Simposium of world food supply

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SYMPOSIUM ON WORLD FOOD SUPPLY

CHARLES E. KELLOGG, *Chairman*

THE symposium opened with the presentation of invited papers by Professor Theodore Schultz of the Department of Economics, University of Chicago; Professor Josué de Castro of the University of Brazil and a member of the Council of the Food and Agriculture Organization; and Professor George Kuriyan of the University of Madras, India. After presentation of these papers, the following members of the symposium spoke briefly on special aspects of the world food supply problem: Dr. W. H. Sebrell, Jr., Director, National Institutes of Health; Dr. Conrad Taeuber, Assistant Director, U. S. Bureau of the Census; Mr. Gove Hambidge, North American Regional Office, Food and Agriculture Organization; Professor L. Dudley Stamp, London School of Economics; and Professor J. Gentilli, University of Western Australia. The symposium closed with a period of general discussion.

FOOD PROBLEMS IN THE AMAZON AREA

JOSUÉ DE CASTRO AND ARTHUR FERREIRA REIS, *Brazil*

FROM an ecological point of view, the Amazon region represents a unified and highly characteristic food area, with manioc meal the basic food element. In this paper I propose to give something of its geographical and historical background and then to take up its present precarious nutritional situation.

The geographical limits of the area are well defined. It lies directly on the equator, extending north to the mountain system of the Guianas and south to the semiarid region of northeastern Brazil, where the forest covering changes to open-field vegetation xerophilous in type. The eastern ranges of the Andes constitute its western boundary. This vast area, bathed by the gigantic Amazon river system and covered almost completely by a thick mantle of forest, embraces a territory of about a million and a half square miles. The closed forest and the river network are the fundamental characteristics of the region. It is true that in the delta, in the Rio Branco valley, and in the lower Amazon in the state of Pará, natural fields occur which to some degree break the unity of the forest background.

It has been said that this equatorial area does not offer man the necessary conditions for a high standard of living and that it will never lend itself to any activities except those of extraction and exploitation. But to what point, exactly, is this true?

The greater part of the region is, in fact, covered with very poor soils that have been robbed of their mineral wealth by the heavy rains falling in the area. Then how are we to explain the ability of this soil to put forth such luxuriant vegetation as the Amazon forest, when its chemical characteristics make it far from fertile? How can it produce this staggering vegetable mass, made up of an infinity of plants, each with its own specific demands for innumerable mineral elements? Where at least do these plants find the 14 minerals that are today considered absolutely indispensable to the life of any vegetable species?

The answer is that the climatic conditions of the region are marvelously favorable to plant life. The unfailing high temperature and humidity offset the unfavorable soil conditions.

In ecological studies of plants there is always this complicated play of compensating forces, which result in an equilibrium making possible the life of the plant. The factors of climate, soil, and biotic environment are always interdependent. The equatorial climate, on the one hand, accelerates vegetable life, speeds up growth, and greatly intensifies the vegetative cycle; on the other hand, it hastens the rapid disintegration of dead vegetation by stimulating the action of micro-organisms, thus returning mineral elements to the soil and balancing the nutritive economy of the region. This balance is the result of the furiously destructive life of the forest, with plants being born and dying at the same time, killing and being killed in a terrible fight for life, each anxious to appropriate its share of mineral salts.

A certain student of such soil questions explains the disproportion between poverty of soil

and richness of vegetation in the following words: In these equatorial regions, " 'the capital [of the soil] is small, but the circulation rapid'." And in fact, it is this impetuous rhythm of circulation that permits the forest to support its strikingly rich vegetable life on the basis of a very limited capital in mineral salts.

What happens as a result of these conditions, however, is that plants, whether wild or cultivated, growing in such soils almost always contain a lower percentage of minerals than the average of similar species growing in other types of richer soil. And there lies the first conditioning factor in the poverty of the regional diet.

Some 15,000 square miles of the region is made up of lowlands subject to flooding. These are the so-called bottoms. Most of the agriculture and 80 percent of the regional population are concentrated on these alluvial plains. There the soil is really fertile. The floods may sometimes destroy the hard labor of the farmer, but they also bring him ample supplies of humus rich in mineral and organic elements, which are deposited on the fields when the waters go down.

Studies carried out by the Agronomic Institute of the North have demonstrated beyond any possible doubt the potential food-raising capacity of these bottom lands. The same thing could be done here as was done in the Orient. The Amazon bottoms could be the greatest rice belt in the West, a new Tonkin delta.

Scattered about this forest region live less than two million people. Geographically, it is the most extensive area of equatorial forest in the world. Demographically, however, it represents one of the most extensive deserts in the world. The thinness of its population can be compared only to that of the tropical deserts of Africa, the deserts of Australia, and the frozen deserts of Greenland and other arctic countries.

This alarming disproportion between the immeasurable size of the Amazon and its diminutive number of inhabitants is the first geographical tragedy of the region. In sharp contrast with the impenetrable grandeur of the geographical environment, this handful of people are crushed by the forces of nature. They are unable to react against the oppressive factors of their environment, mainly for lack of technical resources that could be made available only by forming demographic groups of much greater density. Such denser groups could really act as a colonizing force, as true geographical factors, altering the face of nature, smoothing and polishing the rough spots, and tempering her excessive rigors to the biological needs of men.

The conquest of the Amazon therefore has never been really undertaken. Its history begins in the 17th century, when English, Irish, and Dutch tried to explore its natural resources and experimented with colonization. This half-ceremonial enterprise, which ended in armed conflict with the Luso-Brazilians who came down the coast in 1616 and founded the city of Belém at the delta, was followed by the struggle of the Luso-Brazilians (the Portuguese and their descendants by Indian women) against the environment. For two centuries without a break the resistance to aggressive Nature continued. The result was a society with a strong local color, profoundly tied to the environment, accepting its aggressiveness, but at the same time, here and there, attempting to modify it. Little villages were established. Farmers experimented with sugarcane, coffee, indigo, cotton, rice, and cacao. Attempts were made to raise cattle and to explore the forest and the wealth of fish in the rivers. The gathering of spices and herbs that Europe demanded for seasoning food, for medicines, and for many other industrial uses remained the principal basis of economic life. Swarms of boats of all shapes and sizes went up and down the rivers in the process of gathering this profitable merchandise.

The native population, scattered throughout the hinterland, made a valuable contribution to this enterprise. They acted as guides for the expeditions, handled the boats, identified the vegetable and animal species, and mixed with the colonists as they arrived. Missionaries and civilian functionaries mobilized and gave guidance to the Indians.

The 19th century brought new political conditions to the region. It ceased to belong to the Portuguese colonial empire and became part of an independent Brazil. But working conditions remained the same. The experiments in farming and cattle raising made little progress. What did increase were the extractive industries, which gradually took the lead over other occupations. Uses were found for certain wild gums, notably that of *Hevea brasiliensis*, which grows wild there in abundance.

Intensive exploitation of the new "herb" began. The offensive against the forest in search of trees that would give the precious milk took on truly

sensational proportions. Additional hands were needed, and some hundreds of thousands of men came to the Amazon from northeastern Brazil. History has never seen a more audacious undertaking of this type. However, the whole bold attempt to dominate the space of the Amazon was carried out without the necessary discipline and without the technical resources that could have led to stability, or at least to a less unstable economic and social order.

Lacking sufficient strength to dominate the environment, to make use of the possibilities of the land, to organize a productive economic system, the regional populations of the Amazon even today still live almost exclusively by an economy of destruction. They live by merely gathering wild products; by hunting and fishing; by collecting seeds, fruits, roots, and bark in the forest; and by extracting latex, vegetable oils, and resins.

A certain primitive culture of food products such as manioc, corn, rice, and beans was undertaken only in limited areas and by the most rudimentary methods. How insignificant this production was can be judged from the fact that the planting was done in burned-over areas, a pre-Columbian method, the seeds being thrown in the scarcely cultivated soil still covered with piles of half-burned trunks, branches, and litter.

As to cattle raising, it is practically limited to three small open-field areas, one located on Ilha de Marajó at the mouth of the river, another in the lower Amazon in the state of Pará, and the third in the Rio Branco region. On Ilha de Marajó the cattle live in the marshes, where floods decimate the herds with almost periodic regularity and force the cattlemen to drive their herds long distances in search of higher ground. Another recourse is to bring the cattle together on great rafts (*marombas*) together with sheep, pigs, and hens. These may be seen floating like great Noah's arks about the lakes into which the island is transformed. The lower Amazon area suffers from the same afflictions, while the Rio Branco area is less damp as the fields are above flood level.

In addition to these natural obstacles to cattle raising, what meat and milk there is cannot reach the rest of the region for lack of transportation. These are products that have practically no place in the habitual diet. The only meat available is dried and salted—jerked beef imported from other areas, and even this is in very small quantities. Fresh meat and milk exist only in a few of the more important cities, and even there the quantities involved are insignificant. Milk derivatives such as butter and cheese are hardly ever seen outside of Belém and Manaus. The difficulties of raising chickens in these flood areas make eggs a luxury item. The only fresh meat is wild game, such as tapir, wild duck, or monkeys, and fish, the consumption of which is limited to those who live on the banks of the rivers, inlets, and lakes. Almost all the inhabitants of the area live beside the water, because there are very few who dare to wander far from it, since the rivers are the only means of penetrating the forest and since the waters of the rivers contain the greatest economic wealth for their subsistence.

These few slender resources form the basis of the diet of Amazon man. The food requires little preparation and has little appeal. Even today it reveals the predominant influence of Indian culture over the Portuguese and Negro cultures which also helped to shape it.

The basic element of the diet is manioc meal made from the bitter cassava. It is prepared in this region by special processes that leave a larger usable residue and, therefore, give it a higher caloric value than the farina produced in areas farther south. Manioc meal of this type, locally called "water meal," inevitably accompanies almost everything that is eaten. That is why Theodore Peckolt called it the "bread of the tropics." It is most widely used in the form of *farofas*, *beijas*, porridges, and fermented drinks.

Although manioc meal is the basic food, it is not the only one. If it were the local diet would be as deficient as that of certain hunger areas of China and Indochina, where the food is almost exclusively rice, without mixture or variety. It is this terribly monotonous diet that lowers so sharply the nutritional index of these oriental populations. In the Amazon the farina is combined with other products. These may be derived from the incipient regional agriculture, or they may be wild products, such as fruits and seeds from the equatorial forest. They may be elements of the regional fauna, especially the aquatic fauna, since there are few land animals that can serve as sources of food. There is little room left for animals, because the land is almost completely monopolized by the plants, and hunting therefore offers little in the way of food supply.

Fishing is much more productive, and contributes many varied and nutritious elements to the

local diet. The Amazon is filled with an infinite variety of fresh-water fish, the most common being the *pirarucu*, the *pescadas*, and the *curimatá*. These are all used, as well as crustacea and mollusks, *siris* and *avius*, shrimp, crabs, and so forth. The natives also make abundant use in their diet of turtles, eating both meat and eggs. These products of the aquatic fauna make up the only available source of animal proteins because domestic meat production is so extremely limited.

It must not be forgotten that local foods are prepared with the assistance of certain sauces, which are made from extracts of local herbs and peppers. The Indians were always great eaters of fresh peppers, not only using the juice of shredded peppers to sharpen sauces, but also eating peppers as fruit by the handful. The native populations still use large quantities. The consumption of greens and green vegetables was always very low in this region. The complicated work of gardening is beyond the reach of local agricultural technique, and the importation of these products would go beyond the economic resources of the zone, as well as its technical transportation facilities.

Wild fruits also enter into the habitual diet. The banana, a typical, equatorial tropical product that is widely consumed in the forest area of the Congo, also contributes to the nutrition of the Amazon. However, so little sunlight penetrates the forest cover that the vitamin content of these fruits is lower than in other geographical regions.

In contrast, we need only consider the case of certain oleaginous fruits produced by various species of palms, whose oils are amazingly rich in beta-carotene, that is, in pro-vitamin A. Typical of these vegetable oils is that of the *buriti*, produced by the palm *Mauritia flexuosa*, which contains some 5,000 units of vitamin A per cubic centimeter. The oil of the assai palm is also extremely rich in vitamin A. Assai is used on a large scale, particularly in Pará, where it is one of the fundamental native foods.

Another regional product that deserves special mention because of its extraordinary nutritive value is the "Brazil nut," an oleaginous fruit produced by *Bertholletia excelsa*. Its protein is identical with meat in amino acid content, a fact which led Bottazzi to call it "vegetable meat."

The reason why these palms and nut trees can produce such highly nutritious fruits in a region where fruits in general are of poor quality is because these plants produce in direct sunlight. The palms grow in marshy bottoms, thus eliminating the competition of other tree species, while the Brazil-nut tree is a giant that breaks through the forest covering where it can receive the sun directly. It is the miracle of photosynthesis, therefore, that gives us the magnificent nutritional concentration of these fruits, whose existence is exceptional in a typical equatorial region.

Upon analysis, the Amazon diet proves to have innumerable nutritional deficiencies. It could hardly be a proper diet when it is so extremely poor, or even completely wanting, in certain protective foods such as meat, milk, cheese, butter, eggs, greens, and fruits. It could also hardly be adequate when it is so small in quantity. It is a scanty, meager diet, modest in the extreme. The amount a man eats in a whole day would be insufficient for a single meal in other climatic areas, where food habits consequently are different. And yet the Amazon man seems satisfied with his fate and is able to appease his hunger whenever he wishes with a little manioc meal and coffee, plus a swallow of cane spirits.

But the fact is that these are people whose appetite has been dulled and who live in a chronic state of anorexia. This is a natural consequence of the lack of vitamins in their diet.

The dietary regime of the Amazon, therefore, is deficient in proteins, in various mineral salts, and in vitamins, as well as monotonous in the extreme. This defective nutrition has the most adverse effects on the biological and cultural characteristics of the human groups involved. The low productive capacity, the lack of resistance to innumerable diseases, the short life expectancy, and mortality index so characteristic of the region are all factors that reflect, in great part, the chronic undernourishment of the Amazon population.

THE SUPPLY OF FOOD IN RELATION TO ECONOMIC DEVELOPMENT

THEODORE W. SCHULTZ, *United States*

THE SUPPLY of food is always a lively topic as a rule unencumbered by theory or cramped by relevant statistics. While free from such dull restraints, it is often a victim of the fear that people will sooner or later "eat off their heads." Many have played the game of matching population growth and agricultural land with exciting results. Some of those who come to mind are Malthus and Ricardo, Crookes a century later, more recently Aldous Huxley and Sir John Orr and to mention two a bit more optimistic in assessing the odds, we have Sir John Russell and Robert M. Salter. But with all respects to these and others, I doubt that it can be said that there is at hand a satisfactory general explanation of the supply of food.

It will be my thesis that the fundamental attributes of the supply of food differ importantly between and among countries and that these differences are primarily the consequences of economic development. The comparison which I shall make is between countries with a thin layer of capital, primitive in technology, skills mainly undeveloped, and poor in income—the so-called underdeveloped countries, and those with a thick covering of capital, advanced technology, fairly skilled workers and a relatively high income—the developed, Western countries. The observable differences in the supply of food between these two groups can be explained in terms of economic variables and the explanation is a meaningful representation of the effects of economic growth and development upon the supply of food. I am afraid, however, that this thesis will not allow me to strike an exciting chord, for it will be necessary to indulge in a few technical concepts, to be somewhat taxonomic, and a bit abstract in handling the variables and relations that emerge.

Many of you, I am sure, would like to have me examine the food supply in terms of additional cropland whether by irrigation, drainage, widening the temperature range, bringing in more of the undeveloped tropics, or by the application of more fertilizer and the use of better plants to increase yields, or in terms of still other improvements in farm practices that will increase the output of food. There are two good reasons for my not doing this: In the first place, clearly I am not competent to organize the technical knowledge and data that such an approach would entail, and, in the second place, each of these activities to increase the output of food is subject to a set of economic conditions, because irrigation, drainage, and other means for enlarging the area of cropland require resources and so does fertilizer. New and better production techniques require research, extension, and particular farming skills, and each of these also entails costs in terms of resources. Moreover, a precondition of modern farming, characteristic of Western countries, is industrialization. The food supply, accordingly, may be represented as a function of a set of economic conditions, and it is to these that I shall now turn.

To organize the available data, I shall take two concepts and use them to gauge two important attributes of the supply of food, namely, its elasticity and its growth possibilities. A word on each of the two concepts seems necessary. The elasticity of the supply represents the relation between output and price. We wish to gauge the elasticity in the short run because of its relevance in adjusting an economy to large, sudden changes in food requirements. We shall, therefore, take a period not to exceed three years and abstract from the production effects of improvements in techniques and in total factor supplies. The supply shift possibilities represent the relation between economic development and the position of the supply schedule where economic development moves the entire food supply schedule forward (to the right). We shall here take a somewhat longer time interval, say, a period of a decade.

FOOD SUPPLY ELASTICITIES

The supply of food is slowly becoming more elastic as a consequence of economic development. This important structural change has gone virtually unnoticed, mainly because of the overemphasis of agricultural land in gauging existing food-producing possibilities. As agriculture declines in relative importance, a new factor of safety emerges with regard to food because more resources than formerly can be transferred into agriculture from other lines of endeavor on fairly

short notice; and, at the more advanced stages of economic development, enough resources can be transferred to increase substantially the amount of food produced, assuming, of course, normal weather and for the moment leaving aside the additional favorable effects of new production techniques and growth in total factor supplies. Underdeveloped countries, unfortunately, do not have this particular flexibility in food output and the element of safety it provides.

Let me briefly consider the factors affecting this elasticity. If a country were suddenly hard pressed to increase its output of food, say because of war, the unavailability of imports, or for other reasons, how much more will it produce? Also, conversely, how much will the production of food be reduced if conditions were to take a sudden turn in the opposite direction? In gauging the relevant supply elasticities, I shall hold to a time interval of no more than three years and neglect for such a period longer run developments. To simplify further, I shall assume that the country is not suffering from a major depression associated with mass unemployment and that the sudden changes in circumstances give rise to a substantial movement in relative prices with farm food prices rising (falling), say, 25 percent for purposes of the treatment that follows.

Under these conditions, the collection of resources available to the economy is virtually given and these resources are employed. To increase the output of food—abstracting throughout the effects of variations in weather—it is necessary to transfer *1*) some resources within agriculture from cotton, tobacco, jute, and other nonfood crops to food, or *2*) some resources from the nonfarm sectors to agriculture to produce more food. I shall neglect the possibilities of transferring resources from nonfood to food products within agriculture for two reasons: first, one observes that when sudden changes have occurred in nearly all cases the demand and the price of the more important nonfood products have risen relatively about as much as the prices of farm foods, and second, the food group clearly predominates in most countries whether they are developed or underdeveloped.

In general, conditions favorable to a transfer of resources from nonfarm sectors to farms to produce more food are *1*) an economy in which agriculture is small relative to all production activities and *2*) an agriculture that employs a collection of resources of which a relatively large part is supplied by the nonfarm sectors, and where many of the resources used in farming can readily be employed in nonfarm production.

I shall compare India and the United States to illustrate the consequences of these conditions for the elasticity of the food supply. Less than 10 percent of the resources of the United States are committed to agriculture, whereas in India, it would appear that upwards of 60 percent of all resources are so employed. Furthermore, farmers in the United States draw heavily upon the nonfarm sectors for inputs; about two-thirds of the gross farm income in the United States represents production expenses and a large part of these expenses represents inputs that are either purchased by farmers from other sectors or that can readily be employed in nonfarm production. Although there are no comparable data for India, agriculture in that country is patently much more self-contained in the inputs that it employs.

The differences in supply elasticities of food that emerge are, I believe, of the following order: In countries where the economy is relatively developed, represented presently by the United States, this elasticity appears to fall between .3 and .4 when expansion of food output is called for, but lower, .2 or less, when the price of farm foods falls relatively and contraction is induced. This means that in the event farm food prices were to rise 25 percent, say to a parity of 125, the output of farm food would increase as much as 10 percent during an interval as short as three years, assuming, as already said, normal weather and abstracting improvements in production techniques and growth in total factor supplies. A fall in price of the same magnitude, however, would induce a contraction of only about one-half this figure. On the other hand, in countries that are much less developed, represented currently by India, this particular elasticity under the conditions specified is exceedingly low; it may be virtually zero when one abstracts new techniques and growth in total factor supplies. This means that a substantial rise in the price of food is not likely on short notice to bring about even a small increase in the production of food.

In addition, as an economy develops, the ratio of animal products in the diet increases, and this change in the composition of the food supply represents still another important latent factor of safety. It would be possible in the United States, for example, to provide enough additional food to care for 50 and even 100 million more people

on rather short notice by simply reducing somewhat the ratio of animal products in the food that is consumed. One observes, however, that a rise in the relative price of food of as much as 25 percent will not by itself bring this latent factor into play. We know, nevertheless, that it exists and that it is one of the important differences in the underlying "elasticity" of the food supply of developed and underdeveloped countries.

There is yet another important closely related difference which arises from the income effects upon the demand for home-produced food by farm families to which I wish to call attention. In the United States, home-produced food has become an inferior good against income; this means that as farm incomes rise, for instance, as a consequence of the 25 percent rise in farm food prices as already postulated, farm families will reduce their consumption of home-produced food and increase their sales of food accordingly. In India, in sharp contrast, the cultivators' demand for food is such that much more would be consumed at home in the event their real income were to rise because this food is for them a superior good with a very high income elasticity, probably as high as unity (1.0). The supply curve of food, confronting the nonfarm people dependent upon these cultivators, is, therefore, a backward sloping curve, which means that as the price of this food rises, less rather than more is forthcoming from cultivators because they will, under such circumstances, increase their own meager consumption. A considerable part of the drastic food shortage in some nonfarm communities in India in 1946 was the result of this particular income effect.[1]

SUPPLY SHIFT POSSIBILITIES

I shall now examine the possibilities of increasing the supply of food over a period of years, specifically during a decade. As I have already indicated, nearly all treatments of the food supply neglect completely the elasticity attribute, which I have just considered. Moreover, in taking the longer view, these treatments have certain shortcomings in common. They place all too much importance on the function of agricultural land and on the very long run for which no one can foretell the effects of new production techniques, of new knowledge about nutrition, and of the path that population growth will take.

Here again I shall point out the major differences between the two classes of countries, i.e., those with highly developed economies and those which are distinctly underdeveloped. I shall restrict my remarks to changes in fundamental factor supplies and production techniques and the effects of these upon the supply schedule of food. Although economic growth and development tend to make the supply more elastic, I shall say no more about that attribute in order to concentrate upon possibilities of shifting the entire schedule forward, that is, to the right.

A forward shift of the schedule means simply that production relations have so changed that more food will be produced than formerly at the same relative price.[2] To illustrate: the United States produced about 75 percent more food in 1950 than in 1910 at about the same relative price; this achievement may be represented as a shift of the farm food supply schedule far to the right, namely a forward shift of 75 percent.

The basic underlying conditions affecting the possibilities of shifting this food schedule forward may be represented by the rate of increase *1*) in total factor supplies, *2*) in output per unit of input, and *3*) the extent to which the additional factors and the new and better production techniques can be employed to produce more food.

The situation will be most unfavorable for achieving a forward shift of the supply schedule of food wherever the rate of growth in factor supplies is small; or the additional factors are specific in the nonfarm sectors, and, therefore, cannot be employed in agriculture; or few advances are made in technology; or these new production techniques are in no way applicable to farming. The converse of these conditions would represent the most favorable circumstances for a forward shift of the supply of food.

To compare the developed and underdeveloped countries with respect to these conditions, let me again take the United States and India. *1*) The rate of growth of total factor supplies in the United States is fully twice that of India; further-

[1] SCHULTZ, THEODORE W. THE ECONOMIC ORGANIZATION OF AGRICULTURE. 374 pp., illus. New York, Toronto, London, 1953. See ch. 14, p. 231, for a treatment of this income effect.

[2] This schedule may also shift under circumstances when the relative price of farm food has changed; in that event, however, it becomes necessary to separate out the resource "transfer" effects upon production from the effects of a shift in the supply schedule.

more, India is still hard pressed to accumulate enough additional capital to even maintain its present very low ratio of capital per worker, whereas this particular ratio in the United States is being increased appreciably and readily. *2*) Although the increases in fundamental factor supplies, including not only capital but also workers, that each will achieve during the next decade are not specific either in agriculture or in the nonfarm sectors, it is not possible for India to use these additional factors to enlarge the capacity of her agriculture as effectively and to the same extent as can the United States. This particular difference arises not because such additional capital and labor cannot be used in India to increase the output of food but because the economy of India is much more dependent upon its agricultural land. In the United States, we find, as I have shown in a recent paper, that all of the land that is being used for agricultural purposes represents only about 20 percent of all of the inputs employed in agriculture, and what is much more important, only about 2½ percent of all factors employed by the American economy. In India, in marked contrast, it appears that about a third or more of the inputs in agriculture consist of land and that agricultural land probably represents more than 25 percent of all of the factors employed presently by the Indian economy. Agricultural land, accordingly, is fully ten times as large a share of total factor supplies in India as it is in the United States; and, therefore, to find the capital necessary to enlarge the productive capacity of this land, emphasis is on the importance of being unimportant, as agricultural land has become in the American economy. *3*) In new production techniques, the advantages presently are very much on the side of the United States and the developed countries generally. The research required to "produce" these new techniques and the extension work needed to help farmers apply them is expensive, especially for a poor country. *4*) It is doubtful that technological advances which increase the ratio of output per unit of input are necessarily specific in either agriculture or other production activities. Recent Western history indicates that they are about as applicable to one as to the other. Nor is there any reason for believing that the outcome will be substantially different in the underdeveloped countries as they undertake the slow and painful task of improving their production techniques.

The results of this comparison can be formulated in fairly firm quantitative terms. With normal weather and with growth in factor supplies and with advances in production techniques that are within reach and that probably will be realized, the supply schedule of food in India cannot be moved forward during the next decade as much as 20 percent. The evidence, fragmentary as it is, indicates a forward shift of about 10 percent under the conditions specified. For the United States, the equivalent figure is not 20 percent but a forward shift of the farm food supply schedule of substantially more than this amount. The Bureau of Agricultural Economics—Land Grant College study, *Agriculture's Capacity to Produce*,[3] leaves little room for doubt on attainable possibilities. Even by 1955 with full employment and with cost-price relationships about as they now are (one of the important assumptions is a farm price parity of 105) an increase in total farm output of 20.6 percent is attainable. Moreover, this additional output requires no increase in acreage of farm land or in man hours of farm work. Some improvements in production techniques and a further increase in fertilizer, machinery, and in some other inputs that are purchased by farmers from other sectors of the economy account for the forward supply shift now in prospect.

In closing, let me ask a question. Can the people living in underdeveloped countries free themselves from the niggardliness of Nature as have those in developed countries? There is room enough for both pessimists and optimists. The answer depends on what can be done in achieving economic development. But whether comparable development can be attained, even in the very long run, we do not know.

But this much we can say: The supply of food is a function of economic development. It becomes less and less dependent upon agricultural land, it becomes more elastic, and the possibilities of forward shifts of the food supply are improved importantly as a consequence of economic development.

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[3] Land-Grant College–Department of Agriculture Joint Committee on Agricultural Productive Capacity. agriculture's capacity to produce. U. S. Dept. Agr. Information Bul. 88, 62 pp., illus. 1952.

FOOD PROBLEM IN INDIA

GEORGE KURIYAN, *India*

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