Output Relationships of Agricultural Development in Terms of Land

Cases	Elasticity of substitution	Efficiency of labor growth	Efficiency of capital growth	Technological change rate	Rate of labor increase	Rate of increase in capital	Rate of increase in land productivity
A (Traditional)	0.6436	0.0187	-0.0196	0.0046	0.0044	0.0915	0.0175
B (Developing)	0.4288	0.0110	0.1295	0.0152	0.0107	-0.0051	0.0190
D ("Japanese")	0.4166	0.0070	0.1954	0.0240	0.0070	0.0146	0.0291

dependent on government decisions in many areas, such as the implementation of measures for development, including the effective organization for dissemination of new techniques and for registering farmers' response. Landlords, farmers' organizations, and the market mechanism are the important links in transmitting new techniques to small-scale farmers.

Considering the flexible nature of factor-proportion in agricultural production, the biological nature of the technological process, and the divisibility of input factors that have been developed in the small-scale farming in Japan, the most strategically useful component of Japan's successful record has been the capacity to construct new organizational rules to create a physical and biological environment more in line with farmers' needs and aspirations. The heritage of basic convictions in the present East Asian countries might be incompatible with the organizational rules required by the widespread use of Japan's model. This does not mean that the model is not transferable to the present East Asian countries. But it does mean that the people of East Asia must scrutinize the utility of Japan's experience with their own eyes and fit it into their institutional heritage and value systems.

In conclusion, the following remarks can be made concerning the issues set forth at the outset of this commentary:

1. Viewing the historical growth path of agricultural development in Taiwan, we can understand that agricultural development requires two important measures; (a) creation of growth motivation and (b) sustainment of the growth process. Different policies and criteria of capital allocation are necessary to encourage the above two measures.

2. In densely populated areas, including Japan and the East Asian countries, investment in irrigation facilities, drainage, flood control and land improvement is the primary requirement to motivate the transformation of traditional agriculture. Effective supply of water and appropriate drainage are indispensable to increase land productivity of paddy farming. The policy adopted for financing such investment has to take into consideration the inducement effect of investment on technological change.

3. In the light of point 2, it is clear that water service is an essential input which should be included in the estimate of the agricultural input index. Irrigation facilities must be counted as capital stock in agriculture, a point ignored by Ohkawa and Johnston. Considering that more than 205,000 hectares of paddy land were subjected to new irrigation and drainage in the Meiji period, the omission of water service from the

estimate of the argricultural input index leads to a serious bias. A further investigation on this point will be necessary.[6]

4. The power to sustain agricultural growth is to be sought in the choice of labor-using innovations and in reliance on the market mechanism. The profitability of technical innovations should be looked at from the standpoint of their return to family labor. The policy for development in the periods succeeding the initial heavy investment might better be centered on the measures directed towards the full utilization of land resources. Japan's model will be useful in this case.

5. The proportion of available land and labor in agriculture determines basically the required type of technological change, the measures conducive to development, and the appropriate criteria for capital allocation between sectors. The increase in land productivity results in higher returns to land and higher government revenues from land taxes. Japan's case was deeply influenced by such economic relationships under the labor-using technique. The authors have not clarified the impact of these relationships on the capital transfer from the agricultural sector.

[6] Japan, Ministry of Agriculture and Forestry, *"Meiji Nen-kan Kangai Haisui gigyo Shi-ryo"* (*Statistics for the Irrigation and Drainage Projects in the Meiji Period*), 1929.