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The impact of the colonial development, or exploitation, on metropolitan or mother country economic growth remains a major unresolved issue in economic history and development economics. The conventional wisdom seems to assume a world in which the agricultural and raw material surpluses of the colonial areas are used to fuel metropolitan industrial development.[1/]

This paper analyzes the impact of the very successful Japanese colonial development efforts in Korea and Taiwan on economic growth in Japan.[2/] The results of our analysis suggest that the imports of rice from the two colonial areas to Japan as the result of colonial agricultural development were, to a substantial degree, responsible for the stagnation of Japanese agriculture during the interwar years, though it contributed to industrial growth by keeping the industrial wage low and the return to capital high

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without causing serious drain on foreign exchange. The increased supply of colonial rice did not produce an agricultural transformation comparable to that of the 19th Century England, but it produced agricultural stagnation and low farm income, which were to a large extent responsible for the general economic and political instability of the interwar period.

Following our analysis of the Japanese colonial experience we suggest several hypotheses which should be considered in accounting for the difference between Japanese and English colonial experience. Also we discuss the implications of the Japanese experience for today's developing nations in Asia and other regions in connection with a massive agricultural technology transfer, the so-called "Green Revolution."

The analysis is based on time series data for the period 1890-1937. We deliberately chose 1890 as the starting year, because the data before 1890 are much less reliable, despite the recent attempts to correct official statistics in *The Long-Term Economic Statistics of Japan since 1868* (abbreviated as *LTES*).[3/] Even the data after 1890 are subject to criticism raised by Nakamura.[4/] Although the issue has not yet been settled, we resorted to *LTES* official statistics, since those are the only data which can be used for the kind of analysis we made. We feel that the adequacy of the data should be checked not only in terms of the deliberate text critique of original documents but also in terms of the plausibility of the results of an analysis which uses the data in question.

I. Empirical Observation and Hypothesis

The rate of output and productivity growth in Japanese agriculture varied widely during the 100 years of "modernization" following the start of the Meiji period (1868-1911). Four main periods, sometimes referred to as "technical epochs" are frequently identified (Table 1). The first was a period of rapid growth in output and productivity that ended prior to 1920. This was followed by a period of slower economic growth during the 1920's and 1930's. The third "epoch" was the period of decline and recovery associated with World War II. A fourth period of explosive growth in productivity began in the late 1940's or early 1950's.[5/] Output and productivity trends, both for rice and for the total agricultural sector, appear to have followed the same general pattern, reflecting the dominant role of rice in the agricultural economy.

The two decades of agricultural stagnation which followed the rapid growth in agricultural output and productivity prior to World War I has been a major puzzle in the history of Japanese economic development.[6/] It has been asserted, by Japanese scholars, that imports of rice from Taiwan and Korea, stimulated by the transfer of Japanese production technology to the two colonial areas, depressed rice prices and dampened the growth of productivity and farm incomes in metropolitan Japan.[7/] An alternative hypothesis, that the potential of the Meiji period biological technology had been exhausted and that the new bio-chemical technology, that has

Table 1.--Annual percentage growth rates of output, inputs and productivity in Japanese agriculture in four periods

	Phase I (1882-1917)	Phase II (1917-1937)	Phase III (1937-1947)	Phase IV (1947-1957)
	------------- percent per year	-------------	-------------	-------------
Output:				
Gross output	1.78	.80	-2.79	4.51
Net output	1.37	.69	-1.78	2.14
Conventional inputs:				
Total inputs	.28	.28	- .03	1.41
Labor	.20	.01	1.83	-1.36
Fixed capital				
Including building	.43	.52	- .46	1.70
Excluding building	1.66	1.24	-1.44	3.62
Variable inputs	2.93	1.15	-6.76	12.02
Land acreage total	.60	.15	- .54	.35
Paddy field	.27	.34	- .43	.31
Upland field	1.02	.05	- .67	.39
Productivity per unit of:				
Conventional inputs	1.49	.49	-2.77	3.05
Labor	1.86	.81	-4.54	5.84
Fixed capital				
Including building	1.34	.27	-2.35	2.76
Excluding building	.11	- .44	-1.37	.85
Variable inputs	-1.12	- .45	4.25	-6.71
Land	1.17	.64	-2.27	4.14

Source: Sabura Yamada, "Changes in Output and in Conventional and Nonconventional Inputs in Japanese Agriculture since 1880," <u>Food Research Institute Studies</u>, Vol. 7, No. 3 (1967), pp. 371-413. Calculated from data in Tables 1 and 2.

been so important in fueling Japanese agricultural growth during the last two decades was not available in the interwar period, also has been suggested.[8/] [9/]

The sharp changes in the rate of agricultural output and productivity growth following World War I are clearly reflected in the various indicators of rice production, productivity and price in Table 2. From 1890 to 1920, the area planted in rice and the yield per hectare planted grew respectively by 0.44 and 0.94 percent per year. Total production increased by 1.38 percent per year. In contrast, the growth rates declined to 0.16 for area, 0.24 for yield, and 0.40 for production between 1920 and 1935.

Growth in production and productivity between 1890-1920 was accompanied by an increase in the price of rice from 42 Yen per metric ton in 1890 to 242 Yen in 1920, an annual compound rate of growth of about 6 percent. The internal terms of trade, as measured by the rice price deflated by the general price index, was favorable for agriculture immediately after 1890 and was relatively stable between 1895 and 1915. The fact that the internal terms of trade remained stable without an appreciable increase in rice imports for 1900-1915 indicates a relative balance in the growth of agriculture and industry, in the Ohkawa-Rosovsky sense, during the "big spurt" period of industrialization in Japan from the Russo-Japanese War (1904-1905) to World War I.[10/] Farmers' real income from rice, measured as the total value of rice production at the farm deflated by the general price index, went up rapidly, mainly as a result of growth in physical production.

Table 2.--Area, yield, production, price and seed improvement indexes for rice in Japan, 1890-1935*

Year	Area planted	Yield per unit area	Production	Price	Farm value of production	General price index	Deflated price	Deflated value production	Seed improvement index
	A	Y = Z/A	Z	P=V/Z	V	I	P/I	V/I	S
	(1000 ha.)	(m.ton/ha.)	(1000 m.ton)	(yen/m.ton)	(mil. yen)	(1934-36 =100)	(yen/m.ton)	(mil. yen)	(1890=100)
1890	2717	2.16	5861	42	243	31.7	131	767	100.0
1895	2752	2.05	5651	57	323	35.8	160	902	100.8
1900	2813	2.27	6372	79	501	47.4	166	1057	101.6
1905	2862	2.43	6943	91	633	55.7	164	1136	104.3
1910	2933	2.59	7588	104	790	60.3	173	1310	105.1
1915	3029	2.74	8286	106	882	66.4	160	1328	105.8
1920	3094	2.86	8838	242	2140	131.3	184	1630	106.2
1925	3129	2.78	8700	224	1944	128.3	174	1515	105.8
1930	3203	2.83	9070	143	1297	104.5	137	1241	105.8
1935	3169	2.97	9414	179	1673	101.9	174	1642	107.4
			Annual compound rate of growth (%)						
1890-1920	0.44	0.94	1.38	6.09	7.47	4.95	1.14	2.52	.20
1920-1935	0.16	0.24	0.40	-2.05	-1.65	-1.70	-0.35	0.05	.07

*Five years' averages centering the years shown. Rice in brown (husked but not polished) rice basis.

Source:

A: Ministry of Agriculture and Forestry, Norinsho Ruimentokeinyo (Historical Statistics of Ministry of Agriculture and Forestry), (Tokyo, 1955), p. 24.

Z: Kazushi Ohkawa, et.al. (ed.), Long Term Economic Statistics of Japan (abbreviated as LTES), Vol.9 (Tokyo: Toyokeizaishimposha, 1966), pp. 166-168.

V: LTES, Vol. 9, pp. 146-147.

I: LTES, Vol. 8, 1967, Series 1, Table 1, p. 134.

S: Yujiro Hayami and Saburo Yamada, "Agricultural Productivity at the Beginning of Industrialization," Kazushi Ohkawa, et. al. (ed.), Agriculture and Economic Growth: Japan's Experience, (Tokyo: University of Tokyo Press, 1969), pp. 105-135.

The Japanese economy experienced a sharp inflation during World War I. The wholesale price index in Tokyo more than doubled between 1913 and 1919. Rice prices rose to their highest level relative to the consumer price index in 1913 and to their highest absolute level in 1919.

Stagnation of production and productivity coincided with the decline in the price of rice after 1919. The terms of trade continued to deteriorate and real income from rice to fall. This trend continued to the catastrophe of Nogyo Kyoko (Agricultural Depression) in 1929-32. What were the factors that accounted for such an epochal change - from rapid development until approximately 1920 and the stagnation during the interwar period? Emergence of the stagnation phase can partly be ascribed to an unfavorable shift in the demand for agricultural products, especially such staple foods as rice. Demand for food as well as for other consumers goods declined as a result of the decline in consumer income resulting from the deflation policy Japan adopted in order to return to the gold standard at the pre-war parity. There is also evidence that the income elasticity of demand for rice and staple foods declined as a result of urbanization and of changes in the occupational distribution of the labor force.[11/] Labor's share of income tended to decline.[12/] Such factors should have worked to slow down the shift of the demand schedule to the right. We hypothesize, however, that events of greater magnitude, such as the exhaustion of technological potential or the importation of colonial rice, must be sought to explain changes of the magnitude observed between the two periods.

The process of exploitation and exhaustion of technological potential between the Meiji Restoration and 1920 has been analyzed elsewhere, and will only be summarized briefly here.[13/] The real key to the success of Japanese agricultural growth prior to World War I rests on the nation-wide diffusion of the stock of improved techniques, which had previously been partially blocked by feudal barriers, following the breakdown of feudalism at the time of the Meiji Restoration. Before the Restoration such techniques as high yielding varieties of seeds or better seedling preparation were, though discovered, restricted to small localities due to the lack of communication facilities and the regulations of Han (territory of the feudal lord) and the villages. With the reforms of Meiji, farmers were no longer bound to the land. Moreover, they were free to choose their own crops and methods of farming. Exchange of seeds and technical information between regions was encouraged by the government. The nation-wide diffusion of better techniques brought a rapid rise in yield per hectare -- the fruit of Rono Gijutsu (veteran farmers' technique), which was primarily oriented to achieving increased land productivity, with an adequate supply of fertilizer and the irrigation networks inherited from the feudal Han system.

The diffusion of Rono Gijutsu thus brought about a rise in yield and production, but it caused the exhaustion of the initial backlog of technology in the absence of an adequate flow of new technology. It is true that national and prefectural experiment stations were established before agriculture entered the stagnation phase and that they did have some impact on the supply of new technology. But it would be fair to say that the organized research in experiment stations in those days contributed to the growth of agricultural productivity by exploiting the traditional potential through testing, selecting, and advocating the Rono techniques, rather than by adding new potential.14/

The exploitation and the consequent exhaustion of the technological backlog can best be visualized by the rapid increase in the percentage of area planted in Rono varieties (rice varieties selected by veteran farmers) for 1895-1915 and the saturation in the subsequent period (Fig. 1). The seed improvement index in Table 2 was calculated in an attempt to quantify the influence of diffusion of improved seeds on national average yield. This index is based on the weighted averages of the areas planted in the respective varieties, using as weights the standard yields of various varieties. The standard yields, which are fixed by regions, were based on the reports of comparative yield tests at various experiment stations. The annual growth rate of this index declined drastically from 1890-1920 to 1920-1935, reflecting the saturation in the spread of improved varieties.

The exhaustion of the traditional technological potential and the consequent deceleration of growth in rice yields seem to have coincided with the increase in demand due to the boom of World War I. This forced the rice price to rise to an unprecedented level. The impact of inflation on the price of rice caused serious disruption in urban areas and culminated in the Kome Sodo (Rice Riot) of 1918.

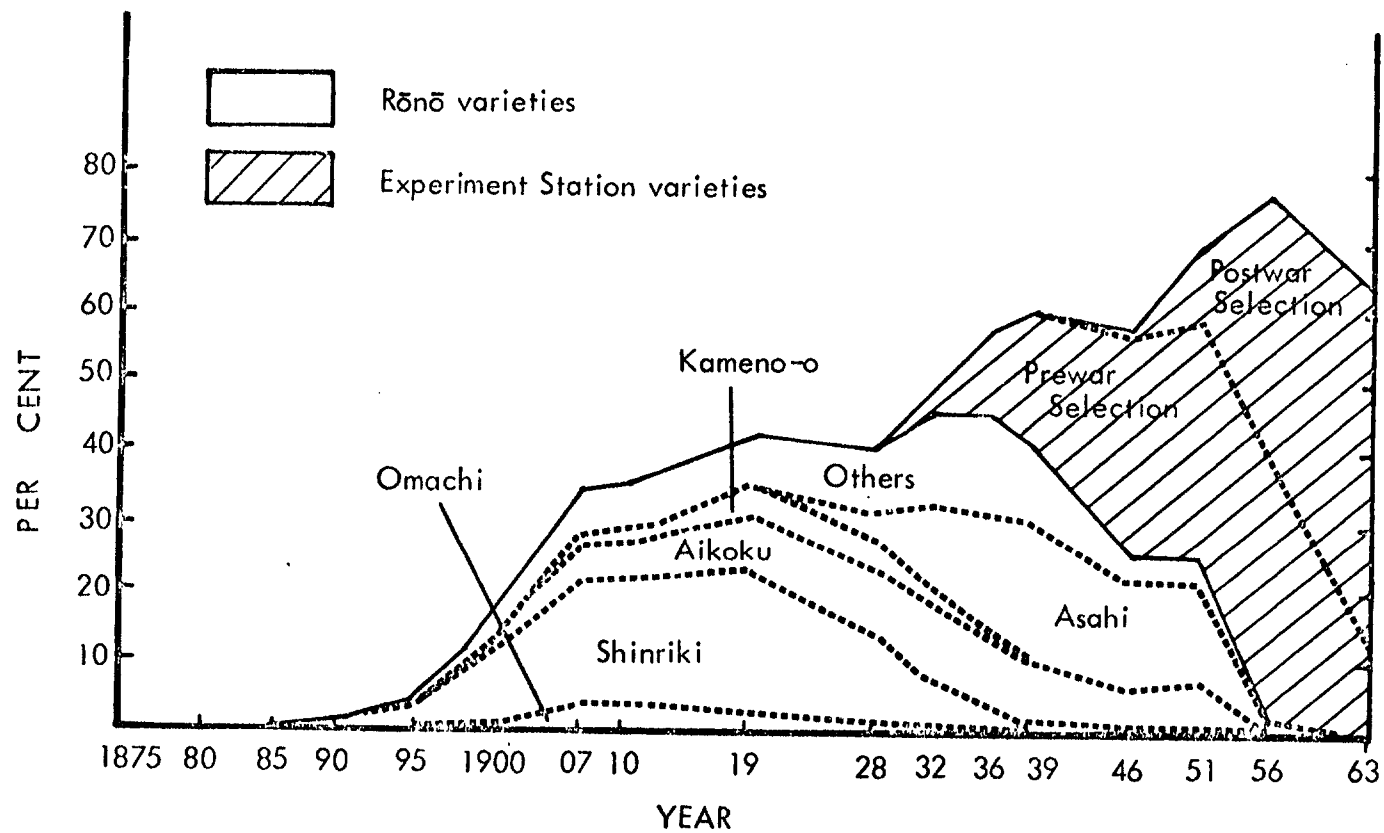

Figure 1. Percentages of area planted of major improved varieties in the total area planted of rice, all perfectures.

Source:

Yujiro Hayami and Saburo Yamada, "Technological Progress of Agriculture," in L. R. Klein and Kazushi Ohkawa (eds.), <u>Economic Growth</u>: <u>The Japanese Experience Since Meiji Era</u>, (Homewood, Illinois : Irwin, 1968), Appendix Table 5A, pp. 159-160.

The reaction of the government to the Rice Riot was to organize programs to import rice from the overseas territories of Korea and Taiwan, in order to create a rice surplus to export to Japan, short-run exploitation policies involved importing sorghum (milo) from Manchuria to Korea, forcing Korean farmers to substitute this lower quality grain for rice in domestic consumption. A similar squeeze was also practiced in Taiwan, forcing Taiwanese farmers to substitute sweet potatoes for rice in their diet. This was enforced by a squeeze on real income through taxation and government monopoly sales of such commodities as liquor, tobacco and salt. The longer-run program was to introduce development programs designed to increase the yield and output of rice in those colonial territories. Under the program titled Sanmai Zoshoku Keikaku (Rice Production Development Program), the Japanese government invested in irrigation and water control and in research and extension in order to develop and diffuse high yielding Japanese rice varieties adapted to the local ecology of Korea and Taiwan.[15/] Success of this effort created the tremendous rice surplus which flooded into the Japanese market. As shown in Table 3, within 20 years from 1915 to 1935 net imports of rice from Korea to Japan rose from 170 to 1,212 thousand metric tons per year, and net imports from Taiwan rose from 113 to 705 thousand metric tons. As the result of the inflow of colonial rice the net import of rice rose from 5 to 20 percent of the domestic production.[16/]

The success of the government program in developing Korea and Taiwan as major suppliers of rice to Japan should have a major impact

Table 3.--Production, import and available supply of rice in Japan, 1890-1935*

Year	Supply $Q = Z + K$	Production Z	Net Import: Total K	Net Import: Korea K_k	Net Import: Taiwan K_f	Production	Net Import: Total $k = K/Z$	Net Import: Korea $k_k = K_k/Z$	Net Import: Taiwan $k_f = K_f/Z$
	(1000 m. tons)					(percent)			
1890	5813	5861	-48			100	-0.8		
1895	5700	5651	49			100	0.9		
1900	6578	6372	206			100	3.2		
1905	7539	6943	596			100	8.6		
1910	7923	7588	335			100	4.4		
1915	8692	8286	406	170	113	100	4.9	2.1	1.4
1920	9720	8838	882	360	132	100	10.0	4.1	1.5
1925	10043	8700	1343	640	278	100	15.4	7.3	3.2
1930	10483	9070	1413	974	389	100	15.6	10.7	4.3
1935	11290	9414	1876	1212	705	100	19.9	12.9	7.5

* Five years' averages centering the years shown. Rice in brown (husked but not polished) rice basis.

Source:

Z: Kazushi Ohkawa, et. al. (ed.), Long Term Economic Statistics of Japan, (LTES), Vol. 9, (Tokyo: Toyokeizaishimposha, 1966), pp. 166-168.

k: LTES, Vol. 6, 1967, pp. 150-152.

k_k & K_f: Bureau of Statistics, Office of the Prime Minister, Japan Statistical Yearbook, (Tokyo, 1949), pp. 630-631.

on rice prices and production in Japan. Such large scale imports of rice, a commodity characterized by a relatively inelastic demand schedule, could be expected to lower the price and discourage the production of rice in Japan. A deterioration in the price and in the terms of trade for rice during this period would appear to be a logical consequence of the policies designed to increase imports from Korea and Taiwan.

Both the motivation and consequence of the colonial rice development program are illustrated in Figure 2 which compares the trends of rice production and yield per hectare in Japan, Taiwan and Korea.[17] Both production and yield per hectare in Korea and Taiwan began to take off in the 1920's when the growth decelerated in Japan. This seems to reflect the process we have discussed so far: (a) The Japanese government launched the colonial rice development program when pressed by the food problem arising from the exhaustion of technological potential in Japanese agriculture and rising food demand from a growing nonagricultural population, (b) The success of the program in raising rice production and productivity in the two colonies permitted large scale imports of rice from these territories, which in turn depressed the price and further discouraged the production of rice in Japan.

The data reviewed in this section appears to support the hypothesis that (a) the slow-down of technological progress, reflected in the slower rise in the seed improvement index, and (b) the

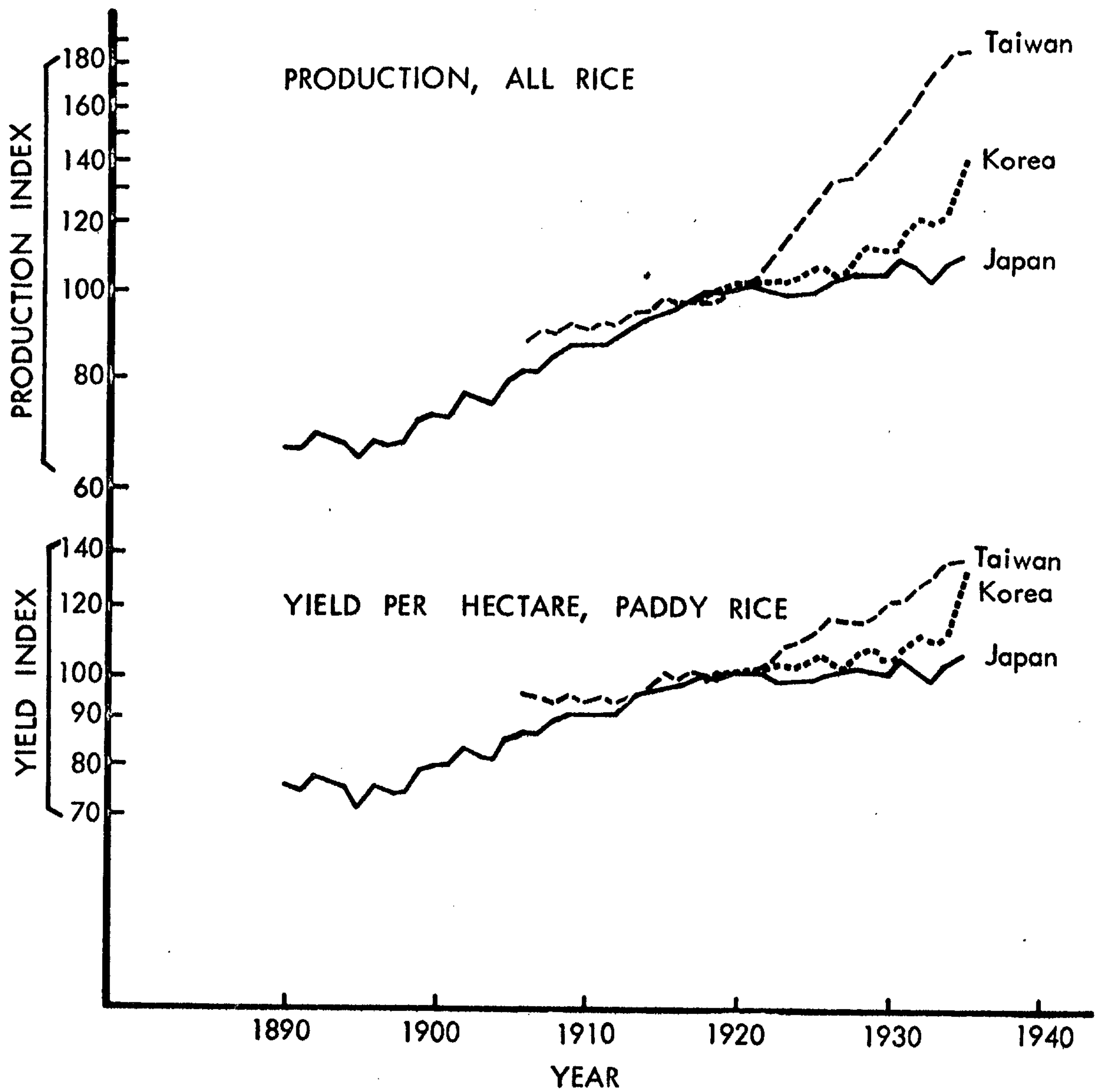

Figure 2. Indices of total production and yield per hectare of rice, Japan, Korea and Taiwan, five years moving averages, 1917-22 = 100.

Source:

Japan -- LTES vol. 9, pp. 166-167; Norimsho Ruinen Tokeihyo (Historical Statistics of Ministry of Agriculture and Forestry), (Tokyo, 1945), p.24.

Korea -- Chosen Sotokutu Tokeihyo (Statistical Yearbook of Government General Korea), 1925 issue (p. 94), 1930 issue (p. 92).

Taiwan -- JCRR, Taiwan Agricultural Statistics, (Taipei, 1966), pp. 23-27.

increase in imports of rice from Korea and Taiwan were the two major factors underlying the epochal turn in the growth trend of rice production in Japan following World War I.[18] In the next section we attempt to assess the quantitative significance of these two factors.

II. Quantitative Analysis

In order to assess the relative influences of the two major causes identified in the last section on the epochal turn in the Japanese rice economy, we present two hypothetical or "counter-factual" calculations to illustrate how production and price would have changed after 1920. In Case 1 we assume that the ratio of net imports of rice to domestic production remained the same as in 1913-17. In Case 2 we assume, in addition to the assumption of a constant import ratio, that the seed improvement index continued to grow at the 1890-1920 rate.

Model

The basic model for such calculations is the equilibrium of demand and supply. We will use the notation for the actual values of variables as specified in Tables 2 and 3; and identify the hypothetical values with a prime (').

Since the actual total supply of rice, Q, can be considered idential to total demand, the equilibrium of demand and supply can be written as:

(1) $$Q = (1 + k) Z$$

where Q is total consumption, Z is domestic production, and k is the ratio of net import (and inventory change) to production. We assume that the above equilibrium relation holds at some actual price, P, and that an equilibrium level of consumption, imports, and production could be specified at some hypothetical price P' as:

$$Q' = (1 + k')\, Z' \tag{2}$$

If we assume a typical constant elasticity demand function as:

$$Q = Q_0\, P^{\eta} \tag{3}$$

where income and other demand shifters are included in Q_0, the relation between Q and Q' is:

$$Q' = Q\left(\frac{P'}{P}\right)^{\eta} \tag{4}$$

where n is the price elasticity of demand for rice.

If we assume a constant elasticity supply function as:

$$Z = Z_0\, P^{\gamma}\, S^{\delta} \tag{5}$$

where supply shifters other than S are included in Z_0, the relation between Z and Z' is:

$$Z' = Z\left(\frac{P'}{P}\right)^{\gamma}\left(\frac{S'}{S}\right)^{\delta} \tag{6}$$

where γ is the price elasticity of supply, S is the seed improvement index, and δ the elasticity of supply with respect to the seed improvement index. Since the following identity holds,

$$Z = A\, Y, \tag{7}$$

where A is the area planted in (hectares) and Y is the yield per hectare (in metric tons). If we assume an area response function as:

$$(8) \qquad A = A_0 \, P^{\alpha}$$

and a yield response function as:

$$(9) \qquad Y = Y_0 \, P^{\beta} \, S^{\delta}$$

where α and β are respectively the elasticities of area response and yield response ($\gamma = \alpha + \beta$ and $Z_0 = A_0 \, Y_0$), the relations between A A' and Y and Y' are:

$$(10) \qquad A' = A\left(\frac{P'}{P}\right)^{\alpha}$$

$$(11) \qquad Y' = Y\left(\frac{P'}{P}\right)^{\beta}\left(\frac{S'}{S}\right)^{\delta}$$

Replacing Equations (4) and (6) for Q and Z in Equation (2) we have:

$$(12) \qquad Q\left(\frac{P'}{P}\right)^{\eta} = (1 + k') \quad Z\left(\frac{P'}{P}\right)^{\gamma}\left(\frac{S'}{S}\right)^{\delta}$$

From Equations (1) and (12) we obtain the formula used to calculate the equilibrium price of rice in Japan under the hypothesized conditions:

$$(13) \qquad P' = P\left(\frac{1 + k'}{1 + k}\right)^{\frac{1}{\eta-\gamma}}\left(\frac{S'}{S}\right)^{\frac{\delta}{\eta-\gamma}}$$

The hypothetical area, yield and production can be calculated with P' by Equations (10), (11), and (7), respectively.

Estimation of Parameters

The problem is now to obtain empirical estimates of five parameters: elasticity of area response to price (α); elasticity of yield response to price (β); elasticity of supply with respect to price (γ); the elasticity of supply with respect to the seed improvement index (δ); and the price elasticity of demand for rice (η).

The estimate of the price elasticity of demand (η) is available from Ohkawa's classical study on the food economy of prewar Japan.[19/] His estimates of the price elasticity of demand for rice were based on household survey data of 1931/32 - 1938/39 for the urban population, and on 1920-38 market data for the rural population. Those estimates differ for different occupational, regional and income groups, but cluster around the mode - 0.2. We will adopt - 0.2 as the elasticity of demand with respect to price (η), since this figure is also consistent with the various estimates of income elasticity of demand for rice.

The supply parameters represent our own estimates. Apparently no study of supply response of rice has been conducted in Japan. We chose to estimate area response and yield response separately and to obtain aggregate supply elasticity by adding the area and yield elasticities. An important consideration in making this approach is the difference in the time lag required to make adjustments in response to price changes between the area and yield responses. The yield response is essentially a short-run phenomena, depending primarily on the time it takes to adjust various inputs, such as fertilizer, to a change in price. Area response involves a long-run adjustment period. In Japan, area planted in upland rice is negligible (less than 5 percent of the total area planted in rice) and no competitive crop exists for rice on paddy land during the summer crop season. Therefore, the area planted in rice is almost completely determined by the available paddy field area. It requires substantial investment to expand the paddy field area (for example, by shifting upland crop fields to paddy fields), because such a change in land use must be accompanied by an extention of the irrigation system. Because of the large capital involved in paddy field development, the short-run response in the area planted to rice to a change in price is limited. The longer-run response may, however, be substantial. Because of the significance of lags on the response of area to price we employ a distributed lag model of the Koyck-Nerlove type for the analysis of area response. The basic model used is:

(14) $$a_t^* = \alpha_0 + \alpha P_{t-1} + \alpha_c P_c (t - 1)$$

and

(15) $$a_t - a_{t-1} = \lambda (a_t^* - a_{t-1})$$

where a_t, p_t and p_{ct} are the logarithmic transformations of area planted in rice, rice price and the price of competitive crops, respectively. a_t^* is the long-run equilibrium area (in logarithm) for certain levels of p_t and p_{ct}. Equations (10) and (11) reduce to:

$$(16) \qquad a_t = \lambda\alpha_0 + \lambda\alpha p_{t-1} + \lambda\alpha_c\, p_c\,(t-1) + (1-\lambda)\, a_{t-1}$$

which we will use for regression analysis.[20] The prices of rice employed in the models estimated were deflated by the general price index which, to some extent, reflects the changes in the cost of opening new paddy fields. An important variable lacking from our model is public investment in riparian and irrigation works. It is assumed that such government investment is induced in the long-run by price trends and, in that sense, is incorporated into our distributed lag models.[21]

The yield response model is specified as:

$$(17) \qquad y_t = \beta_0 + \beta p_t + \delta s_t$$

where y_t, p_t and s_t are the logarithmic transformations of rice yield per hectare, rice price, and the seed improvement index, respectively. For purposes of estimation we deflated the rice price by the fertilizer price index in order to reflect the changes in the price of the major current input item.

The results obtained from estimating Equations (16) and (17) by least squares are summarized in Table 4. In area response the coefficients of the price of competitive products were nonsignificant, and the estimation was repeated after dropping that variable. The estimates of the response of rice area with respect to the price of

Table 4.--Least squares estimates of area and yield response of rice production to price based on 1890-1937 annual time series data

Regression number	Equations estimated	Coeff. of determination (adjusted)	Standard error of estimate (adjusted)	Durbin-Watson statistics	Long-run price elasticity: Infinite time adjustment a/	Long-run price elasticity: Ten years adjustment b/
	Area response					
A - 1	$a_t = 0.0529 + \underset{(0.0069)}{0.0083}\, p_{1(t-1)} + \underset{(0.0107)}{0.0034}\, p_{c(t-1)} + \underset{(0.0223)}{0.9833}\, a_{t-1}$	0.9872	0.00654	2.35	0.497	0.071
A - 2	$a_t = 0.0691 + \underset{(0.0058)}{0.0092}\, p_{1(t-1)} + \underset{(0.0163)}{0.9785}\, a_{t-1}$	0.9874	0.00641	2.34	0.428	0.077
A - 3	$a_t = 0.0719 + \underset{(0.0076)}{0.0138}\, p_{2(t-1)} + \underset{(0.0101)}{0.0026}\, p_{c(t-1)} + \underset{(0.0219)}{0.9787}\, a_{t-1}$	0.9876	0.00643	2.39	0.648	0.113
A - 4	$a_t = 0.0848 + \underset{(0.0070)}{0.0150}\, p_{2(t-1)} + \underset{(0.0162)}{0.9749}\, a_{t-1}$	0.9878	0.00273	2.39	0.598	0.122
	Yield response					
Y - 1	$Y_t = -6.6713 + \underset{(0.0626)}{0.1287}\, p_{3t} + \underset{(1.1903)}{2.8219}\, s_t$	0.6356	0.08731	2.28		
Y - 2	$Y_t = -8.0034 + \underset{(0.0395)}{0.0673}\, p_{4t} + \underset{(0.8052)}{4.2887}\, s_t$	0.7490	0.03112	2.18		
Y - 3	$Y_t = -6.6695 + \underset{(0.0615)}{0.0911}\, p_{5t} + \underset{(1.1405)}{3.5058}\, s_t$	0.6199	0.03872	2.32		
Y - 4	$Y_t = -14.6023 + \underset{(0.0606)}{0.0831}\, p_{6t} + \underset{(1.1672)}{3.6244}\, s_t$	0.6173	0.08346	2.34		

(continued)

Footnotes - Table 4.

* Variables are a_t - log A_t: area planted in rice (1000 ha.); Y_t — log Y_t : rice yield per hectare planted (m. ton); p_1 — log (P/I): unit farm price of rice deflated by general price index (yen per m. ton); p_2 — log of calendar year average of wholesale price of rice deflated by general price index (yen per m. ton); p_3 — log of unit farm price of rice of previous year deflated by fertilizer price index of current year (yen per m. ton); p_4 — log of calendar year average of wholesale price of rice of previous year deflated by fertilizer price index of current year (yen per m. ton); p_5 — log of rice year (November of previous year to October of current year) average of rice deflated by fertilizer price index of current year (yen per m. ton); p_6 — log of January - July average of wholesale price of rice deflated by fertilizer price index of current year (yen per m. ton); p_c — log of price index of farm products except rice deflated by general price index; s — log of S: seed improvement index.

Sources of data are in Table 1 except —

Wholesale prices of rice (Monthly prices at Fukagawa Rice Market in Tokyo): Nobufumi Kayo (ed.), Nihon Nogyo Kiso Tokei (Basic Statistics of Japanese Agriculture), (Tokyo, Norin - Suisangyo Seisansei Kōjo Kaigi, 1958), p. 514.

Fertilizer price index: Kazushi Ohkawa, et. al. (ed.), Long Term Economic Statistics of Japan, (LTES), Vol. 9 (Tokyo: Toyokeizaishimposha, 1966), pp. 192-193.

Price index of farm products except rice: Price indexes by major commodity groups in LTES, Vol. 8, 1967, pp. 168-170, aggregated with 1934-36 value weights in LTES, Vol. 8, p. 78.

a. (Coefficient of p_{t-1}) $\div$ (coefficient of a_{t-1})

b. (Coefficient of p_{t-1}) $\times$ [1 - (coefficient of $a_{t-1})^9$]

$\div$ (coefficient of a_{t-1})

rice are significant at or near the 5-percent level. The magnitudes of the price coefficients are small and the coefficients of the lagged independent variable are close to one, indicating that the short-run response to price in area planted in rice is very small; but the long-run response is relatively large. This was the expected result considering the long time required to adjust the paddy field area. The long-run elasticity, allowing infinite time adjustment, is in the order of 0.4-0.6. Such estimates are not incompatible with the results of estimation of area response elasticity in other Asian countries.[22/]

The price coefficients in the yield response regressions are positive and significant at or near the 5 percent level. The seed improvement index variable is also highly significant. The price coefficients, especially in case of (Y - 1), is very consistent with the results obtained in a study of fertilizer demand obtained in an earlier study by Hayami.[23/] In that study, the estimates of the elasticity of demand for fertilizer with respect to the price of fertilizer relative to the price of farm products center around 1.5 and the estimates of the elasticity of rice production of fertilizer center around 0.15. Considering the ratio of rice production to total agricultural production in value terms is about 0.55, those estimates imply that the price elasticity of rice yield response to rice price is around 0.12 (=1.5 x 0.15 x 0.55), which is compatible with the results of direct estimation in Table 3.

From the results of the estimation of the yield response relation we decided to adopt a yield response elasticity (β) of 0.1 and a seed improvement elasticity (δ) of 3.0. The problem of deciding on an appropriate area response parameter (α) from the results of estimation of the distributed lag area response model is more difficult. The model provides us with a short-run elasticity (allowing one year adjustment period) and long-run elasticity (allowing infinite adjustment period), neither of which is adequate for our purpose. The span of time we are concerned with is the 20 years from 1915 to 1935. We chose ten years as the average adjustment period, and selected to use an area response elasticity (α) of 0.1, based on the range of results shown in the last column of Table 3. It should be recognized that this is a convention adopted for computation ease. It has some intuitive appeal but little theoretical justification.

The results of applying the specified parameters to the previous model are summarized in Table 5.

Table 5.--Actual and hypothetical paths of growth of area, yield, production and price of rice in Japan, 1920-1935*

Year	Area planted	Yield per unit area	Production	Price	Farm value of production	Price deflated by general price index	Value production deflated by general price index
	A	Y	Z	P	V	P/I	V/I
	(1000 ha.)	(m. ton/ha.)	(1000 m. ton)	(yen/m. ton)	(mil. yen)	(yen/m. ton)	(mil. yen)
			- Actual -				
1920	3094	2.86	8838	242	2140	184	1630
1925	3129	2.78	8700	224	1944	174	1515
1930	3203	2.83	9070	143	1297	137	1241
1935	3169	2.97	9414	179	1673	174	1642
			- Hypothetical, Case 1 -				
1920	3116	2.87	8954	257	2307	196	1757
1925	3204	2.85	9126	284	2587	221	2016
1930	3280	2.90	9514	181	1726	173	1652
1935	3277	3.07	10064	250	2496	244	2450
			- Hypothetical, Case 2 -				
1920	3116	2.87	8954	257	2307	196	1757
1925	3170	3.02	9335	254	2366	197	1844
1930	3219	3.10	9886	150	1480	143	1416
1935	3223	3.23	10402	212	2195	207	2164
			- Annual compound rate of growth from 1920 to 1935 (%) -				
Actual	0.16	0.24	0.40	-2.05	-1.85	-0.35	0.05
Case 1	0.34	0.44	0.78	-0.18	0.51	1.88	2.21
Case 2	0.21	0.79	1.00	-1.30	-0.30	0.40	1.40

* Five years' averages centering the years shown. Rice in brown (husked but not polished) rice basis.

Case 1: Assumes the net import of rice stayed at the 1913-17 level relative to domestic production.

Case 2: Assumes, in addition to the assumption of Case 1, the seed improvement index continued to grow at the 1880-1920 rate.

III. Findings and Implications

The results in Table 5 are plotted in Figures 3 and 4 in order to make comparisons between actual and hypothetical growth paths of Japanese rice economy.

Figure 3 shows that the decline in the rate of growth in the seed improvement index and the increase in the imports of colonial rice explains most of the decline in the rate of growth in rice yield and production during the interwar period. The rates of growth in hypothetical yield and production declined slightly from 1890-1920 to 1920-1935, but it is unlikely that anything resembling the "epochal" change in the rate of growth of actual rice production would have occurred if imports had been held at the 1913-17 level relative to production, and the seed improvement index had continued to rise at the 1890-1920 rate (Case 2). The slight decline in the growth rates even in Case 2 could be accounted for by the structural changes affecting the demand for rice mentioned in Section I. Neither is it necessary to invoke underestimation in rice production statistics in the earlier period, as claimed by Nakamura, nor to invoke failure of industrial capacity to produce inputs, as suggested by Rosovsky, to explain the decline in the rate of growth in rice production during the interwar period. It is also clear that imports of rice from the colonial areas (Case 1) is not, by itself, an adequate explanation for the decline in the rate of growth of rice production in the interwar period. The "technology gap" between the exploitation of the yield gains from the diffusion of the superior varieties of farmers'

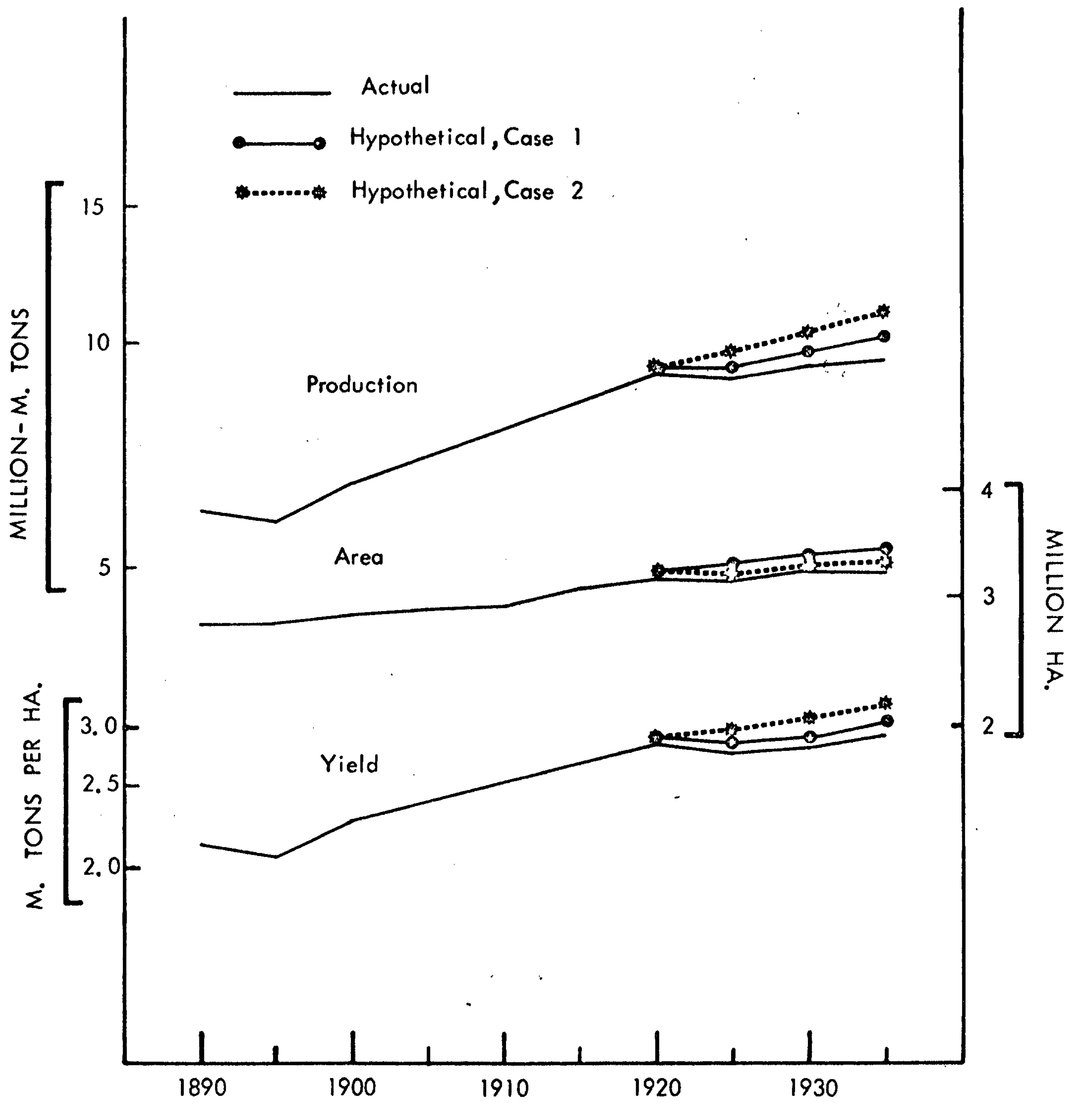

Figure 3. Area, yield and production of rice in Japan, 1890-1935

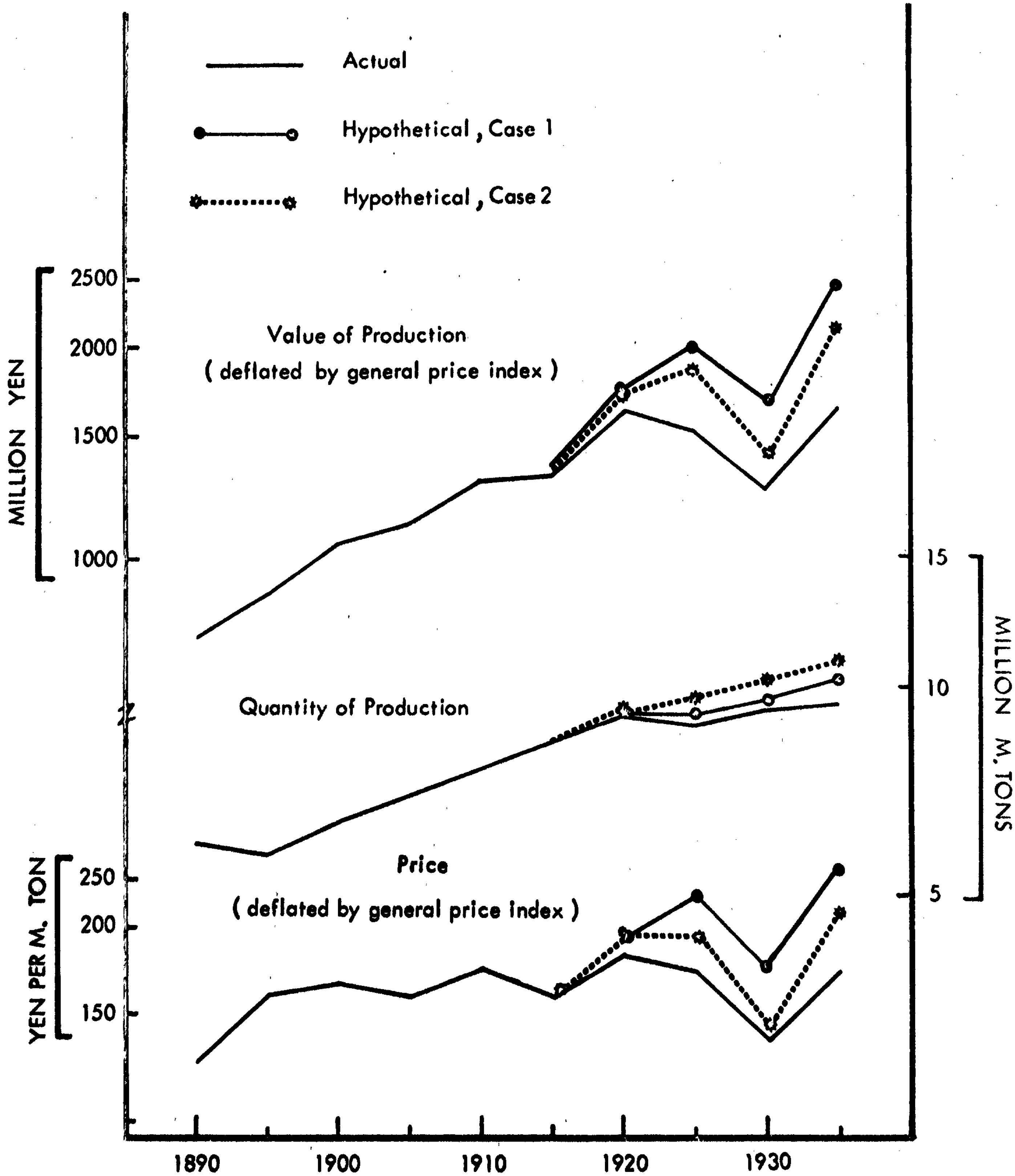

Figure 4. Production of rice in Japan, 1890-1935.

selections and the introduction of the new experiment station varieties also exerted a significant impact on dampening the rate of growth of rice production in Japan during the interwar period.

The influence of the rice imports did exert a sizable impact on rice prices and on the incomes of rice producers in Japan. Under the assumption of Case 1 production went up less rapidly than during 1890-1920, while the internal terms of trade for rice improved and the real income of farmers from rice rose after 1920 as rapidly as before 1920. Even in Case 2, where imports are held at the 1913-17 ratio and yield technology represented by seed improvement is assumed to continue at the earlier rate, the terms of trade improved gradually, except during the depression, and the real incomes of rice producers rose significantly over the period 1920-1935 in contrast to almost no change under the condition that actually prevailed.

In an economy which is closed, in the sense that there is no international trade, and in which there is no technological progress and no capital accumulation in agriculture, industrialization and economic growth will eventually lead to a point that the terms of trade deteriorate for industry and the supply price of labor from agriculture to industry will rise in terms of industrial products - - the "shortage point" of Ranis and Fei.[24/] Japan was able to prolong the arrival of this point by exploiting the technological potential in the traditional peasant agriculture until World War I. Industrial development was supported by the very elastic supply of labor from agriculture.[25/] Colonial policy seems to have been designed to postpone the arrival of the "shortage point" further and to make the progress of industrialization easier by expanding the supply of rice in the domestic market through imports from the colonies. Success of this policy kept the industrial wage low and the competitive position of industrial products strong in the international market. If the same amount of rice were supplied from foreign countries, precious foreign exchange would have been drained significantly and the import of capital goods should have been curtailed.

This success was a mixed blessing for Japan. It depressed the price and the income of farmers and contributed to serious social disorders in the agricultural sector. The so-called military reformists made this social uneasiness and disorder among farmers the springboard for the invasion of Manchuria in 1931 and the other military adventures which followed. The policy decision concerning the rice supply after the Rice Riot in 1918 had thus not only economic but vast social and political implications.[26/]

Why did the economic effects of colonial development policy fail, in Japan, to produce the "classical" results associated with the importation of cheap grain into England from colonial areas and other areas of new settlement in the 19th Century? The answer seems, at least in part, to be associated with the different structure of agriculture and the different pattern of industrial development in the two countries when the policies of dependence on overseas sources of food supply was initiated.

The inflow of cheap grain to England following the repeal of the Corn Laws in 1846 was accompanied by the continuing absorption of labor into the industrial sector and a transformation of the agricultural sector away from grain production and toward a more extensive system of livestock agriculture.[27/] The transformation was facilitated by rising incomes in the industrial sector which stimulated the demand for the products of an animal agriculture.[28/]

A number of obstacles impeded Japan to achieve a similar agricultural transformation in response to rising imports and declining prices of grain during the interwar period. Japanese agriculture was rigidly locked into a sophisticated labor intensive system of crop production, highly dependent on irrigation and fertilizer as leading inputs.[29/] There was not a fully adequate basis, in either agricultural research or industrial infrastructure, to make a rapid transformation from grain production to a more diversified agricultural system. More critical was that the rise in imports of grain was not accompanied, in Japan, by rapid growth in the demand for labor by the industrial sector. The demand for labor in the industrial sector slackened after 1920 as a results of (a) contraction of world demand for the products of Japanese industry after World War I, (b) contraction of domestic demand due to the deflation policy adopted to permit a return to the gold standard at a prewar parity, (c) the adoption of an industrial rationalization policy in an attempt to stay competitive in world markets. This policy placed major emphasis on attempts to increase productivity and to save labor through more capital intensive methods of production.[30/] Finally, income levels in the urban industrial sector of the Japanese economy remained too low to create a large increase in the demand for the products of a more diversified agriculture.

The conditions which lead to agricultural stagnation in Japan during the interwar period have been reversed since World War II. The application of modern biological science, particularly post-Mendelian genetics, in agricultural research has sharply raised agricultural productivity potentials. New technological potential, accumulated gradually under the Assigned Experiment System (initiated in 1926), began to exert a major impact on agricultural production in the post World War II period. Japan emerged from World War II with an adequate industrial infrastructure to provide the fertilizer and other agricultural chemicals needed for a modern labor intensive biochemical agricultural technology. Since World War II this has been complemented by the capacity of the engineering and machinery industries to introduce an efficient small scale mechanical technology suited to the factor proportions of Japanese agriculture. Incentives for rapid realization of the new agricultural potential have been reinforced by high price supports for agricultural commodities, particularly rice, and by modifications in the tenure system, which strengthen the impact of the price incentives on farm management decisions.

By the mid 1960's evidence was emerging to support an argument that the shift in direction of agricultural policy may represent an over-compensation for the errors of the interwar period. The high price support for rice, at more than double the world price, and the subsidies for paddy development are resulting in surplus production at a time when the prices of rice, and other food grains, in the world market are declining. The restrictions on growth of farm size under the land reform legislation have been discouraging the introduction of labor saving mechanical technology at a time when labor shortages are beginning to emerge as a permanent feature of the Japanese economy. It is too early to be overly confident of the long-run effect of these policies on Japanese agricultural development. The unique success of Japanese agricultural development over the long run, has been due to the effective response of Japanese agricultural scientists, the agricultural supply industries, and farm operators to price relationships which have accurately reflected the resource endowments and factor proportions of the Japanese economy.[31/] It appears the present policies are inducing a significant malallocation of national resources. Today Japan should learn from the experience of free trade and agricultural transformation of the 19th Century England.

The policies associated with the Japanese agricultural stagnation during the interwar period are also of significance for development policy in many of the less developed economies of South and Southeast Asia. These nations are attempting to utilize the new agricultural production potentials associated with the "Green Revolution" as a basis for sustained economic growth.[32/] The problem of converting current or potential food surpluses into a basis for sustained economic growth poses an extremely difficult problem for most countries of South and Southeast Asia during the next decade. The continuing decline of export opportunities and prices sharply reduces the opportunity to use surplus production to earn the foreign exchange needed to finance domestic development. Furthermore, the relatively large share of the population engaged in agricultural production and the slow (absolute) growth in non-farm employment opportunities limits the economic gains that can be realized by using the surpluses primarily to support employment in the urban-industrial sectors, unless the transfer of surpluses is also accompanied by lower food prices.

Thus, if Japan and other developed countries do not adopt less protectionist policies with respect to their domestic agriculture, the economies of Southeast Asia are likely to face difficulties during the 1970's similar to those faced by the Japanese economy during the interwar period. The main difference is that the downward pressure on rice prices in these countries will come from increased supplies generated from internal rather than colonial sources. The problems (a) of maintaining sufficient equity in income distributions both within the rural economy and between the rural and urban sectors and (b) of generating sufficient internal demand to absorb the productive capacity of an expanding urban sector while simultaneously using lower rice prices as a device for transferring the gains of agricultural productivity into capital formation and economic growth in the urban-industrial sector will require extreme skill. It may also generate more social tension than the political structures of many South and Southeast Asian economies seem able to absorb.

Notes

1/ The status of economic thought on imperialism, including the impact of colonial policy on the metropolitan economies, is particularly unsatisfactory. For two recent reviews see Hans Neisser, "Economic Imperialism Reconsidered," Social Research, Vol. 27, No. 1 (Spring 1960), pp. 63-82; Mark Blaug, "Economic Imperialism Revisisted," Yale Review, Vol. 50 (Spring 1961), pp. 335-349.

For a classical statement on the contribution of colonies to the economic development of the metropolitan economies see Friedrich List, The National System of Political Economy (London: Longman Greer, 1885), pp. 268-270 (reprinted by Augustus M. Kelley, New York, 1966). According to List, "The highest means of development of the manufacturing power, of the internal and external commerce proceeding from it...are colonies" (p. 269). This is essentially the view held by Marx and elaborated by his followers. See M. M. Bober, Karl Marx's Interpretation of History (Cambridge: Harvard University Press, 1940), pp. 226-231.

Joan Robinson has recently ennunciated a post-imperialist view "... the misery of being exploited by capitalists is nothing compared to the misery of not being exploited at all." Economic Philosophy (New York: Doubleday (Anchor)), p. 45.

2/ The English language literature on Japanese colonial policy in Korea is less complete than for Taiwan. The impact of colonial development policies in both Taiwan and Korea has been reviewed by J. I. Nakamura, "Incentives, Productivity Gap, and Agricultural Development in Japan, Taiwan and Korea," (Columbia University, mimeo, 1969).

For two recent evaluations of Japanese colonial policy in Taiwan see Samuel Pao-San No, "Agricultural Transformation Under Colonialism: The Case of Taiwan," Journal of Economic History, Vol. 28, No. 3 (Sept. 1968), pp. 315-340, and Han-Yu Chang and R. H. Myers, "Japanese Colonial Development Policy: A Case of Bureaucratic Entrepreneurship," Journal of Asian Studies (August 1963). The Japanese language literature is extensive. The two classical works which have special relevance to the present study are: Shigeto Kawano, Taiwan Beikoku Keizairon (A Treatise of Rice Economy in Taiwan) (Tokyo: Yuhikaku, 1941), and Seiichi Tobata and Kazushi Ohkawa, Chosen Beikoku Keizairon (A Treatise of Rice Economy in Korea) (Tokyo: Nihongakujutsu Shinkokai, 1935).

3/ Kazushi Ohkawa, et al. (eds.), The Long-Term Economic Statistics of Japan since 1868 (Tokyo: Toyokeizaishimposha, 1965), 12 volumes, forthcoming.

4/ J. I. Nakamura, Agriculture and Economic Development of Japan: 1873-1922 (Princeton: Princeton University Press, 1966). The

questions regarding the official statistics raised by Nakamura have been widely discussed by Japanese and other scholars: Yujiro Hayami, "On the Growth of Japanese Agriculture: A Review Article," Rural Economic Problems, Vol. 4, No. 2 (May 1968), pp. 79-88; Yujiro Hayami and Saburo Yamada, "Agricultural Productivity at the Beginning of Industrialization," Kazushi Ohkawa, B. F. Johnston and Hiromitsu Kaneda (eds.), Growth: Japan's Experience (Tokyo: University of Tokyo Press, 1969), pp. 105-135; J. I. Nakamura, "The Nakamura Versus the LTES Estimates of Growth Rate of Agricultural Production," Keisai Kenkyu, Vol. 19 (October 1968), pp. 358-362.
Appraisals by other scholars include: Henry Rosovsky, "Rumbles in the Ricefields: Professor Nakamura vs. the Official Statistics," Journal of Asian Studies, Vol. 27 (Feb. 1968), pp. 347-360, and Colin Clark's review on the Nakamura's book in the September 1967 issue of Journal of Agricultural Economics.

5/ Yujiro Hayami and Saburo Yamada, "Agricultural Productivity at the Beginning of Industrialization," op. cit.; Saburo Yamada, "Changes in Output and in Conventional and Nonconventional Inputs in Japanese Agriculture Since 1880," Food Research Institute Studies, Vol. 7, No. 3 (1967), pp. 370-413; Bruce F. Johnston, "Agricultural Development and Economic Transformation: A Comparative Study of Japanese Experience," Food Research Institute Studies, Vol. 3, No. 6 (1966), pp.223-76.

6/ For example, B. F. Johnston, "Agricultural Productivity and Economic Development in Japan," Journal of Political Economy, Vol. 59 (Dec. 1951), pp. 498-513 and Kazushi Ohkawa and Henry Rosovsky, "The Role of Agriculture in Modern Japanese Economic Development," Economic Development and Cultural Change, Vol. 9 (Oct. 1960), pp. 43-68.

7/ "The years after 1920 were difficult years for Japanese agriculture. Cheap rice began to be imported from Korea and Taiwan, where rice cultivation had been encouraged by the Japanese government following the food shortage of World War I and the Rice Riots that resulted in 1918." Shujiro Sawada, "Innovation in Japanese Agriculture, 1880-1935," in W. W. Lockwood (ed.), The State and Economic Enterprise in Japan (Princeton: Princeton University Press, 1965), p. 334. See also Ohkawa and Rosovsky, op. cit.

8/ R. E. Evenson, J. P. Houck, Jr., and V. W. Ruttan, "Technical Change and Agricultural Trade: Three Examples (Sugarcane, Bananas, and Rice," paper presented at National Bureau of Economic Research Conference on Technical Change and International Trade, New York, November 1968 (St. Paul: University of Minnesota AE Staff Paper P68-4, mimeo, 1969).

9/ The Ohkawa - Rosovsky development model asserts that during the beginning of modernization the development of the modern economy depends on accelerated growth of the traditional economy, and that during later stages the transformation of the traditional sector depends upon the ability of the modern sector to support the rationalization of the traditional sectors. They attribute the lag in the agricultural sector during the interwar period to failure of the modern industrial sector to produce the capital and current inputs needed for the transformation of Japanese agriculture during the interwar period. Kazushi Ohkawa and Henry Rosovsky, "A Century of Japanese Economic Growth," in W. W. Lockwood (ed.), op. cit., pp. 68-83. In correspondence with the authors, Rosovsky places major importance on the limited development of a mechanical technology suited to the needs of agriculture. The authors of the present article place greater emphasis on the lag in the transition from the traditional biological technology of the Meiji era to modern bio-chemical technology.

10/ Ohkawa and Rosovsky, op. cit., 1960.

11/ See the summary by Hirofumi Kaneda, "Long-term Changes in Food Consumption Patterns in Japan, 1878-1964," Ohkawa, Johnston and Kaneda (eds.), op. cit., 1969. Paper presented at Agriculture and Economic Development: A Symposium of Japan's Experience, July 1967 (Tokyo: University of Tokyo Press, 1969), forthcoming.

12/ See Table 4, p. 79 and Table 7, p. 85, in Mataji Umemura, Chingin Koyo Nogyo (Wage, Employment and Agriculture) (Tokyo: Taimindo, 1961).

13/ Yujiro Hayami and Saburo Yamada, "Technological Progress in Agriculture," in L. R. Klein and Kazuski Ohkawa (eds.), Economic Growth: The Japanese Experience since the Meiji Period (Homewood, Ill.: Irwin, 1968), pp. 135-161.

14/ The major improved varieties which achieved nation-wide diffusion prior to 1930 were almost all selected by veteran farmers. For example, the Shinriki variety, which made by far the largest contribution to the growth in yield during the Meiji Period, was selected in 1877 by Jujiro Maruo, a farmer in the Hyogo Prefecture, (the variety was called Shinriki, meaning the power of God, by the farmers, who were surprised at the high yield of the variety). The Kamenoo variety, which contributed greatly to increasing and stabilizing the yield in Northern Japan, was selected in 1897 by Kameji Abe, a farmer in the Yamagata prefecture. Organized research, by experiment stations, to create new varieties started in 1904 when Koremochi Kato and Kotaro Ando made the initial hybrid experiments in the Kinai Branch of the National Experiment Station. The first major breakthrough in organized research was by Hiroshi Terao with the development of Rikuu 132 in the Rikuu Branch. But the appreciable contributions of organized research in seed improvement to the national average yields occurred only after the establishment of a nation-wide organized research system, Norinsho Shitei Hinshu Kairyoshiken Seido (System of Seed Improvement

Experiments of Varieties Assigned by the Ministry of Agriculture and Forestry) in 1926, and the creation and diffusion of Norin numbered varieties as the research result of this system (Norin No. 1 appeared in 1931). See Noringijutsu Kyokai (Association of Agricultural Technology), Meiji Iko ni Okern Nogyo Gijutsu no Hattatsu (Progress of Agricultural Technology Since Meiji), Tokyo, 1952.

15/ This reorientation of colonial agricultural development policy in response to the shortage of rice in Japan is clearly described by Tobata and Ohkawa in reference to Korea: "Since the Rice Riot Japan has faced a so-called 'population-food problem'. Rapid increase in population and even more rapid increase in nonagricultural population, as the result of industrial development, have been pressing the need for an increase in rice production. In Japan, however, rice farming had already approached a technical limit of intensification, and economically there was little possibility of increasing rice production. Therefore, the solution of the population-food problem was sought in the direction of enlarging the rice production area. In this connection Korea represented the biggest hope, where extensive and underdeveloped farming have been practiced without progress for hundreds of years. It was anticipated that if Korean agriculture were to be developed by the weapons of modern science it would be possible to increase its intensity as well as to expand the paddy field area." (Tobata and Ohkawa, op. cit., 1935, p. 7). The process of agricultural development in Korea and Taiwan under this policy orientation is described in the literatures cited in Footnote 2. Quantitative analysis of this process is now under way by the authors.

16/ A somewhat similar phenomena occurred during the 1890-1905 period. Increase in the supply (and presumably consumption) of rice outpaced domestic production, although the 1905 (1903-07 average) observation includes the abnormal years of the Russo-Japanese War (1904-05). The fact that Japan shifted from a net exporter to a net importer of rice during the last decade of the nineteenth century pressed the government to take measures to encourage agricultural production including the establishment of The National Agricultural Experiment Station (1896), the Law of State Subsidy for Prefectural Agricultural Experiment Stations (1899) and the Arable Land Replotment Law (1899). With the existence of indigenous technological potential that was not being fully exploited, these government efforts were effective and contributed to the advances in rice production and in yield per hectare during the first two decades of this century (Figure 2). As a result Japanese agriculture continued to supply about 95 percent of the rapidly growing domestic rice consumption during this period.

17/ Data plotted for Taiwan and Korea for the periods after cadastral surveys (completed in 1906 and 1918, respectively), for which the data are more reliable.

18/ The data presented in Table 3 indicates that the rate of growth in the supply (presumably consumption) of rice declined after 1920 (from the annual compound rate of 1.7 percent during the 1890-1920 period to 1.0 percent during the 1920-1935 period). Population continued to grow at an annual rate of about 1.0 percent for both periods. This stagnation of per capita rice consumption, if due to a decline in demand, might be expected to have a significant influence on production and productivity trends, although in an open economy domestic consumption does not represent a direct constraint on domestic production. Analysis in the present paper indicates the stagnation of domestic rice production and productivity in Japan can be consistently explained by two major factors, the exhaustion of indigenous technological potential and the importation of colonial rice. This does not, however, refute the hypothesis that demand contraction may have also contributed to the decline. Quantitative analysis of the influence of demand contraction on domestic rice production during this period awaits a future analysis.

19/ Kazushi Ohkawa, Shokuryo Keizai no Riron to Keisoku (Theory and Measurement of Food Economy) (Tokyo: Nihonhyoronsha, 1945), pp. 9-34 and pp. 77-96.

20/ Various variations of area response model were tried, e.g., using net income or profit instead of price. The estimates of such models were inferior to the present model.

21/ This assumption is based on the following reasoning: The government, whether democratic or not, would try to perceive and respond to the demand of the people. If the price of agricultural products goes up, the benefit-cost ratio of irrigation and water control investment would improve. In that situation, farmers, landlords and consumers would demand more such constructions. The government, sensitive to this demand, would allocate a larger amount of funds for irrigation and water control. This would increase national wealth and might also result in increase in government revenue under an appropriate tax system. Whether the present distributed lag specification of geometric convergence is adequate for describing this process is, of course, open to challenge.

22/ Raj Krishna, "Price Policy for Agricultural Development," in B. F. Johnston and Herman Southworth (eds.), Agriculture and Economic Development (Ithaca: Cornell University Press, 1967), pp. 497-540, and Mahar Managahas, A. E. Recto, and

V. W. Ruttan, "Market Relationships for Rice and Corn in the Philippines," _Philippine Economic Journal_, Vol. 5 (First Semester 1966), pp. 1-27.

23/ Yujiro Hayami, "Nogyo Seisanryoku no Hinogyoteki Kiso (Non-agricultural Sector as the Basis of Agricultural Productivity)," in Jinkichi Tsukui and Yasusuke Murakami (eds.), _Keizaiseichoriron no Tenbo_ (Perspective for the Theory of Economic Growth) (Tokyo: Iwanami, 1968), pp. 218-233.

24/ Gustav Ranis and J. C. H. Fei, "A Theory of Economic Development," _American Economic Review_, Vol. 51 (September 1961), pp. 533-565.

25/ It is questionable if there existed the unlimited supply of labor in the sense of Ranis and Fei, but a recent study by Minami indicates that there was a situation which could well be identified as the unlimited supply of labor from agriculture to industry. See Ryoshin Minami, "The Turning Point in the Japanese Economy," _Quarterly Journal of Economics_, Vol. 82 (August 1968), pp. 380-402.

26/ It is interesting to consider what would have happened if the colonial development policies had been accompanied by land reform and other economic democratization measures similar to those implemented during the U.S. occupation after World War II. Land reform might have (a) raised the rate of growth in agricultural production by increasing the incentives of farmers, (b) improved the level of income and living of farmers and contributed to social and political stability of the rural sector and (c) expanded the domestic market for industrial products through the increased consumption of farmers and depressed incentives to the imperialistic expansion of overseas market. On the other hand the improved level of income and consumption of farmers might have depressed industrial growth by (a) decreasing the net outflow of savings from agriculture to industry and (b) shifting upwards the schedule of labor supply to industry, which was determined by the level of living in the rural sector, with the possible rise in industrial wage rate. More extensive analysis is required to evaluate the overall effects of alternative land tenure policies on economic growth and social and political development.

27/ The shift away from grain production toward mixed farming characterized by "high feeding" of livestock was pronounced during the two decades following the repeal of the Corn Laws. Prior to 1850 livestock feeding was justified primarily on the basis of the value of the manure produced by the livestock to the grain enterprise. After 1850 livestock production became profitable in its own right. For an excellent assessment of the changes in farming during this period see E. L. Jones, "The Changing Basis of English Agricultural Prosperity, 1853-73," in W. E. Minchinton (ed.), Essays in Agrarian History, Vol. II (Newton Abbot: David and Charles Ltd., 1968), pp. 219-236, (reprinted from Agricultural History Review, Vol. 10, 1962). Jones summarizes the factors responsible for the shift as follows: "...after the Repeal the altered relative value of wheat and livestock products, due to imports which prevented a rise in the price of wheat, the growth of population, and rising real incomes of which an increasing proportion was spent on livestock products,..." (p. 229). He also quotes an observation by James Caird made in 1878, "Thirty years ago probably not more than one-third of the people of this country consumed animal food more than once a week. Now, nearly all of them eat it, in meat or cheese or butter, once a day. ..The leap which the consumption of meat took in consequence of the general rise of wages in all branches of trade and employment, could not have been met without foreign supplies,.." (p. 227).

28/ Phyllis Dean and W. A. Cole, British Economic Growth, 1688-1959 (Cambridge: Cambridge University Press, 1962), pp. 154-181.

29/ Shigeru Ishikawa, Economic Development in Asian Perspective (Tokyo: Kinokiniya Bookstore, 1967), pp. 84-122.

30/ Ohkawa and Rosovsky, op. cit., pp. 68-83.

31/ Yujiro Hayami and V. W. Ruttan, "Factor Prices and Technical Change in Agricultural Development: The United States and Japan, 1880-1960," (St. Paul: University of Minnesota, AE Staff Paper P69-13, mimeo 1969).

32/ See Randolph R. Barker, "Economic Aspects of High Yielding Varieties of Rice with Special Reference to National Price Policies," paper prepared for Thirteenth Session of the FAO Study Group on Rice, Manila, March 20-27, 1969; also Clifton R. Wharton, "The Green Revolution: Cornucopia or Pandora's Box," Foreign Affairs, Vol. 48 (April 1969), p. 464-476.