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The Role of Agricultural Productivity in Economic Development

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THE NATURE of agriculture's contributions to national economic development has been described in excellent papers by Johnston and Mellor, Ranis and Fei, D. Gale Johnson, Sherman Johnson, Simon Kuznets, Lawrence Witt, and others. Recently, we added to this literature an article on the mechanics of agricultural productivity and economic growth, which shows how improvement in agricultural productivity contributed to national economic growth of an imaginary country called Hypothetica.¹ For this annual meeting assignment we are asked to shed some light on the extent or magnitude of agriculture's contributions to economic development of countries in the real world where data required for analysis are not as readily available as they were in the case of Hypothetica. We draw upon findings from an AID research project which identified and measured factors associated with changes in agricultural productivity in underdeveloped countries. But first we need to show how the contribution that the agricultural sector makes to national economic growth depends upon improvement in agricultural productivity.

Problems of Economic Productivity

Increase in agricultural output comes from two sources: use of additional inputs, and increased productivity resulting from improved technology. We define agricultural productivity as the ratio between total output and total input with annual outputs and inputs (land, labor, and capital goods) valued at constant prices so that real changes in the overall productivity ratio can be observed over time. Increases in agricultural productivity contribute to national economic development and income growth in three major ways: (1) They supply an economic surplus² that can be consumed or used for further production in agriculture or transferred out of agriculture to provide capital for economic growth and meet expanding consumption needs in the nonagricultural sectors.

* We are indebted to colleagues in the Economic Research Service for comments and suggestions.

¹ Raymond P. Christensen and Harold Yee, "The Mechanics of Agricultural Productivity and Economic Growth," *Agr. Econ. Res.*, Vol. 16, July 1964.

² In an aggregative construct, economic surplus at time t (S_t) is defined as the

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This transfer can take place in several ways, e.g., lower prices for agricultural products, investment of agricultural income in nonagricultural sectors and taxation. (2) They make possible the release of labor and other resources for use in nonagricultural sectors. (3) They increase purchasing power of rural people, expand markets for industrial products, and bring about structural changes needed for national economic growth.

Expansion in agricultural output derived solely through additional inputs may supply an economic surplus provided the productivity ratio is greater than one. However, this method of increasing output fails to release resources for nonagricultural production and to increase per capita income of the rural population. Hence, for agriculture to play a positive role in the general economic development of a country, it is imperative that a substantial increase in output be obtained through improved productivity.

Change in agricultural output per person employed in agriculture may provide a rough approximation of change in the overall productivity ratio. However, use of additional capital inputs from nonfarm sources usually will be associated with increased agricultural output per rural person.

Overall agricultural productivity ratio can rise as the result of a decline in total input relative to total output with total agricultural output increasing at a slower rate than total population. This apparently is what happened in England during the late 1800's when English agriculture was exposed to competition from abroad, imports of farm products increased, and large numbers of rural people moved to jobs in industry. English agriculture became more efficient, although not more prosperous, and thereby contributed to national economic growth. Japan apparently has entered a similar state in its development.

But we hasten to point out that conditions in most developing countries today differ greatly from those in England in the late 1800's. They probably will need to rely mainly upon domestically produced food supplies to meet rapidly expanding food needs. Fortunately, many have large potentials for increasing agricultural productivity by applying ap-

difference between output (O_t) and input (I_t) at time t , i.e., $S_t = O_t - I_t$. Since output is the product of the level of input and its average productivity (P_t) or $O_t = P_t I_t$, we have $S_t = P_t I_t - I_t$. The time path of the economic surplus is given by differentiating S_t with respect to time: $dS_t/dt = I_t dP_t/dt + P_t dI_t/dt - dI_t/dt$. Change in economic surplus can result from two sources. If productivity is constant over time, change in surplus results from change in input times the level of productivity less the change in input; $dP_t/dt = 0$ and $dS_t/dt = P_t dI_t/dt - dI_t/dt$. If there is no change in the level of input, $dI_t/dt = 0$, then an increase in surplus can result from increase in the efficiency of input multiplied by the level of input; $dS_t/dt = I_t dP_t/dt$. Obviously, the problem encountered in practice is the identification of the contributions from the respective sources since it is likely that both productivity and the level of input will change over time.

proved technology, although some will be hard pressed to expand food production in pace with population growth. Industrialization cannot proceed rapidly enough to provide productive employment for all of the additional workers resulting from rural population growth for another generation or two in most of these countries. And it will be even longer before many will reach the stage when the absolute number of workers in agriculture can be reduced. But we should not rule out the possibility that many of the densely populated countries will rely heavily upon agricultural imports when they become developed.

Problems of Economic Productivity

Economic productivity problems facing agriculture in developing countries are reasonably clear. Population growth is taking place at 2 or 3 percent a year, more than twice as high a rate as that in Western European countries or in Japan during the years when they moved into the take-off stage of economic development. The less developed countries must increase their supplies of agricultural products by 3 to 5 percent a year to meet domestic demand resulting from population growth and slowly rising incomes in order to avoid price inflation and disruption of industrial growth.

Most developing countries have limited land resources. Many must find ways to double crop yields in the next 20 years if they are to develop rapidly. Abundant labor needs to be used to improve natural resources. Scarce supplies of capital inputs from outside agriculture need to be used sparingly and where marginal returns are largest in order to increase crop yields and the overall productivity ratio in agriculture. Agriculture must gradually shift from subsistence to market production. Perhaps most important, investments must be made to improve technical skills and managerial talents of rural people.

We can get a better picture of the agricultural productivity problems facing the less developed countries from data in Table 1 showing recent per capita income levels and growth characteristics. Countries have been grouped arbitrarily in three categories: developed, developing at rapid growth rates, and developing at slow growth rates. The major points that need to be observed are agricultural sector output accounts for less than half of gross national product in most developing countries and for less than a fourth in the developed countries, and slow growth developing countries have relatively low rates of growth in agricultural sector output while the reverse is true of rapid growth developing countries.

Compound annual growth rates for agricultural output and population for individual countries during the 1952-62 period are shown in Figure 1. Countries fall in three sections on the chart: (I) a few where agri-

Table 1. Income per capita, compound annual growth rates, and agriculture's share of gross national product and total employment¹

Country	Income per capita 1959-61 ²	Compound annual growth rates ³					Agriculture's share	
		Total population	Gross national product	Agricultural sector output	Total agricultural production	Total food production	Gross national product	Total employment
	Dollars	Percent	Percent	Percent	Percent	Percent	Percent	Percent
<i>Developed⁴</i>								
United States.....	2,289	1.7	3.3	—	1.5	1.8	5.1	12
Australia.....	1,170	2.2	4.0	(3.0)	3.4	3.0	—	13
Denmark.....	1,058	1.7	3.3	1.6	2.4	2.4	12.4	23
France.....	1,006	1.9	4.3	2.5	2.9	3.0	11.1	26
Netherlands.....	801	1.3	4.9	3.3	2.8	3.0	11.6	19
Israel.....	763	3.5	10.6	9.5	10.1	3.9	11.9	17
Italy.....	514	3.6	6.1	2.5	2.0	2.3	21.9	28
Venezuela.....	729	4.1	7.6	5.9	3.5	3.8	7.0	41
<i>Developing, rapid⁵</i>								
Rep. of So. Africa.....	397	2.4	(5.1)	(2.4)	3.2	3.7	12.7	33
Jamaica.....	355	1.4	9.0	3.1	—	—	15.2	49
Japan.....	346	1.4	8.8	(3.4)	3.7	3.9	20.0	40
Greece.....	333	1.0	5.7	4.5	4.0	3.8	32.8	53
Mexico.....	312	3.1	(7.0)	(7.5)	7.0	7.6	—	58
Spain.....	296	1.9	(7.2)	—	2.8	2.5	25.5	49
Yugoslavia.....	218	1.2	10.0	6.9	6.1	6.5	29.8	67
Colombia.....	203	2.2	4.5	3.1	2.5	1.6	37.3	54
Guatemala.....	153	3.0	(5.6)	—	4.9	2.7	34.0	68
Egypt.....	138	2.4	4.9	2.4	2.9	3.4	36.2	64
Brazil.....	130	3.2	5.7	4.2	3.6	3.2	38.3	59
Taiwan.....	110	3.4	(6.2)	(4.5)	4.7	4.6	32.7	50
Korea.....	102	1.9	5.8	2.5	2.7	2.9	41.6	80
Thailand.....	82	3.6	5.6	4.3	3.8	3.4	46.2	82
<i>Developing, slow⁶</i>								
Chile.....	491	2.9	3.4	1.0	1.2	1.1	14.0	30
Argentina.....	363	1.6	1.6	2.0	.9	.9	20.5	25
Panama.....	335	3.1	3.7	(3.5)	3.5	3.5	27.3	50
Costa Rica.....	313	3.9	(5.6)	(4.6)	—	—	41.0	55
Malaya.....	211	3.1	2.2	2.2	3.5	4.8	46.0	58
Turkey.....	176	2.9	(4.2)	5.7	3.5	3.6	(43.0)	77
Jordan.....	168	3.1	4.3	(1.5)	—	—	(20.0)	—
Tunisia.....	157	1.6	3.5	3.5	1.4	1.3	(34.1)	68
Ecuador.....	145	3.1	4.9	4.1	—	—	37.5	53
Philippines.....	131	3.2	4.9	2.4	2.9	3.4	36.2	64
Peru.....	130	1.8	(2.4)	(2.3)	2.3	1.9	27.6	—
Sudan.....	80	3.3	2.0	—	—	—	58.5	—
Pakistan.....	76	2.1	2.5	1.6	1.7	1.7	56.7	65
India.....	68	1.9	3.7	3.0	3.0	3.0	48.4	71

¹ Data in parentheses are estimates.

² Estimated by Arthur Mackie, DTA, ERS, USDA, from UN reports.

³ Computed from beginning and ending points of linear trend for years indicated. Population growth for 1952/53-1961/62, and gross national product and agricultural sector output for 1950 to 1960 or other years in this decade from UN reports. Total agricultural production and total food production for 1952/53-1961/62 and agriculture's share of gross national product from reports of FAO.

⁴ Per capita annual income \$500 or more.

⁵ Per capita annual income less than \$500 and per capita income growth rate 2 percent or more annually.

⁶ Per capita income less than \$500 annually and growth rate less than 2 percent annually.

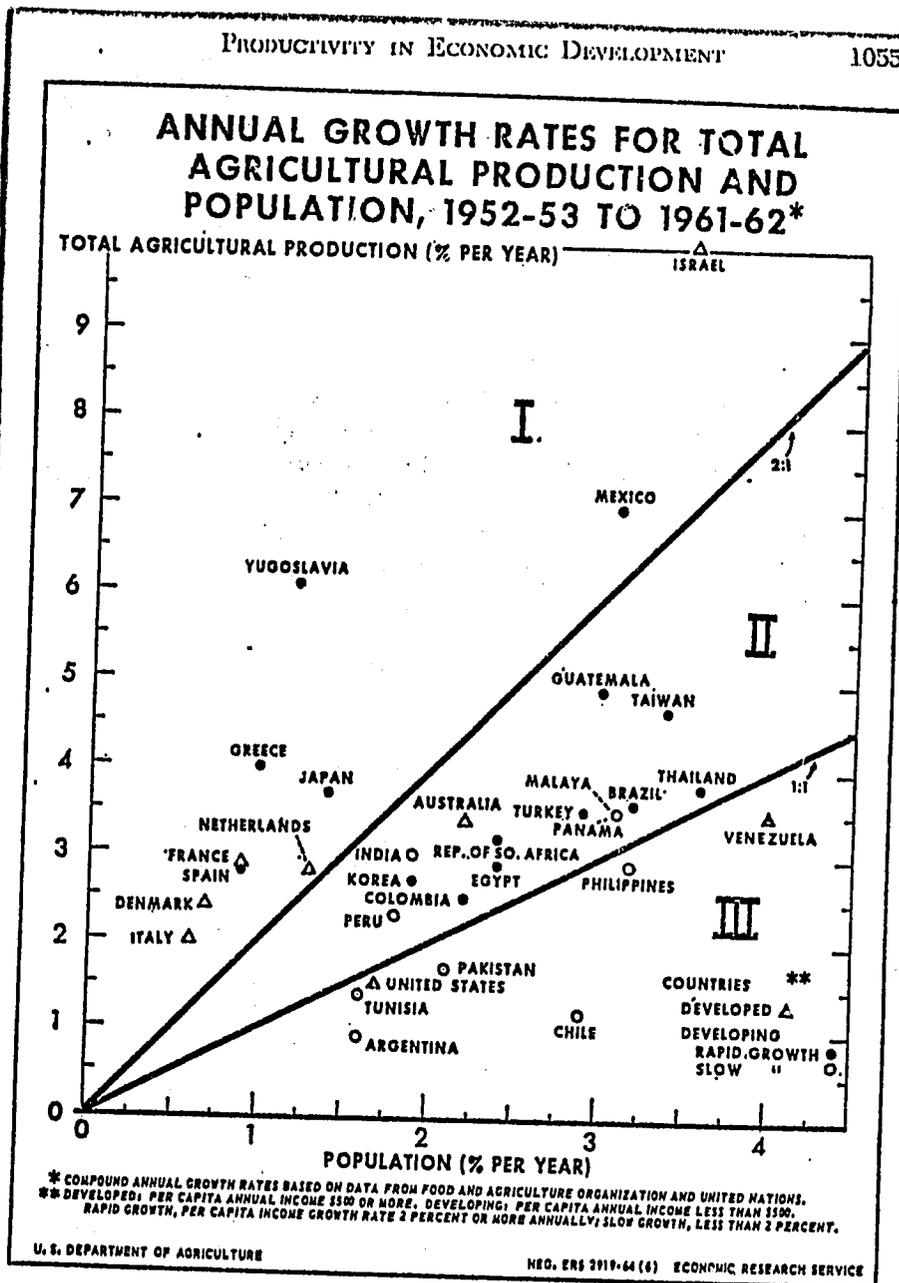


Figure 1. Annual growth rates for total agricultural production and population

cultural production increased two or more times as rapidly as population, (II) a large number where production increased less than twice as rapidly as population, and (III) a few where production went up

less rapidly than population. Per capita output of agricultural products went up greatly in rapid growth countries like Japan, Greece, Mexico, and Spain, but it declined in slow growth countries like Chile, Argentina, and Pakistan.

Additional evidence concerning the association between growth in the agricultural sector and national economic growth is presented in Figure 2. The scatter of points indicate a positive relationship between the growth in GNP and agricultural sector output.³ But what is the degree of association between the two growth rates? It seems plausible to argue that the growth of GNP induced by growth of the agricultural sector is determined by the rate of growth of the agricultural sector and its size relative to the total economy. In most countries where agriculture contributes a large share to GNP, a small share of the inputs are purchased and a small part of the output is marketed. In such cases connecting links between the agricultural sector and the rest of the economy are weak and the impact on the growth of GNP is largely a matter of the size of the agricultural sector rather than the multiplier effects induced by the rate of agricultural sector growth. In a developed country with a small share of its income from agriculture, the multiplier effects induced by per unit change in agricultural sector output will be larger because of the economic links between agriculture and the rest of the economy in both the product and factor dimensions. However, the relative size of the agricultural sector usually is much smaller. The question of the degree of association between the growth in GNP and agricultural sector output, however, cannot be answered without much more research on the complex interrelationships between agriculture and the rest of the economy during the growth process.

Agricultural Productivity in Economic Development

Now we consider more specifically the role of agricultural productivity in the economic development of selected countries, giving attention to the three ways in which agriculture contributes to national economic growth. Japan, Greece, Mexico, and Taiwan are examples of countries where rising productivity in agriculture created an economic surplus that supplied capital for industrial growth, released labor and other resources for nonagricultural sectors, and helped bring about structural

³ We regressed GNP on agricultural sector output to obtain a measure of the association between the two growth rates. The net regression line in Figure 2 is given by $GNP = 2.069 + .846 O_A$ with a R^2 of .5425 obtained with 33 observations. O_A is agricultural sector output growth rate; and GNP is gross national product growth rate. Data are from Table 1. The observed values must obviously be thought of as simultaneously determined and no direct causation between GNP and agricultural sector growth should be inferred.

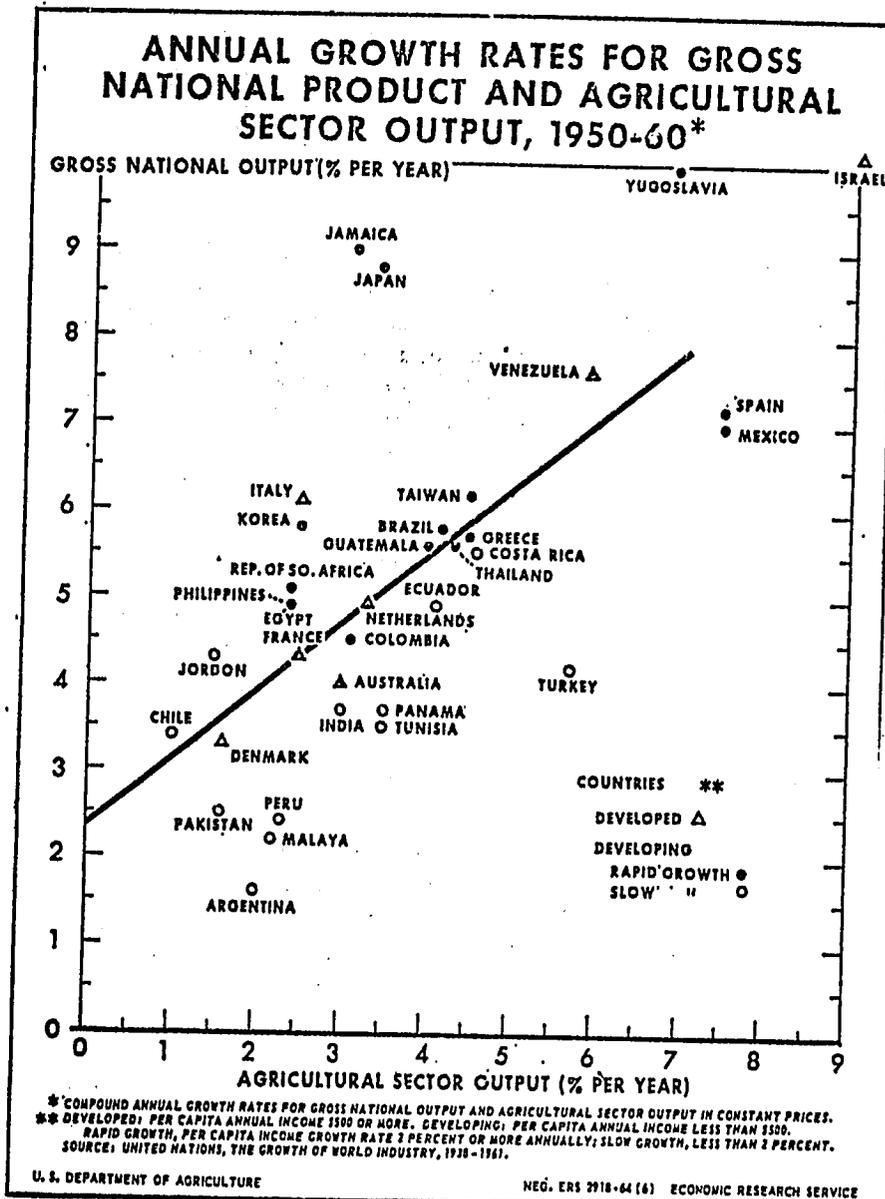


Figure 2. Annual growth rates for gross national product and agricultural sector output

changes in the national economy through changes in markets for products and services.
 Increased productivity in agriculture was a major factor contributing

to economic take-off in Japan during the 40-year period from 1880 to 1920. Annual growth of net agricultural output averaged 2.3 percent a year, substantially more than the annual population growth rate which varied from .8 to 1.3 percent. Increased demand for food resulting from population growth and per capita incomes rising about 2 percent a year were met by expanding domestic production. Japan was a net exporter of agricultural products until about 1890 when it became a net importer. Exports of raw silk and tea continued for another 20 years to be important earners of foreign exchange for financing imports. Abundant rural labor supplies were used to improve land resources. Net agricultural output increased 80 percent per acre and 136 percent per worker during this 40-year period. Gains in agricultural productivity provided an economic surplus which was largely transferred to other sectors by land taxes and declining relative prices for food. Direct taxes on agriculture accounted for over half of total taxation revenue and 12-15 percent of the net income produced in agriculture. Agriculture became a major source of workers for nonagricultural sectors in the early 1900's when total employment in agriculture began to decline. Rising productivity in agriculture generated significant changes in demand for industrial products and in the structural organization of the national economy.

Greece is an example of a country in the Mediterranean area where agricultural productivity has gone up greatly since World War II. During the first half of this century, Greece was burdened with external wars, internal strife, unstable political conditions, or occupation by enemy forces. Total agricultural production was reduced during the war years, but it recovered to the prewar level in 1949. During the 1950's, agricultural output increased 5 percent a year and population 1 percent a year. Crop production per acre went up 3.5 percent annually and output per worker about 5 percent. Total labor force in agriculture began to decline. The overall agricultural productivity ratio was improved substantially. Increased agricultural output improved dietary levels and was a major source of larger foreign exchange earnings. But Greece now faces agricultural adjustment problems not unlike those of developed countries where agricultural output has gone up more rapidly than markets.

Mexico has been one of the most successful countries in Latin America in improving agricultural productivity. National output and agricultural sector output went up about 7 percent a year as compared with population growth of about 3 percent a year during the last decade. However, dietary levels have improved only slightly and much of the increased agricultural production has moved into export channels where it has helped finance imports of materials necessary for industrial development. Labor force in agriculture has continued to increase but it has

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declined relative to total labor force. Net migration out of agriculture averaged about 300,000 annually in the 1950-60 period. If it is assumed that cost of rearing, educating, and training of these people averaged about \$1,500 each, an amount equal to 10 years at a per capita income of \$150 a year, the total investment in people moving out of agriculture annually was about \$450 million. This may be compared with total capital formation in material forms which averaged about \$1,500 million annually in the 1950-60 period.

Argentina's record is in sharp contrast with that of Mexico. Both national and agricultural sector output increased 2 percent or less a year in the last decade, about as rapidly as population. Although agriculture did not supply an expanding economic surplus for transfer to other sectors during the 1950's, it was the "growth engine" upon which the rest of the economy depended in earlier years. Argentina perhaps is the most prominent example of how government policies affecting the terms of trade can be made so unfavorable for agriculture that the progress in improving agricultural productivity is slowed to the point where stagnation of national economic growth results.

We return to the Far East for examples of countries where progress has been outstanding and not so outstanding. In Taiwan, agricultural output increased at an annual rate of 4.5 percent and gross national product at about 6 percent as compared with a population growth rate of 3.4 percent during the last decade. The overall productivity ratio increased 20 percent from 1935 to 1956 making it possible for agriculture to become a major source of capital for industrial development. Agriculture's share of total employment decreased to about 50 percent, but the absolute number employed on farms still is increasing because growth of other sectors is not sufficiently rapid to absorb the additional workers resulting from the high population growth rate.

In the Philippines, agricultural production recovered to the prewar per capita level in 1952. During the last decade, total agricultural production increased about 3 percent a year, about as rapidly as total population. The overall level of productivity in agriculture probably has not gone up very much. Total area under cultivation and employment in agriculture increased about as much as total agricultural output. The proportion of total labor force employed in agriculture has remained relatively constant at about 65 percent. Agriculture has continued to be the major source of foreign exchange earnings, but agriculture apparently has not supplied an expanding economic surplus for transfer to non-agricultural sectors because of lack of improvements in agricultural productivity.

Conclusions

What light does all of this shed on the role of agricultural productivity on economic development? In the case of the developed countries where the agricultural sector usually accounts for less than 20 percent of national income, increased productivity in the nonagricultural sectors obviously will be more important than increased productivity in agriculture in achieving economic growth. However, even in these countries rising agricultural productivity may have important multiplier effects on the rest of the economy.

There are a number of rapidly developing countries that have moved into the take-off or sustained growth stages of economic development during the last few decades. In each case, rising productivity in agriculture was a major source of an economic surplus that supported growth of the nonagricultural sectors.

But most of the less developed countries are finding it extremely difficult to keep agricultural output increasing as rapidly as population. The data referred to here describe changes during the last decade, and we need to be aware of the fact that during the last few years increases in agricultural output in many countries has lagged behind increases in population. The less developed regions of the world—Asia, Africa, and Latin America—have failed to maintain upward trends in food output per capita after the latter part of the 1950 decade. Latin America reached its peak in 1958 at just up to the prewar per capita level, then dropped continuously to 12 percent below prewar by 1962. The Far East (excluding Mainland China) reached its peak at 4 percent below the prewar level in 1961-62 and then fell further behind in 1962 and 1963.

Countries with high population growth rates face extra difficulties in moving into the take-off stage of economic development. It is significant, for example, that population growth was only about 1 percent a year in Japan and Greece during the 1950's when they successfully achieved high per capita growth rates in agriculture and national output. Countries like Taiwan, Thailand, Turkey, Philippines, and Brazil have increased agricultural output 3 percent or more a year during the last decade, but population growth also increased 3 percent or more annually, leaving little or no surplus for investment in future growth. One might question whether it will be possible for countries to move into the sustained growth stage of economic development with an annual population growth rate much in excess of 2 percent. However, Mexico appears to be doing it.

The less developed countries apparently will not find it possible to enter the take-off stage of economic development unless they find ways of increasing supplies of agricultural products by 4 to 5 percent a year if

they continue to have population growth rates of around 3 percent a year. Some may be able to rely upon imports to meet part of their growing food needs, but in most instances they will need to rely chiefly on domestic production. In any case, it will be essential that a substantial part of the increase in agricultural output be achieved through improved productivity so that an economic surplus will be available for transfer to other sectors. Incidentally, an increase in agricultural output of 4 to 5 percent annually is much larger than that experienced in the United States and most other developed countries. During the 1870-1920 period when agriculture was making very large contributions to economic development in the United States, total agricultural output increased at a compound rate of 2.2 percent a year.

Finally, it should be clear that there is nothing magic about gains in agricultural productivity. Agriculture is but one of a set of interdependent sectors in the economy and gains in these other sectors are no less important. However, if we include marketing, transportation, and processing of agricultural products and the production of fertilizer, tools, and other materials under the heading of agriculture, we find that agriculture accounts for a large part of all economic activity in the low income countries. Because of the overwhelming size of agriculture and its penetrating links with other sectors, national economic development largely depends upon improvements in agricultural productivity. How to generate this improvement, of course, is a question that we have not dealt with.