Does Agriculture Really Matter? The Case of Korea, 1910-1970

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Introduction

The East Asian experience of rapid growth in the last three decades has been documented largely by describing the implementation of export-led industrial policies. Most of the empirical work that looks at East Asian growth focuses on the modern period beginning around 1960. This essay argues that for several decades preceding industrial expansion, critical investments were made in several sectors as a result of a new and unique method of formulating agricultural policy. Korean policy toward the agricultural sector subsequently evolved into a general policy approach that went far beyond the traditional role of government. The role of the government as investor that emerged from the policy experiments in the agricultural sector spread to other sectors such as transportation, communication, and eventually to industrial production, as the Korean economy made the transition from being predominantly agricultural to partially industrial. Expectations about the role of government in promoting private enterprise changed drastically during the period of colonial rule and continued to change during the period

following the Korean war. Several new institutions were created to administer agricultural policy-institutions whose structure was replicated in other sectors after the war. Finally, the type of agricultural policy formulated to increase production in Korea-intensification of land use-became the prototype for agricultural growth in the rest of East Asia. The Korean approach has also become relevant for developing countries which are land-scarce and labor-rich.

Starting with the colonization of Korea by Japan in 1910, investment in the agricultural sector created a growing food supply. Simultaneously, investments in infrastructure in the form of roads and railways, and the creation of government institutions that laid the foundation for new and highly effective use of public revenues resulted in substantial growth. This analysis is based on annual data of investment and output and is carried out in two parts-the first estimates the economic returns to investment by Japan while the second focuses on economic growth in the post-Korean war period prior to industrial takeoff. Both parts of the analysis reveal that rapid economic growth in Korea started with investment in the agricultural sector and that this investment was accompanied by the creation of infrastructure and institutions in other sectors. The main lesson of the analysis described below is that development does not really occur without investing in agriculture first. It is an important lesson for countries which are taking the first steps in the process of development.

In recent years, research on the agricultural sector in developed and developing countries has indicated that the contribution of agriculture to the process of economic development is very significant. The role of the government in fostering agricultural development in the early stages of development has proved to be vital, not only for raising rural incomes but also for enabling the transformation into an industrialized economy (Timmer 1991, Eicher and Staatz 1984, Timmer et al 1983). An increase in agricultural productivity appears to be essential to an industrial take-off, irrespective of region or time period under consideration. Various policy experiments have shown that industrialization without adequate development of the agricultural sector has resulted in a low or

negative growth rate or in a highly skewed income distribution with a large majority of the population unable to participate in the process of economic development (Bhagwati and Srinivasan, 1975).

The Korean case is regarded as the exception to the rule. The general consensus on Korea seems to be that it is an anomaly with regard to the agro-industrial transformation (Ban et al, 1980; Amsden, 1989). Scholars of the Korean economy have concluded that Korea industrialized without substantial growth and development of the agricultural sector. The main objective of this paper is to challenge this conclusion. The key questions to be answered are the following- were the Koreans really able to leapfrog over the process of agricultural development and enter into the process of export-oriented industrialization? What were the elements of the Korean strategy regarding the role of government, the creation of institutions and ultimately, the development of the agricultural sector? To answer these questions, I focus on an analysis of government investment in agriculture between 1910 and 1970. My goal is to evaluate the magnitude and scope of agricultural investment in order to determine the extent to which Korean policy targeted the development of the agricultural sector. The main conclusion of this analysis is that through simultaneous development of several sectors, the Korean case stands out as a massive effort of land intensification in Asia-the prototype for the model of East Asian growth that includes new technology and labor intensity as its key elements.

I. The Colonial experience: 1910-1938

The magnitude and scope of Japanese investment in Korea clearly reveals that Japan intended its annexation of Korea to be permanent. Full annexation of the Korean peninsula occurred by 1910. Immediately thereafter, a land reform began. A cadastral survey of land was completed, enabling a complete evaluation of size and value of landholdings, ownership status of the land, and the implementation of a new system of taxation. An analysis of the data on colonial investment reveals an emphasis on growth in infrastructure. Figure I shows that investment in irrigation and roads as a fraction of total expenditure

was between 35 and 50 per cent, indicating clearly that one of the priorities of the colonial government was to create an infrastructural base in rural areas. Figure II shows that land tax revenues as a percentage of irrigation investments rarely exceeded 10 per cent, indicating that investment in rural areas greatly exceeded any taxation of these areas. Tax revenues rose only toward the very end of the colonial period, as war preparations began in Tokyo. Figure III shows that as a fraction of government revenues, investment in irrigation and roads was between 30 and 45 per cent for the entire colonial period. During this time, area under irrigation rose from under 10,000 hectares to over 160,000 hectares and average annual growth in irrigated land area was around 18 per cent.

Table I shows the pattern of expenditures and output for each of the three decades of colonial rule. While expenditure on the rural sector was high, growth of rice production and exports was also very high, at annual rates of 4 and 9 per cent respectively. Table II reveals the magnitude of investment in agricultural inputs. The increase in fertilizer consumption is the most significant of all, growing at an average annual rate of approximately 22 per cent in the period 1910-1938. The multiple cropping index grows at 2.77 per cent in the first of the three decades of colonization, with the growth rate dropping as diminishing returns set in. Irrigated land area also registers its highest growth in the first decade with an average annual growth over the entire colonial period of 18 per cent. Land area shows the smallest gain, indicating that growth in rice production and yield was largely a result of land intensification.

Table III shows the correlation of fertilizer consumption, irrigation, and multiple cropping with production and exports. The correlation of investment with irrigation and production is very strong, as is the correlation of fertilizer consumption and production. It is interesting to note the low and negative correlation with the terms of trade index. Terms of trade are dominated by other variables in terms of their effect on production. Also, higher agricultural prices are not correlated with higher output, perhaps reflecting the direct control exercised by the colonial

government over the process of rice production. However, the relationship between exports and terms of trade suggests that there was some response in exports when rice prices were higher. In general, rice production and exports were more sensitive to the cost-reducing investments made by the colonial government than to movement in prices, which were not particularly favorable to farmers anyway.

Land intensification was clearly the major objective of the colonial government. Figure IV shows that growth rates in fertilizer consumption and multiple cropping greatly exceed any efforts to increase the area of land under cultivation. Setting the value of the index of each input to be 100 in 1910, the graphs in Figure IV show the growth of each input over the period of colonial rule. Cultivated land area stays virtually constant. Irrigated land increases steadily growing at an average annual rate of 18 per cent. The value of fertilizer consumption in constant (1934) prices increased from under a million yen to over 38 million yen by the end of the colonial period with an average annual growth of around 22 per cent. Consumption of domestic fertilizer increased rapidly as a nitrogen fertilizer plant built by the Japanese in North Korea went on-line in the last decade of the colonial period. Evidence suggests that the Japanese government strongly encouraged farmers to use chemical fertilizers as well as traditional organic fertilizers (Kang, 1994).

Figure V shows the scatter plots of fertilizer consumption, irrigated land area, and multiple cropping with production and exports of rice. The relationship between output and the various inputs is revealed in these plots. The graph of rice production versus area irrigated shows an s-shaped curve where returns to irrigation are extremely high as area irrigated exceeds 100,000 hectares. The relationship between exports and irrigated land area is almost linear. The graph of production versus fertilizer consumption shows a sharp increase in production as fertilizer consumption increases from very low levels in the early colonial period to relatively high levels as the domestically manufactured fertilizer becomes available to farmers. Other aspects of land intensification compounded the effect of increased use of fertilizer. The use of multiple cropping

techniques increased steadily during the colonial period with an average annual growth rate of 1.28 per cent. The graph of production versus the multiple cropping index reflects large increases in production as the use of multiple cropping becomes widespread. In general, the scatter plots reveal that production and exports increased as cultivation of land intensified.

The results of the multiple regression analysis presented in Table IV are principal component estimations of a Cobb-Douglas production function.[1] The econometric estimation of this production function involves the regression of production, yield and exports on the various inputs in the production process, with all variables expressed in logarithmic form. The purpose of carrying out this estimation is to consider the contribution of each input -irrigation, fertilizer, area cultivated and multiple cropping- to production, yield, and exports while controlling for the effect of other inputs. Thus, we can evaluate the investments made in the agricultural sector by the colonial government. The econometric estimations of the contribution of fertilizer, irrigation and multiple cropping to production, yield and exports of rice serve to confirm what the individual correlation coefficients tell us i.e. these inputs made a substantial contribution to the expansion of rice production, explaining over 70 per cent of the variance in production.

The terms of trade variable is not statistically significant when included as an independent variable in Table IV. The amount of variance in the dependent variable explained by the independent variable does not increase when terms of trade are included in the latter set. This result highlights a curious aspect of Korean agricultural policy- the pursuit of agricultural growth through cost-reduction rather than incentive creation through price policy. Some scholars have argued

1 Principal component analysis is used when the variables on the right hand side of the regression equation are heavily correlated. The technique consists of identifying linear combinations of the correlated variables and regressing the dependent variable on these combined variables rather than including each variable separately.

that price discrimination in the agricultural sector has led to little or no development in the agricultural sector in Korea. The data show us, however, that this is not the case. The pattern of terms of trade in Figure VI shows that the price index of agricultural goods to manufactured goods fluctuates a great deal and does not show any movement in favor of agriculture until the last few years of colonial rule. This reflects the goal of the colonial government to create a cheap yet abundant source of rice for Japan. However, the correlation between the terms of trade and rice production is weak or negative, suggesting that other factors were more important in affecting food supply than rice prices. Price policy is simply not one of the key determinants of growth.

In terms of institution-building, several significant events occurred during Japanese rule, which had an enormous impact on agricultural growth. A land survey was carried out immediately after annexation. It served to put into place, a system of private property rights that proved to be far superior to the feudal system that preceded it. Land was rented by Japanese and Korean landlords to Korean farmers and a system of property rights came into being that resulted in a lowering of risk both for Japanese landlords and Korean farmers. Korean tenant-farmers paid rents to landlords who were then taxed by the government. Rates of taxation were neither ad hoc nor high, landlord-tenant disputes were resolved by law, and rent dissipation in order to purchase political patronage no longer occurred. Tenancy of the land became widespread; as much as 54 per cent of agricultural land was cultivated by tenant farmers by the early 1930s. Tenancy rates reached almost 60 per cent by the end of the colonial period. In a system where land ownership was highly skewed -less than 3 per cent of the population owned two-thirds of the land- and much of the land was owned by Japanese landlords, the new policies resulted in a substantial increase in rice production. The new system was different than the previous system of ad hoc taxation of the peasantry in that expected risks associated with production were somewhat lower by making rental rates and tax rates known in advance. Furthermore, aided by government

investment in infrastructure, landlords invested in fertilizer and new technology for use by tenant farmers (Keidel, 1981). In general, these actions compounded the investment in infrastructure and inputs discussed earlier. More importantly, they significantly transformed the expectation of the population regarding the role of the government in economic development.

In terms of overall development of the agricultural sector, it seems that the colonial government was aware of the scarcity of arable land and invested in intensification soon after annexation. The goal was to create a permanent and effective source of supply of the *japonica* variety of rice for consumption in Japan. Institutions of property rights and taxation were put into place in order to realize this goal and investments in inputs and infrastructure were made greatly in excess of revenues generated off the land. Between 1910 and 1930, the colonial government focused on creating a steady source of rice for Japan by investing in irrigation systems that were technically superior to those in Japan and fertilizer plants that would provide a source of domestically produced nitrogen fertilizer. Thus, economic growth in the agricultural sector began early in the twentieth century. It was during the period of colonization that the stage was set for economic expansion and the creation of an industrial economy.[2]

II. Agricultural growth in modern Korea: 1954-1970

The role of government in the post-war development of Korea has been discussed extensively in the literature on industrial Korea; what is often not explained is the origin of the Korean style of government. From examining the structure of investment during the period of colonial rule, it is clear that the multi-sectoral effort undertaken by the government during this period was carefully recreated after the Korean war. However, analysis of

2 It would be interesting to measure that extent to which private investment complemented the large investments made by the colonial Japanese government. From the literature cited in this paper, it is clear that there were significant amounts of private investment in the agricultural sector. However, the data were not available to the author to confirm this observation.

the data reveals that the returns to investment were positive but not spectacular. The magnitude of the investments themselves was not insignificant. Irrigated land increased by about 85 per cent between 1954 and 1970. According to Wade, maintenance of the irrigation system was not very good but crop losses were small because there was not much need for the efficient use of water (Wade, 1982). Irrigation associations were formed along the lines begun by the Japanese in the 1930s.

The Figure VII shows the number of the associations formed between the years 1954 and 1970. This number grew at over 4 per cent per year, with over 800 associations in existence by 1970. These associations served as an important channel of communication for disseminating inputs. They decreased the amount of control that individual farmers had over the production process because association heads, in close collaboration with ministry officials, made most of the decisions on the adoption of inputs, technology and new methods of cultivation. Figure VIII shows the number of farmers cooperatives that were created during the period 1954-1970. These cooperatives served much the same purpose as the irrigation associations, further increasing the channels of communication and control available to the South Korean government.

The graph in Figure IX shows the consumption of pesticide, measured in *kg / hectare*. Pesticide consumption increased dramatically after the Korean war. The decision to increase pesticide use was probably made for two reasons- the returns to fertilizer consumption were already maximized and it was assumed that pesticide had been underutilized and would increase yield further. Whatever the reason, pesticide production and consumption increased drastically; consumption growing at almost 18 per cent per year. Simultaneously irrigated land area expanded and agricultural credit grew rapidly, at around 16 per cent per year. Figure X shows the nominal value of agricultural credit, as measured by four different types of credit funds controlled by the government. Fertilizer consumption, already at a high level, remained steady at around 30 *kg/hectare*. The number of farmers clubs grew at close to 5 per

cent per year while membership in these clubs grew at 13 per cent. Table V shows the means and growth rates for each of the inputs in the production process.

In general, growth in production was not as rapid as that during the colonial period. The yield for paddy grew at around 2 per cent per year while production grew at less than 3 per cent. Upland rice yields grew at the rate of 4.54 per cent per year but the amount of land under cultivation in upland areas was minuscule -about 15,000 hectares- compared to total land cultivated. Cultivated land area did not expand significantly, increasing at the rate of 0.69 per cent per year. Figures XI and XII show the production of paddy and upland rice. Table VII shows the mean values and growth rates of area cultivated, production and yield for the period 1954-70. There is no doubt from the data that growth in the post-Korean war period was not as high as the early phases of agricultural growth. In the second decade of post-war growth, government policies toward the agricultural sector became somewhat less favorable as well. Grain imports, urban-biased pricing policy, and an increasing focus on rapid industrialization did not provide the right incentives to increase production.

The correlation coefficients in Table VII indicate that the link between irrigation and production is still very strong. Agricultural credit and cooperative membership are also highly correlated with production but the coefficient for fertilizer is much smaller than for the colonial period. But the data also show that the growth in production and yield is now much smaller than before. The agricultural sector in post-war Korea has stabilized, becoming one of the sources of food for the industrializing economy.

The analysis described above clearly shows that a substantial amount of investment in the agricultural sector preceded the industrial growth of the post-war era. If we go back several decades in Korea, we can observe the rapid and sustained growth in the agricultural sector *through land intensification and investment in other sectors such as transportation and infrastructure.* The role of the government in early twentieth century Korea, however, was to increase consumption *in another*

country. Investments in agriculture made during the colonial period were a significant fraction of total expenditures and revenues of the colonial government and the returns to these investments were substantial. After the Korean war, the agricultural sector did not grow as rapidly but had matured enough to become a steady source of food for the industrial sector. The general consensus regarding the lack of agricultural development in Korea were based on a period of analysis beginning after World War II. As the data presented in this essay show, it is in fact true that agriculture did not grow rapidly after the Korean War. However, for an accurate picture of growth in the agricultural sector, *we need to go back much further*. The analysis shows that rather than having very little development in the agricultural sector, there was a substantial effort undertaken to increase the production of food.[3]

The first lesson from the Korean experience is that it does not represent a case of industrialization without growth in the agricultural sector. For countries which are yet to realize a sustainable positive growth rate in the agricultural sector, the Korean case does *not* provide an example of leapfrogging over agricultural development. Rather it provides an example of agricultural growth that occurred several decades before industrial take-off but nonetheless had a strong influence in the creation of a source of food supply to the modern industrial economy. The second lesson is that agricultural growth in Korea occurred through substantial investment by the government in various inputs and in infrastructure. This role of government as a major source on investment funds became the norm, not just for agricultural development but also for industrial

3 It is important to keep in mind that not all the lessons from the Korean experience are relevant for other countries. Japanese investment in Korea occurred largely because Korea as a source of food for Tokyo, without much regard for the level of food consumption inside Korea. The exploitative nature of the colonial Japanese government was and continues to be the subject of much discussion and political debate. The point of this analysis is that despite the motivations of the colonial government, post-war Korea was able to benefit from the pre-war investment in agriculture and other sectors.

growth in the post-war era.[4] Other governments in East Asia pursued similar policies over time; however the Korean case stands out a far-reaching effort to transform the role of government in order to drastically increase its participation in the process of economic growth.

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4 Albert Keidel has pointed out to me that the Meiji experience in Japan suggests that agricultural investment in Korea may have begun much before the period of colonization. It is indeed important to consider the types and levels of investment that occurred in the nineteenth century. Although this is beyond the scope of this paper, it is by no means unimportant.

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Table I
Output and Expenditure, 1910-1938

	1910-1919	1920-1929	1930-1938	1910-1938
Infrastructure expenditure as % of revenues	0.30	0.39	0.43	0.37
Infrastructure expenditure as % of total expenditure	0.37	0.43	0.47	0.43
Terms of trade (agriculture to manufactured goods)	0.83	0.80	0.88	0.84
Value of rice exports (Growth rate in %)	72.53 (11.7)	150.32 (8.37)	156.46 (26.43)	(9.30)
Volume of rice production (Growth rate in %)	77.26 (2.83)	88.06 (1.43)	116.01 (8.06)	93.57 (4.0)
Value of land tax	506.78	734.70	7052.15	3167.11

Notes: Value of rice exports is in million yen in 1934 constant prices.
Value of land tax is in 1000 yen in 1934 constant prices.
Volume of rice production index is based on 1934=100.
Figures in parentheses are unweighted average annual growth rates.

Table II
Inputs: 1910 - 1938

	1910-1919	1920-1929	1930-1938	1910-1938
Fertilizer consumption (growth rate in %)	778.44 (24.05)	7861.10 (27.06)	38872.89 (14.19)	15552.61 (21.96)
Multiple cropping index (growth rate %)	116.53 (2.77)	132.24 (0.79)	139.97 (0.33)	129.68 (1.28)
Irrigated area (growth rate in %)	14877.33 (31.44)	61776.9 (19.80)	148693.8 (2.87)	74639.6 (18.1)
Area under cultivation (growth rate in %)	4458.6 (0.77)	4582.4 (0.22)	4835.9 (0.70)	4624.1 (0.55)

Notes: Value of fertilizer consumption is measured in constant 1934 prices.
The multiple cropping index is set to 1934=100.
Irrigated area and area under cultivation are measured in hectares.
Figures in parentheses are average annual growth rates.

Table III
Correlation Coefficients

With rice production:	1910-1920	1921-1930	1931-1938	1910-1938
Fertilizer consumption	0.52	0.34	0.66	0.82
Multiple cropping	0.87	0.48	0.38	0.72
Irrigated land area	0.81	0.42	0.91	0.77
Terms of trade	-0.04	-0.07	0.57	0.33

With rice production:	1910-1920	1921-1930	1931-1938	1910-1938
Fertilizer consumption	0.53	0.72	0.27	0.71
Multiple cropping	0.54	0.58	0.26	0.83
Irrigated land area	0.56	0.69	0.25	0.95
Terms of trade	0.44	0.18	0.42	0.39

Table IV
Estimations of the Cobb-Douglas Production Function Using Principal Component Analysis

Dependent Variable	Principal component	terms of trade	R^2	F	n
Production	0.08 ** (7.38)		0.66	54.51	29
Yield	0.06 ** (6.17)		0.57	38.08	29
Exports	0.24 ** (16.61)		0.91	275.96	29
Production	0.08 ** (6.88)	0.02 (0.13)	0.64	26.27	29
Yield	0.06 ** (5.85)	-0.02 (0.21)	0.55	18.39	29
Exports	0.24 ** (15.48)	0.10 (0.55)	0.91	134.57	29

Notes: The principal components for production, yield and exports are as follows:

Production: (0.02*area) + (0.52*irrigation) + (0.78*fertilizer) + (0.04*multiple cropping) + (0.35*time).

Yield: (0.52*irrigation) + (0.78*fertilizer) + (0.04*multiple cropping) + (0.35*time).

Exports: (0.02*area) + (0.52*irrigation) + (0.78*fertilizer) + (0.04*multiple cropping) + (0.35*time).

All variables are expressed in logarithmic terms. The constant terms is suppressed. For a description of the variables, see notes in Tables I and II. The t-statistic for each coefficient is reported in parentheses.

** indicates that the coefficient is significantly different from zero at the 1 per cent level of confidence.

Table V
Inputs, 1954-1970

	Mean	Average annual growth rate
Number of irrigation associations	604.3	4.33%
Area irrigated	277.9	5.13%
Number of plows	0.67	10.11%
Number of threshers	0.65	2.78%
Pesticide consumption	10.26	17.92%
Fertilizer consumption	32.0	0.05%
Agricultural credit	3.60	15.55%
Number of farmers cooperatives	37447	4.78%
Membership in farmers cooperatives	531834	13.15%

Notes: Area irrigated is in thousand hectares. Number of plows and threshers is measured in numbers per hectare. Pesticide and fertilizer consumption are reported in *kg per hectare*. Agricultural credit is measured in million won in constant (1960) prices.

Table VI
Output, 1954-1970

	Mean	Average annual growth rate
Area under cultivation	1.18	0.69%
Polished rice yield	2970	2.10%
Rice production	3679	2.79%
Paddy area	1.17	0.59%
Paddy yield	3000	2.12%
Paddy production	3060	2.71%
Upland rice area	15516	0.63%
Upland rice yield	103.2	4.54%
Upland rice production	18996	5.17%

Notes: Area cultivated is measured in million hectares except for upland rice area which is reported in hectares. Rice yields are measured in *kg per hectare*. Rice production is measured in million metric tons.

Table VII
Correlation of Output with Inputs, 1954-1970

	Rice Production	Rice Yield
Fertilizer consumption	0.34	0.24
Pesticide consumption	0.57	0.77
Irrigated land area	0.90	0.74
Agricultural price index	0.75	0.59
Membership in cooperatives	0.75	0.40
Agricultural credit	0.78	0.51
Area under cultivation	0.83	0.47

Notes: For variable descriptions. See tables V and VI.

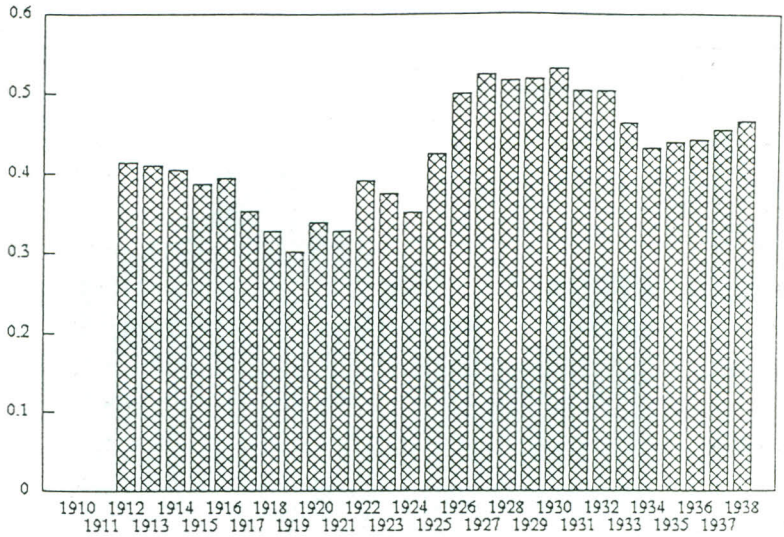


FIGURE 1. Share of Irrigation and Infrastructure Investment as a Proportion of Total Government Expenditures

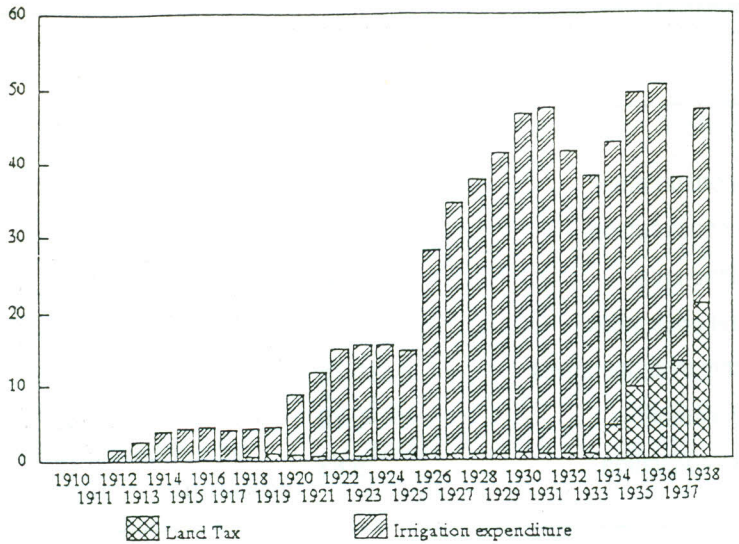


FIGURE 2. Irrigation Expenditure and Land Tax (million yen in 1934 constant prices)

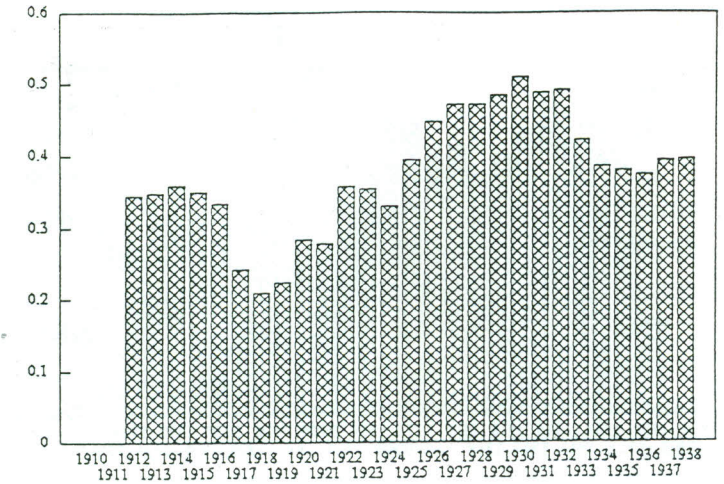


FIGURE 3. Share of Irrigation and Infrastructure Investment as a Proportion of Total Government Revenue

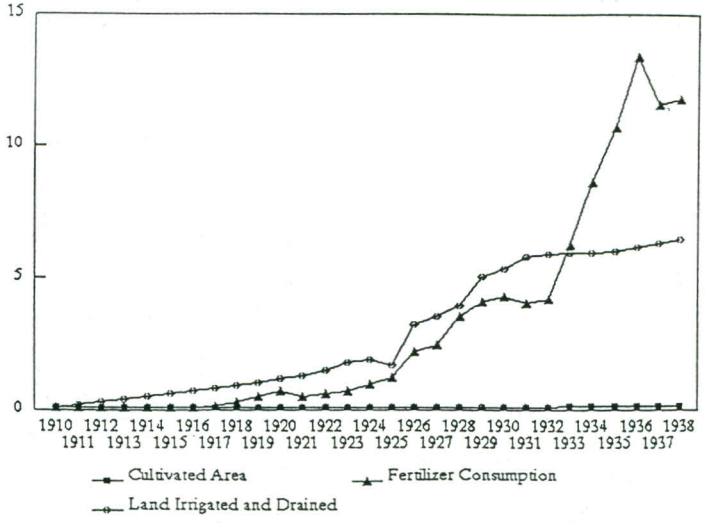


FIGURE 4. Index of Cultivated Land Area, Fertilizer Consumption, and Irrigation Index = 100 for 1910 for Each Variable

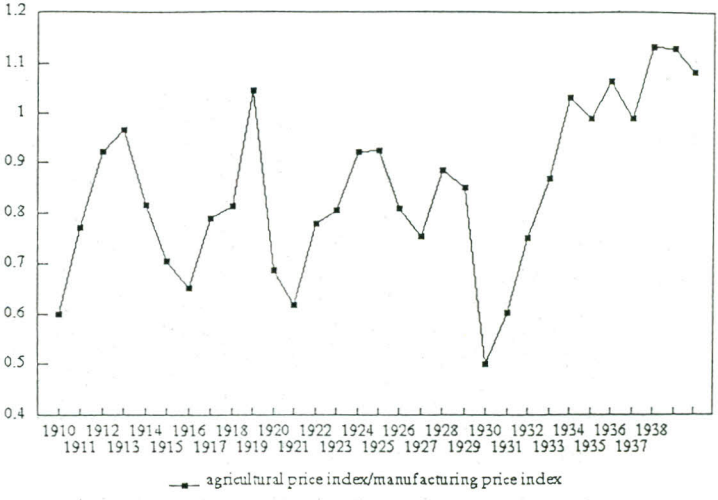
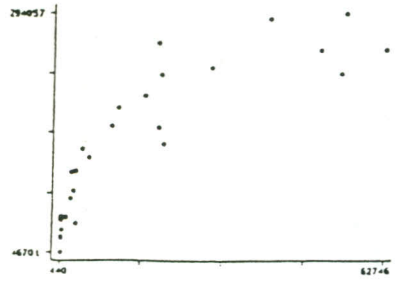
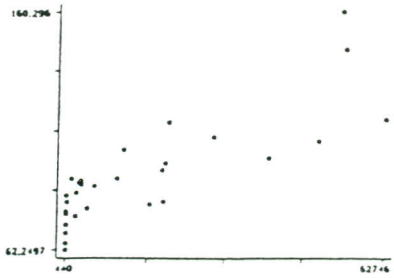


FIGURE 6. Terms of Trade Ratio of Agricultural Prices to Manufacturing Prices

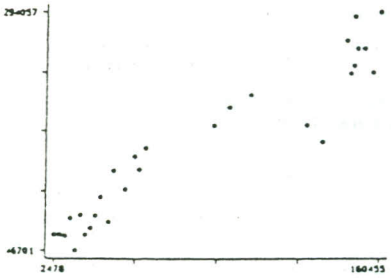
Exports versus fertilizer consumption:



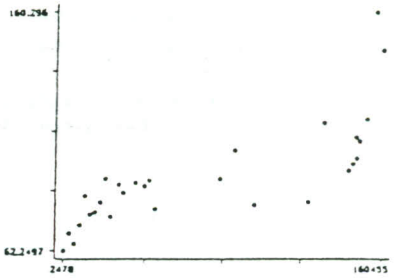
Production versus fertilizer consumption:



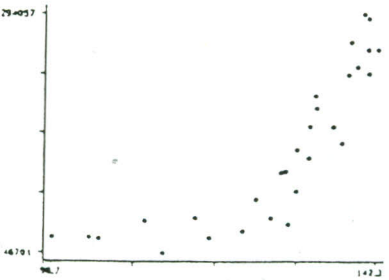
Exports versus irrigated land area:



Production versus irrigated land area:



Exports versus multiple cropping:



Production versus multiple cropping:

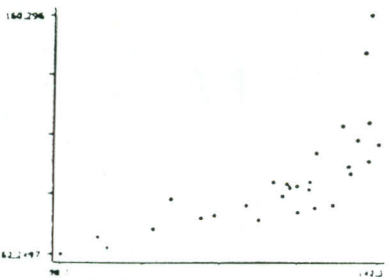


FIGURE 5. Exports and Production Versus Fertilizer Consumption, Irrigated Land Area and Multiple Cropping

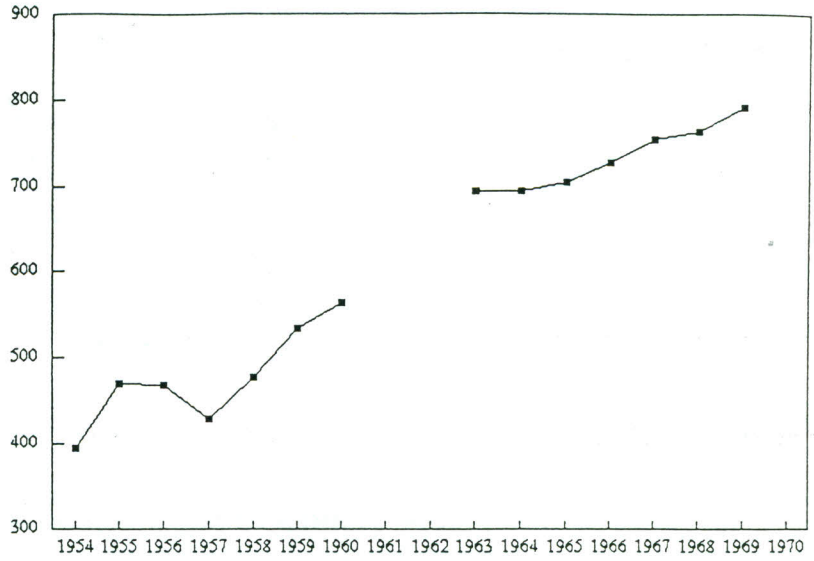


FIGURE 7. Number of Irrigation Associations

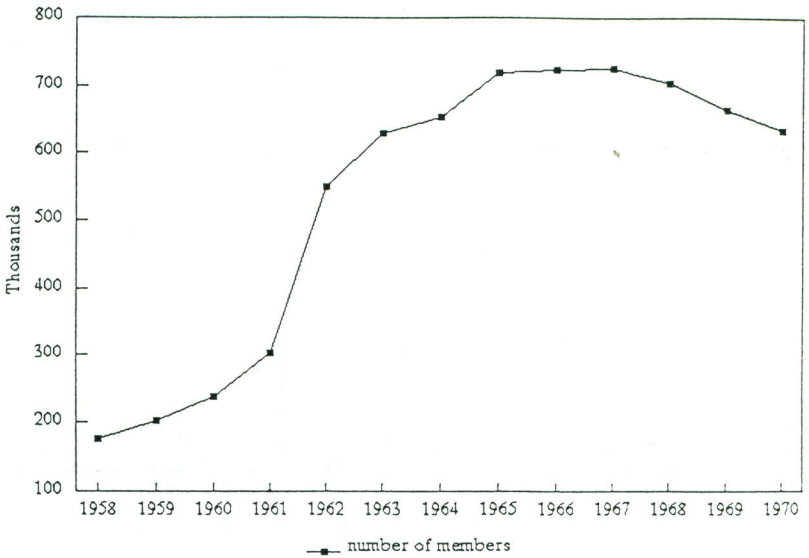


FIGURE 8. Establishments of Farmers Cooperatives

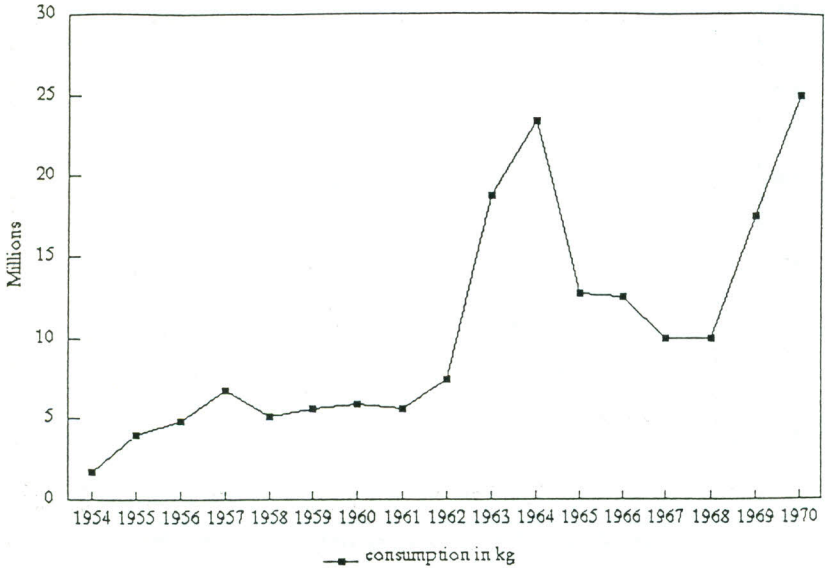


FIGURE 9. Consumption of Pesticide

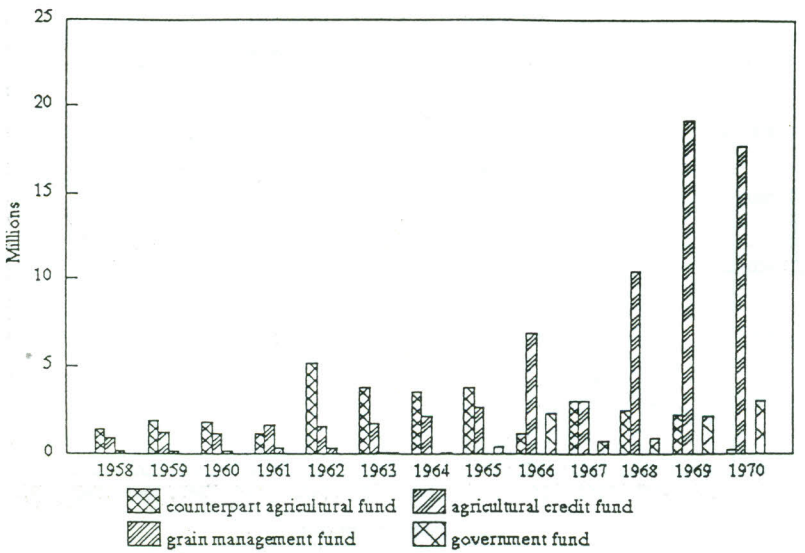


FIGURE 10. Nominal Value of Agricultural Credit

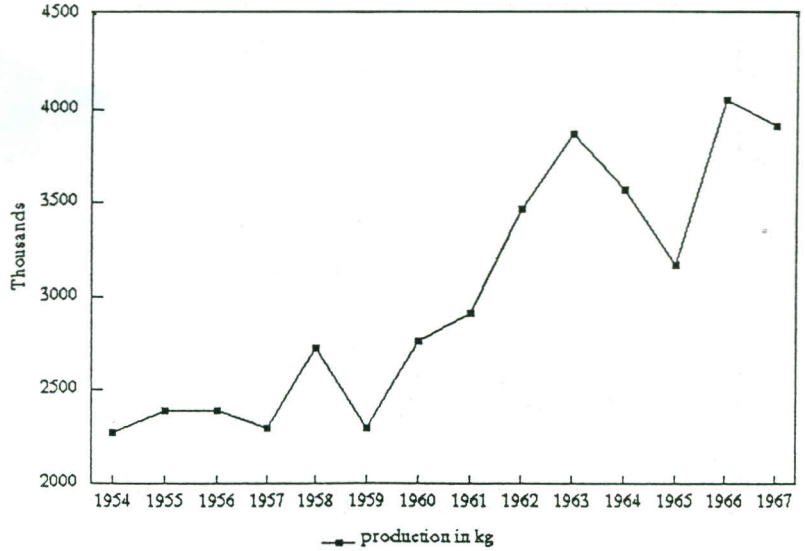


FIGURE 11. Production of Paddy Rice

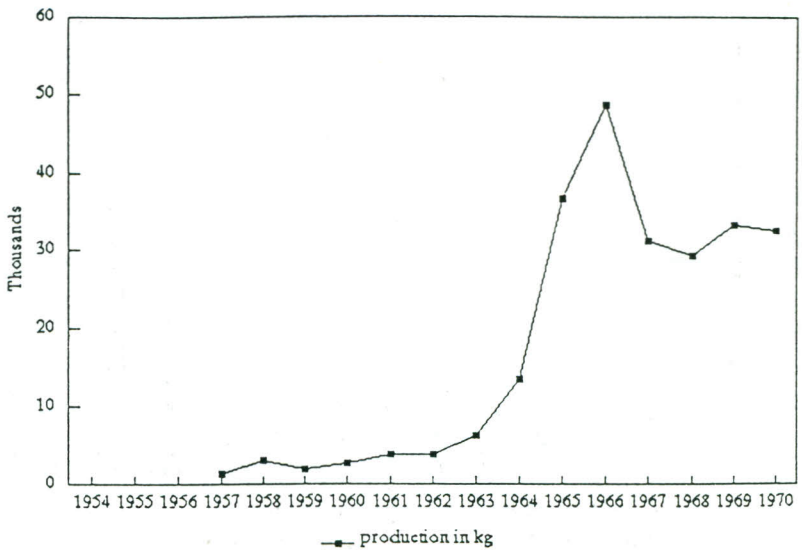


FIGURE 12. Production of Upland Rice