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Population Growth and Agricultural Development[1]

By Raymond P. Christensen

AGRICULTURE'S SHARE of total population declines with economic development. Farm-to-city migration takes place as countries move up the income ladder. A declining share of the total labor force is employed in agriculture (fig. 1). As per capita incomes rise, people spend a smaller share of their income for farm products and a larger share for other things. Shifts in the structure of demand for products and services cause fewer workers to be employed in agriculture and more in other sectors.

But agricultural population will continue to increase for another generation or two in the less developed countries. Agricultural population may double in some countries in the next 30 to 40 years, even though agriculture's share of total population decreases. Population growth rates in most of the less developed countries now are relatively high, 2 to 3 percent a year or more. This, together with the fact that agriculture now accounts for a large share of total employment in these countries, means that nonagricultural employment would need to increase 10 to 15 percent a year to absorb all of the net increase in number of workers. Yet employment opportunities in nonagricultural sectors cannot be expected to increase more than 4 to 5 percent a year. Of course, productivity per worker in agriculture must also increase before it will be possible for agriculture to release workers to the nonagricultural sectors.

Prospects for continued growth of agricultural population and labor force in the developing countries have important implications for agricultural development planning, especially in densely populated countries where opportunities for expanding the land area under cultivation are limited. Several questions should be faced. How can additional farmworkers be employed effectively? How can production per farmworker be increased at the same time that land available per worker decreases? Should farms be reduced in size or should additional people be employed as hired workers?

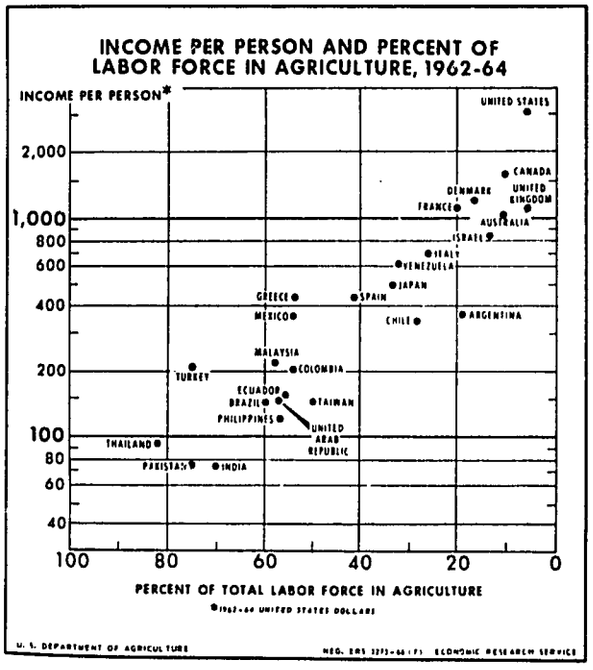

Figure 1

Professor Folke Dovring called attention several years ago to the growth of farm population during the early stages of economic development (2).[2] But relatively little attention has been given in agricultural development plans to the problems of finding productive employment for increasing numbers of farm

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[1] Revision of a paper presented at seminar of faculty and graduate students, Department of Agricultural Economics, Cornell University, May 2, 1966.

[2] Underscored numbers in parentheses refer to items in the Literature Cited, p. 128.

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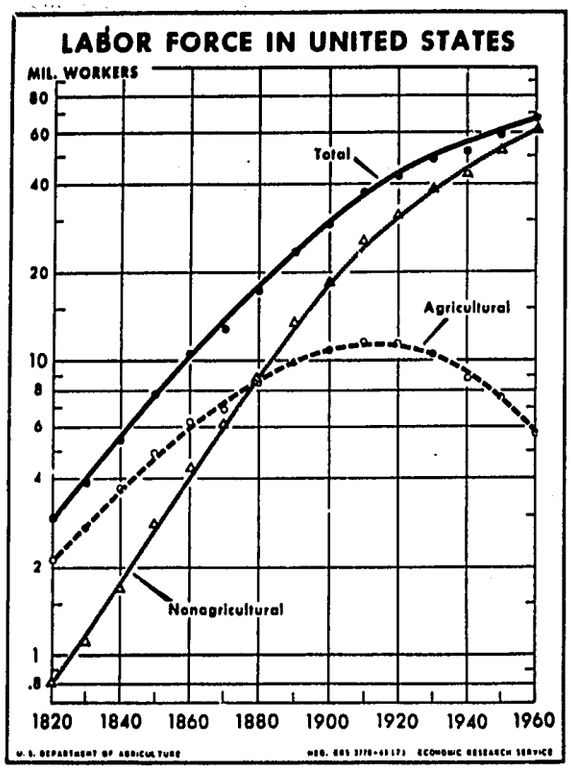
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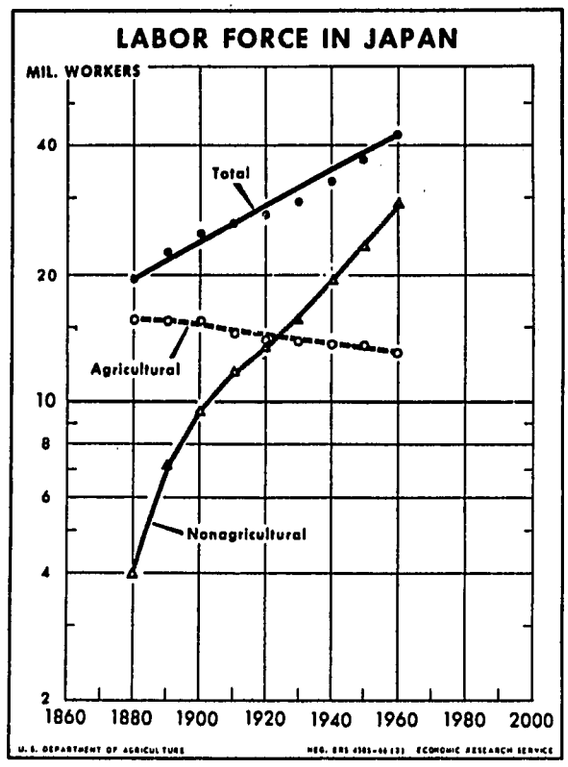
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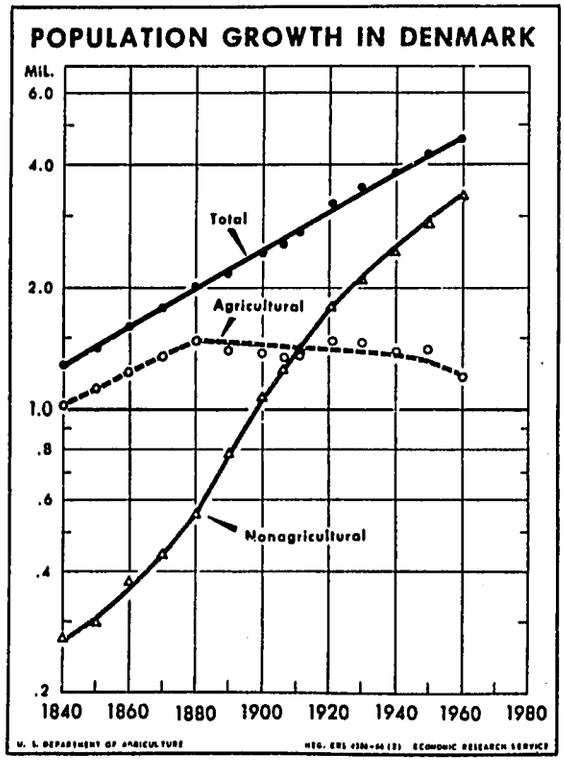
POPULATION GROWTH IN DENMARK
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6.0
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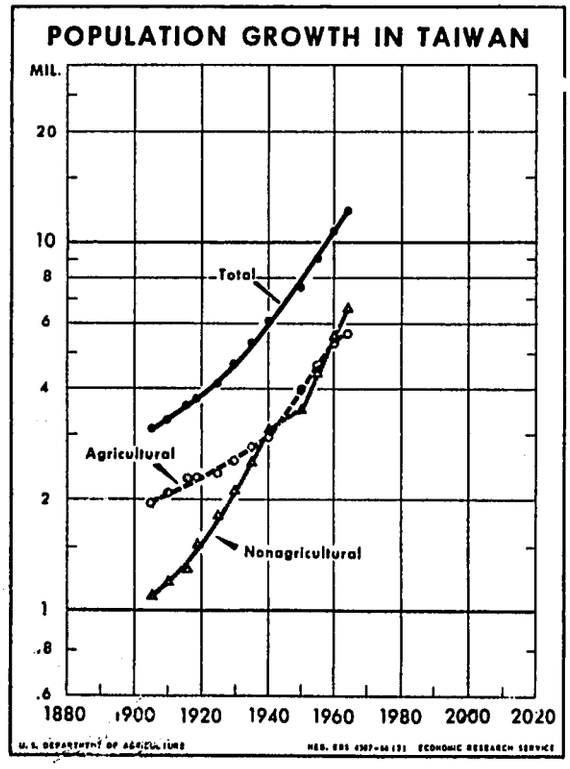
POPULATION GROWTH IN TAIWAN
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Agricultural
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1880
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2020

Figure 2

people or to problems of farm size and structural organization of farming in the developing countries.

Population Growth Patterns

Historical growth patterns for the agricultural and nonagricultural parts of the labor force and population in the United States, Denmark, Japan, and Taiwan suggest what may happen to growth in numbers of people directly dependent upon farming for a livelihood in the less developed countries (fig. 2).

The growth pattern for the United States may be representative of what might be expected in some developing countries. Agriculture's share of the total labor force was 72 percent in 1820, and it declined to 49 percent in 1880 (table 1). The total labor force increased 3.1 percent a year during this period. The agricultural labor force increased 2.3 percent a year and the nonagricultural labor force 4.1 percent a year. Agricultural employment increased about threefold, from a little over 2 million in 1820 to a little over 8 million in 1880. It continued to increase until about 1910, when it was a little over 10 million, before it began to decline.

Japan and Denmark are often referred to as countries that achieved outstanding progress in agriculture during the early stages of economic development. Data for these countries show that much hinges upon total population growth rates. Both countries made the transition from over 70 percent of total population or employment in agriculture to 49 percent in a period of about 35 years (table 1). But in both countries population increased only 1 percent a year or less. In Denmark agricultural population increased slightly during the transition period, while in Japan, where the total labor force increased only 0.7 percent a year, the agricultural labor force decreased slightly. However, agricultural population is now increasing much more rapidly in the less developed countries than it did in Denmark or Japan during the early stages of their economic development.

Taiwan's experience in the last 50 years may be representative of many developing countries where population growth rates are relatively high. Agriculture's share of total employment decreased from 64 percent in 1908 to 50 percent in 1938. It increased during World War II but it has decreased to less than 50 percent in the last few years. If we include in agriculture people employed in forestry and fisheries, agriculture's share of total population decreased from 69 percent in 1930 to 56 percent in 1956 (table 1). During this period, total population increased 2.7 percent a year. The population of Taiwan has increased 3 percent or more annually in the last few years but may now be

Table 1.--Estimates of agriculture's share of total employment and rates of growth in employment or population during early periods of development, selected countries [1]

Country	Period	Agriculture's share of total employment		Compound growth rates in employment or population		
		Beginning of period	End of period	Total	Agricultural	Nonagricultural
	Years	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
United States.....	1820-1880	72	49	3.1	2.3	4.1
Denmark.....	1880-1911	72	49	1.0	([2])	3.0
Japan.....	1885-1920	73	49	.7	([3])	2.5
Taiwan.....	1930-1956	69	56	2.7	1.9	4.1

[1] Computed from following sources: United States--Statistical Abstract (11); Denmark--Danish Agriculture (5); Japan--Agricultural Development (7); Taiwan--data supplied by Joint Commission for Rural Reconstruction (data for Taiwan include workers in forestry and fisheries).

[2] Little change.

[3] Slight decrease.

beginning to decline. However, the total agricultural labor force probably will continue to rise for the next 10 to 20 years.

If we use change in agriculture's share of total employment as an indicator of economic development, it is evident that most developing countries show progress during the last 20 or 30 years. Agriculture's share of total employment has decreased in nearly all countries, according to data reported by the Food and Agriculture Organization (table 2). Indonesia apparently is an exception. In several countries agriculture's share of the total labor force has decreased 5 to 10 percent in the last 20 or 30 years. However, in India, Pakistan, Thailand, the Philippines, Brazil, Colombia, and many other countries, agriculture still accounts for 60 percent or more of total employment.

Better data on agricultural and nonagricultural employment obviously are needed. But available data show that in many countries nonagricultural employment has increased more than twice as rapidly as agricultural employment. However, nonagricultural employment growth rates of more than 4 percent a year have not been achieved over an extended period of time by many countries.

Puerto Rico made the transition from 67 percent of total employment in agriculture in 1931 to 31 percent in 1962. Nonagricultural employment increased 3.3 percent a year during that period, while agricultural employment decreased about 1 percent a year. Total employment increased only 1 percent a year. The natural rate of population growth was higher than 1 percent a year but many people migrated to the continental United States.

Future Growth Patterns

What can one conclude about future growth in population or labor force directly dependent upon agriculture for a livelihood? Much depends upon how rapidly total population increases. Population growth rates have gone up rapidly

Table 2.--Percentage of total employment in agriculture and estimates of annual growth rates in employment, selected countries [1]

Countries	Period	Percentage in agriculture		Annual growth rates in employment		
		Beginning of period	End of period	Total	Agriculture	Nonagriculture
	Years	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Japan	1930-60	41	26	1.2	-0.3	2.0
United Arab Republic	1937-60	69	58	1.4	.6	2.8
Philippines	1939-62	75	66	1.9	1.3	3.0
India	1931-61	70	65	1.6	1.5	1.7
Pakistan	1961	--	73	--	--	--
Indonesia	1930-61	68	73	1.4	1.7	.8
Turkey	1935-60	73	61	2.0	1.4	3.5
Thailand	1937-60	84	78	3.0	2.7	4.4
Brazil	1940-50	69	66	2.2	1.6	3.3
Chile	1940-60	44	34	1.7	.4	2.5
Colombia	1938-51	70	63	1.6	.8	3.3
Peru	1940-61	66	55	2.0	1.1	3.5
Mexico	1940-60	65	55	2.7	1.9	4.2
Puerto Rico	1930-62	67	31	1.0	-1.0	3.3

[1] Computed from data on active population and population engaged in agriculture (males) reported in FAO Production Yearbook (8).

in the less developed countries in the last 15 years. During the first 50 years of this century, population increased less than 1 percent a year in Asia and less than 2 percent a year in Latin America. But in the last few years population has increased over 2 percent a year in most countries in Asia and over 3 percent a year in most countries in Latin America.

The application of modern health and disease control measures has reduced annual death rates from over 40 per 1,000 of total population to 10 to 20 per 1,000 in many countries. Meanwhile, birth rates have continued high at around 40 per 1,000 each year. As a result, populations have grown at rates of 2 to 3 percent a year. Young people now account for a large share of the total population of the developing countries. Consequently, these countries probably will continue to have high birth rates for the next 20 to 30 years.

India's experience during recent decades is typical of many developing countries. Total population increased only 5 percent during the 30 years from 1891 to 1921, or only one-sixth of 1 percent a year (1). However, population increased 44 percent during the next three decades, or over 1 percent a year. Birth rates continued high at about 45 per 1,000 of total population from 1891 to 1951, while death rates declined from 41 to 31 per 1,000. Since 1951, death rates have continued to fall while birth rates have remained high. Consequently, population growth in India now exceeds 2.5 percent a year.

In Taiwan total population increased less than 2 percent a year from 1905 to 1940, but it has increased more than 3 percent a year since 1950 (fig. 2).

According to estimates of the United Nations, world population will grow 2.1 percent a year between now and 1975 and 2.6 percent a year between 1975 and the year 2000. These estimates are world averages; population growth rates for the less developed countries are higher. The 1964 Demographic Yearbook of the United Nations reports annual population growth rates during 1958-63 of 2.9 percent for Turkey, 3.0 percent for Thailand, 3.2 for the Philippines, 3.1 for Brazil, 3.2 percent for Mexico, and 4.5 for Costa Rica. Of course, programs to limit population growth may be expanded and become more effective. However, even with effective population control programs, it seems likely that population will increase 2.5 percent a year between now and the year 2000, more than doubling the numbers in many developing countries.

For illustrative purposes we may assume for a typical developing country that 70 percent of the total population is agricultural. Let us also assume that, between now and the year 2000, total population increases 2.5 percent a year and nonagricultural population increases 4 percent a year (table 3). In this case,

Table 3.--Projected growth rates for population and agricultural production in a typical developing country, 1965 to 2000

Item	Annual growth rate	Year		Percentage increase
		1965	2000	
Population:	*Percent*	*Million*	*Million*	*Percent*
Total	2.5	100	237	137
Nonagricultural	4.0	30	119	296
Agricultural	1.5	70	118	68
Agricultural production:		*Percent*	*Percent*	
Total [1]	3.1	100	291	191
Per hectare	3.1	100	291	191
Per farm worker	1.6	100	173	73

[1] Total agricultural production projected to meet increase in economic demand, assuming annual income growth of 1 percent per person and income elasticity of demand for farm products of 0.6, in addition to population growth.

agricultural population would increase 1.5 percent a year. The country would make the transition from 70 percent to 50 percent of total population in agriculture by the year 2000. Total population would increase nearly 140 percent, nonagricultural population about 300 percent, and agricultural population nearly 70 percent. Population growth rates in many developing countries during the next 30 to 40 years may exceed the annual growth rate of 2.5 percent assumed here. Agricultural population of some countries may double before it begins to decrease, even though rapid economic development takes place.

Population Pressure on Land Resources

The developing countries in the next few decades will need much larger increases in agricultural production than those achieved in most of the now developed countries during the early stages of their development. In the case of the illustration referred to here, total agricultural production would need to increase 3.1 percent a year to meet economic demands resulting from population growth and slowly rising per capita incomes (table 3). If no additional land were available for cultivation, production per hectare would need to increase 3.1 percent a year, or nearly triple by the year 2000. In countries where population is increasing 3 percent or more annually, agricultural production must go up 4 to 5 percent a year to meet increasing demands for food resulting from population and income growth.

The increases in agricultural production required in European countries and in Japan, of course, were much smaller because population growth rates were only about 1 percent a year. Agricultural production did not need to increase more than about 1.5 percent a year to meet demands resulting from population and income growth. In the United States, Canada, and other newly settled countries, where population growth rates were around 3 percent a year during early stages of development, large areas of fertile land were available for cultivation. Agricultural production could be increased 4 to 5 percent a year by bringing additional land under cultivation.

Does rapid population growth in the densely populated low-income countries make economic development impossible? Do the small amounts of land and capital available per person limit development possibilities?

Japan is a country that achieved economic development with relatively few land resources. India and Pakistan usually are considered to be densely populated countries, but they now have 5 to 6 times as much arable land per person as Japan (table 4). However, land resources vary widely in quality. The potential productivity of arable land may not be as high in India and Pakistan as it is in Japan.

Countries like India, Pakistan, Thailand, and the Philippines appear to have enough land resources to feed the populations expected by the year 2000 if crop yields can be increased to levels now realized in Japan. Crop yields for rice now average about 3 times as large in Japan as those in most developing countries. But yields must go up much more rapidly than they did in Japan. During the 35 years from 1885 to 1920, when Japan made the transition from 72 percent to 49 percent of total population in agriculture, total agricultural production increased 120 percent or about 2 percent a year. And as has been pointed out, developing countries today will probably need annual increases in agricultural production of 4 to 5 percent.

The developing countries today may be in an advantageous position because they can utilize advanced agricultural technology from the developed countries. Certainly, the basic scientific principles are directly transferable. But some adaptation of production techniques now used in the developed countries, where average crop yields are relatively high, will be necessary before they can be applied to developing countries located mainly in tropical climates. However, the technological gap between known production methods that would increase crop yields and those that are currently being applied in tropical areas may be quite small.

Capital Requirements

Improved technology in agriculture requires the use of additional capital goods. In Japan, for example, inputs of working capital increased

Table 4.--Arable land per person and average size and number of workers per farm or holding[1]

Country	Arable land area per person		Average size of farm or holding[3]	Number of workers per farm or holding[2]
	Total population	Agricultural labor force[2]		
	Hectares	*Hectares*	*Hectares*	*Number*
Japan	0.06	0.42	1.2	2.0
Taiwan	.07	.58	1.2	1.6
Netherlands	.08	2.21	9.0	1.5
United Arab Republic	.09	.56	2.6	--
Peru	.15	1.15	--	--
Israel	.17	3.38	14.2	--
Indonesia	.17	.54	1.0	--
Brazil	.25	1.84	112.5	--
Pakistan	.26	1.13	2.4	1.9
Italy	.30	2.89	--	--
Colombia	.33	2.49	30.2	--
India	.35	1.24	3.0	--
Thailand	.35	1.04	4.4	--
Philippines	.37	1.90	3.5	--
France	.44	5.43	--	--
Ireland	.47	3.41	18.4	--
Mexico	.52	3.24	105.2	--
Denmark	.59	7.53	16.0	1.8
Chile	.67	8.51	183.6	--
Turkey	.86	2.30	7.7	--
United States	1.00	34.07	123.0	1.4
Argentina	1.38	20.53	366.2	--

[1] Data from Production Yearbook (8) and from World Agricultural Structure (9). Data on average size and number of workers per holding are for years around 1960 for Japan, Pakistan, Taiwan, Netherlands, Denmark, and the United States, and for years around 1950 for other countries.
[2] Male workers only.
[3] All land.

200 percent during 1885-1920 when agricultural production increased 120 percent. In Taiwan, inputs of working capital increased nearly 1.5 percent for each 1 percent increase in total agricultural output during the period from 1911-15 to 1956-60. Capital inputs accounted for only 11 percent of all inputs in 1911-15, but for 28 percent in 1956-60 (4). In the United States, capital inputs increased about 1.5 percent for each 1 percent increase in total agricultural output during 1870-1920 (6).

In most countries capital inputs probably will need to increase 4 to 5 percent a year to achieve annual increases in agricultural production of 3 percent. Most of these capital inputs will need to be supplied by the nonagricultural sectors. Fertilizer, pesticides, and other materials are especially needed to increase crop yields.

The developing countries have not reached the stage where large-scale substitution of capital for labor would be economic. Labor is abundant while capital and land resources are relatively scarce. However, greater use of machinery to improve land preparation and cultivation and to increase crop yields may be economic in some instances.

Abundant labor supplies can be a source of capital if used for such things as construction of roads and land-improvement projects. These

projects are especially useful in providing employment during seasons when labor is not fully occupied with farmwork.

Rapid population growth is a serious obstacle to growth in output per person. The capacity to save is reduced because a high proportion of the population is in the dependent age group (typically 60 percent as compared with 40 percent in the developed countries). At the same time, greater investment is required because a larger increase in gross national product is needed to provide a given increase in per capita income.

Enke has analyzed the economic aspects of slowing population growth (3). He concludes that resources used for birth control can be 100 times more effective in raising income per person than resources used in traditional development projects.

Most countries may have enough land resources and may be able to obtain enough additional capital so that, with improved technology, agricultural production can be expanded sufficiently to meet the food needs of expected population growth during the next 30 or 40 years. But population growth rates must decrease eventually if the world is to feed itself. Dr. Philip Hauser has pointed out that: "One hundred people multiplying at 1 percent a year for 5000 years of human history would have produced a contemporary population of 2.7 billion per square foot of land surface of the earth! Such an exercise in arithmetic, although admittedly dramatic and propagandistic, is also a conclusive way of demonstrating that a 1 percent increase in world population could not have taken place very long in the past; nor can it continue long in the future."[3]

Farm Size Problems

How will sizes of farms need to change as agricultural labor force increases? Questions relating to economies of scale will be very real in the future. Looking ahead 10 or 20 years, it should be possible to estimate at least approximately for each country how many people will depend upon farming for employment, how much land will be available for farming, and how much capital can be allocated for agricultural use. Should these resources be combined in small family-sized units, or should large farms employing 5, 10, or more workers be established? Policies influencing farm size and structural organizations in agriculture will affect income distribution as well as the efficiency of farm production.

Experience in the United States, Japan, and other developed countries does not provide much guidance on how sizes of farms need to change as total labor force increases. The United States brought large areas of land into cultivation during the years when its agricultural population was increasing. In fact, total area of cropland increased along with agricultural population until about 1915. Cropland area per farmworker increased slightly. Total cropland area in the United States has not changed much since 1920, but with the decline in farm employment in recent years, cropland per farmworker has gone up greatly. Sizes of farms have also increased. Similar trends have taken place in Canada, Australia, and New Zealand where population growth was rapid during early stages of development.

In Japan, where agricultural employment remained relatively stationary during the transition period 1885-1920, cropland per worker did not decrease. Little change in average size of farm or in the size distribution of farms took place. Most farms in Japan remained small with land distributed quite evenly among farmworkers.

In most West European countries where population increased only 1 percent a year and agricultural population remained stationary or decreased slightly during early stages of development, cropland per farmworker did not change greatly. However, several European countries had land reforms that involved breaking up large estates into small family-size units.

In Puerto Rico the farm labor force decreased about 1 percent a year during 1930-62, while agriculture's share of the total labor force declined from 67 percent to 31 percent. Cropland per farmworker increased. Thus, sizes of farms could be expanded without increasing the number of workers per farm.

[3] Quoted in: Joseph M. Jones, Does Overpopulation Mean Poverty?, Center for International Economic Growth, Washington, D.C., 1962.

In countries like India, Pakistan, Turkey, the Philippines, Thailand, and Egypt where not much additional land is available for settlement, farms will need to decrease in size, or the number of workers per farm will need to increase, to provide employment for the expected rise in farm labor force. Information about farm size structure is incomplete. However, data compiled here from publications of the Food and Agriculture Organization indicate that farms in India, Pakistan, Thailand, and the Philippines average twice as large as those in Japan or Taiwan (table 4). In most developing countries in Asia, it would be possible to double the number of farmworkers without increasing the number of workers per farm, by reducing the average size of farm by one-half; farms would still average as large as those in Japan or Taiwan. But little is known about how reductions in sizes of farms would affect crop yields in these countries.

There is no simple answer to the question of whether size of farms should be reduced or number of workers per farm should be increased. However, it is significant that Japan and Taiwan have achieved high levels of productivity per hectare with very small farms. Studies conducted in Japan, Iran, and India show that crop yields average higher on small farms than on large farms (10). Farming systems need to be developed that provide satisfactory living conditions for hired farmworkers as well as for operators. In most instances, the plantation system of agriculture has not done this.

The number of workers per farm or holding averages about the same in Japan, Taiwan, and Pakistan as in the Netherlands, Denmark, and the United States (table 4). In these countries most farmwork is done by the farm operator or members of his family.

It is sometimes suggested that farms need to be at least a certain size to provide satisfactory income levels. However, if only 2 hectares of arable land are available per farmworker, farms cannot be established that provide 3 hectares per worker without causing a large amount of unemployment. Because of the prospects for continued population growth in agriculture, average sizes of farms must decrease or more workers must be employed per farm. Furthermore, ways must be found to increase production per hectare and thereby provide satisfactory income levels with less land per person, especially in the densely populated countries.

Conclusions

Agricultural problems in the developing countries today are more difficult than those faced by the developed countries during their early stages of development. Much less agricultural land is available per person in most of the developing countries than was available in European countries, Canada, the United States, Australia, or New Zealand. Consequently, the developing countries now must achieve much higher crop yields per acre than the more mature countries during the corresponding stages of their development.

But even more important is the fact that crop yields must go up much more rapidly in the developing countries in the next 20 to 30 years than they ever did in the now developed countries. Because of rapid population growth and limited land resources, crop yields must increase 3 to 4 percent each year in most developing countries in order to meet expanding food needs. In the developed countries, increases in crop yields of 1 to 2 percent a year were large enough to meet expanding food needs because population growth was slower or additional land was available for cultivation.

The less developed countries have advantages today because of the advance in agricultural technology. However, high-yielding varieties of crops developed in temperate zones, where most of the developed countries are located, are not well adapted to the tropics where most of the less developed countries are located. Crop yields can be increased through the use of fertilizer and pesticides, but capital to finance the use of these materials is scarce in the less developed countries.

Continued population growth in rural areas of the developing countries will cause heavy pressure on land resources. Expansion of employment opportunities in urban areas resulting from industrialization can absorb only a small

share--probably less than half--of the growing agricultural population. Farms average relatively small in most developing countries, usually less than 5 hectares. But they will need to become even smaller and increase in number in most of these countries unless the number of workers employed per farm is increased.

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