The Protein Problem

Moises Béhar M.D.

Director, Institute of
Nutrition of Central America
and Panama (INCAP),
Guatemala City, Guatemala, C.A.

The capacity of civilizations to meet their nutritional requirements through adequate food supply has been one of the basic factors determining their stability and progress. In this struggle population groups have always given priority to meeting their total caloric needs. In the tropical and subtropical regions of the world the most efficient production of dietary calories, under the prevailing ecological conditions and economic and technical resources, is achieved by cultivating vegetable foods of high-carbohydrate content, such as cereal grains and starchy roots and fruits. In this way, rice, corn, cassava, and bananas have become the staple foods of the majority of the world's population. The production of protein-rich foods (leguminous seeds and particularly animal products) is much less efficient in terms of calories

The protein in the diets of these populations, therefore, is usually very low in concentration and biological value, even though caloric requirements may be satisfied. When calories are also limited, the protein deficit becomes even greater because at least part of the dietary proteins must be utilized for energy. Protein deficiency, with or without a caloric deficit, is always the result and constitutes, at the present time, one of the most serious aspects of the nutritional problems affecting most of the world's population.[1]

This problem could become much more serious in the near future because of the present trend in population growth, demanding a rapid increase in food production, particularly in the less-developed countries, precisely the areas where food production is in many instances already lagging behind.

It is not necessary to elaborate on the effects of protein-calorie malnutrition on the children in developing countries; this has been described many times. I would like only to emphasize that, in addition to the well-documented increase in morbidity and mortality resulting from malnutrition among small children,[2] evidence is accumulating on the serious damage it produces in the surviving population. Its effects on mental development, learning capacity, and behavior are now matters of great concern.[3] The information currently available indicates

that severe malnutrition during the first months of life results in serious and permanent damage to the central nervous system.[4] Mild to moderate forms of protein-calorie malnutrition are much more frequent, usually affecting children at a later stage of development (between 6 months and 5 years of age). A correlation has been demonstrated between the retardation in physical growth of these children — which is primarily due to malnutrition — and their performance on some behavioral tests, suggesting a similar retardation in mental development.[5] Although we do not believe that it has yet been clearly determined whether these behavioral changes are the direct result of malnutrition per se or of the social deprivation usually accompanying it, or to a combination of both, there is no question that malnutrition is one of the important components of the entire poverty syndrome.

In addition to the biological effects on the population, malnutrition also shares responsibility for serious economic, social, and political problems. Along the same line of thinking, particularly from the economic point of view, the long-term effect of chronic malnutrition on the working capacity of the individual also must not be neglected.

Studies now under way at the Institute of Nutrition of Central America and Panama (INCAP) suggest that although there is some degree of adaptation, the efficiency of physical work performance of agricultural laborers is handicapped by long-standing nutritional deficiencies, usually subclinical, and therefore largely unrecognized. The effects of this situation on the more subtle but no less important characteristics of these populations, such as motivation and initiative, may prove to be of even greater significance.

We should therefore be seriously concerned over the future. If the present problems, already serious, are left uncorrected and become further aggravated as a consequence of an unbalanced population growth, the future of underdeveloped countries and hence that of all humanity will be jeopardized.

Under this pressure of a very rapidly expanding population, particularly in those areas where malnutrition prevails, the situation daily becomes more serious. The pressure may first force a greater production of calories in proportion to protein which could aggravate the protein deficit for the reasons already indicated.

To illustrate the failure of the increase in food production to correct the already existing gap and to cope with the rapid rate of population

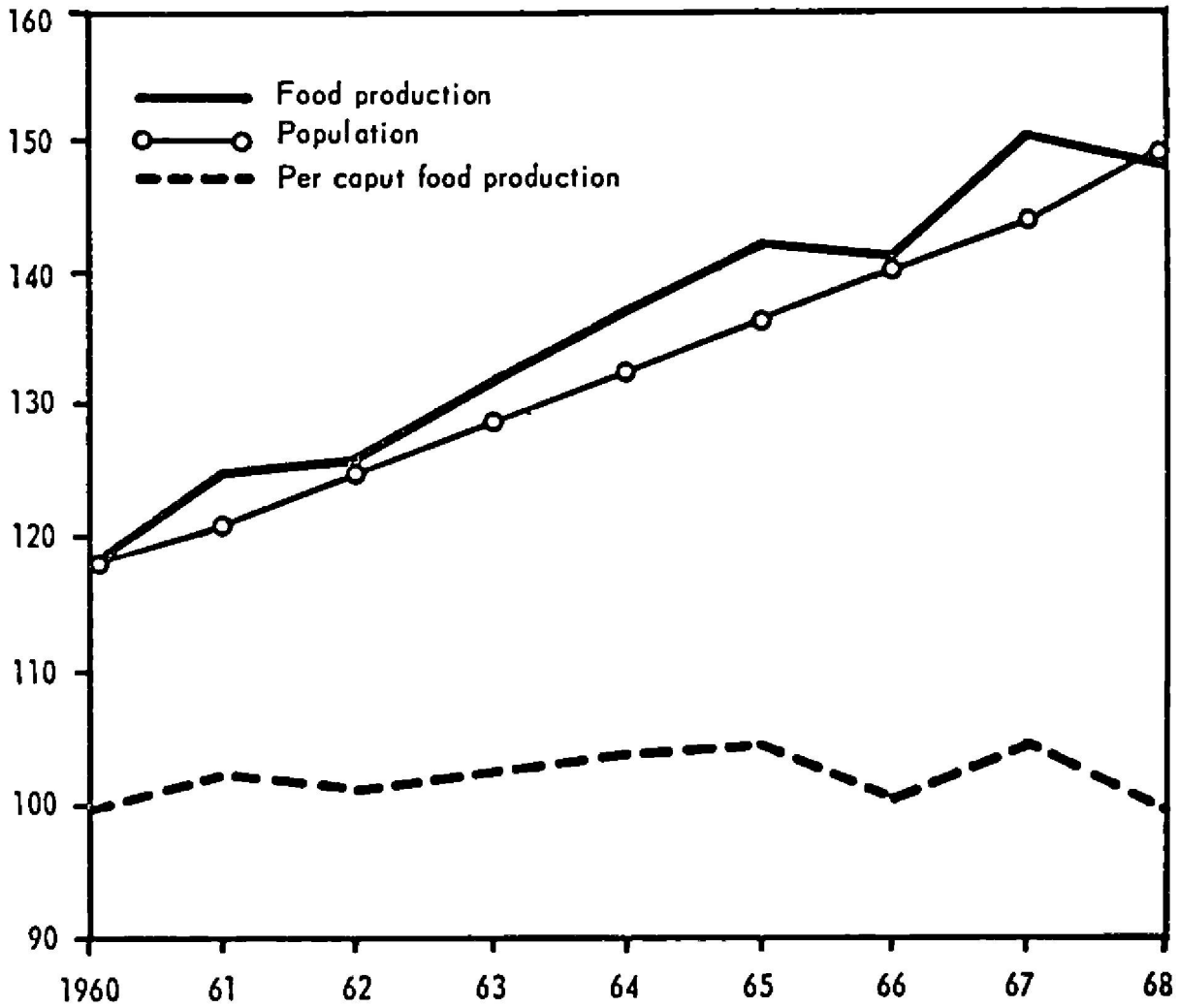

Figure 1. Trends in food production and population in Latin America. From Organización de las Naciones Unidas para la Agricultura y la Alimentación. El estado mundial de la agricultura y la alimentación, 1969. Roma: FAO, 1969 (C 69/2), p. 3.

growth, I will refer to Figure 1, taken from the Food and Agriculture Organization 1969 report on "The State of Food and Agriculture."[6]

During the last 20 years both food production and population have been increasing in Latin America at about the same rate, now close to 3 percent per year. As a consequence, the per capita production has not been significantly modified. It should be stressed, however, that in this type of statistic, some facts of great practical importance are not apparent. First, these are average figures for a very large and heterogeneous group of countries. Some, such as Mexico and Argentina, have made significant progress in increasing food production to levels well above the average for the region; but per capita food production has, in fact, deteriorated in many other countries. According to estimations made by INCAP, this has been the case in Central America for some of the important food items.

Another fact not apparent in statistics of these types is the qualitative nature of the change. For example, food production includes coffee, sugar, and other items of little nutritional significance but of greater economic interest to the countries because they are cash crops for exportation. For this reason they receive greater stimulus and support from governments, frequently to the detriment of the basic food crops. In fact, our data indicate that in Central America, the production of some of the most important sources of dietary protein, such as beans, has decreased significantly in recent years.

Finally, in relation to the interpretation of these statistics, it is well recognized that distribution of nationally available foods is unequal among the different socioeconomic groups of the population. This also applies to the food intake of different members within each family, a distribution that works against the small children of the less-privileged majority groups.

The adequacy of protein in a given diet not only depends on its concentration but also on the nutritional value of the protein. Both factors, concentration and nutritional value, must therefore be considered simultaneously. It is well known that the biological value of a protein, or of a mixture of proteins, is primarily determined by the essential amino acid patterns. For rapidly growing children, who not only have greater nitrogen requirements in relation to total calories but also proportionally higher requirements for essential amino acids than do older children or adults, both protein concentration and nutritional value are particularly critical. To exemplify the importance of this situation, we can take the case of populations whose main staple is corn. Under these circumstances, a two-year-old child could satisfy his caloric requirements with 350 g of corn a day, assuming that he could consume that amount. The child would then be receiving about 35 g of proteins. However, he would not receive the required amounts of essential amino acids, particularly lysine and tryptophan. For the child, therefore, the protein will have a low biological value and the indicated amount will be insufficient to satisfy his protein requirements. This has been demonstrated at INCAP by the nitrogen balance technique. With protein intakes of the order indicated(3 g/kg/day), children 2 to 5 years old have a very low or negative nitrogen retention when corn proteins are the only sources of nitrogen. This situation can be corrected by the addition of lysine and tryptophan.[7]

By contrast, an adult satisfying his caloric needs with corn will be obtaining 78 g of protein. In spite of the low essential amino acid con-

centration, he will be receiving sufficient quantities to satisfy his needs, including lysine and tryptophan and will be obtaining more than sufficient total nitrogen. With this food of "low" protein concentration, containing proteins of "low biological value," he will still be able to satisfy his protein requirements if enough of it is consumed to satisfy his caloric needs, although this may not be the most efficient way of satisfying nitrogen requirements. The problem, of course, is still worse for small children consuming starchy roots or fruits that have an even lower concentration of protein than cereal grains.

In the areas of the world where protein malnutrition now prevails, what is needed is an increase in the availability and consumption of total dietary sources of protein, and, particularly for small children, of those with a higher concentration and better nutritional value. The problems to be faced in achieving this goal are mainly socioeconomic and cultural and not infrequently political as well. Again, the lag is evident between scientific achievement and the application of technical knowledge to the realities of the developing world today. Attempts to deal with some of these realities have been made for 20 years in Central America.

The conventional adequate sources of dietary protein such as meats, eggs, and milk are much too expensive for the large majority of the populations in the developing countries. Under these circumstances, the internal market cannot compete with the international market where some of these foods are in high demand. As a result we see that countries with a great deficit of such products frequently export them in large amounts. For example, in rural Guatemala the average per capita consumption of meats is 40 g/day,[8] with large population groups consuming practically none. Nevertheless, in 1968, the country exported 10,000 tons of beef. At first sight this may seem illogical. It should be pointed out, however, that without the possibility of exportation, this meat would not have been produced at all because the internal market simply could not afford so much of a "luxury" protein.

In a recent study carried out as part of a nutritional survey in Guatemala,[8] it was found, for example, that the price of one pound of beef in the local market represented up to 60 percent of the daily salary of an agricultural worker, a situation which, among other sociological reasons, reflects the low prices of agricultural products exported by developing countries to international markets. For large segments of the population who are practically outside of the cash economy and living primarily on their own production, the situation is considerably worse.

Another serious limitation to these conventional products of animal origin is the difficulty of preserving them without adequate processing and home refrigeration, neither of which is available to most families in the developing countries. An illustration of the importance of this situation and its implications is the dairy industry in Guatemala. There is a natural increase in milk during the rainy season due to more abundant pasture, and production surpasses the local demand. As a consequence, farmers encounter great difficulty in selling their dairy products. The price in the producing areas goes to as low as 4 cents per liter and is sold mainly for cheese production. During the dry season, on the other hand, there is not enough milk.

Even though the demand for milk is not great, production is insufficient for the entire country on a year-round basis. Hence, imported powdered milk is used to cover the deficit. In 1968, Guatemala imported over 6 million pounds of powdered milk at a total cost of over 2½ million dollars. A similar amount of skimmed powdered milk was brought into the country for free distribution as part of the foreign aid program of the United States of America.

It is obvious that if the milk produced in excess of local demand during the rainy season could be locally processed into powdered milk, the economy of the country, the producers, and the consumers would benefit. There is a problem here, however, in that locally processed milk cannot compete in price with imported milk even after the addition of transportation expenses and import duties. This, of course, is due to more efficient production and a much larger volume of operation in the industrialized exporting countries. Furthermore, and of significant importance, is the fact that in most cases, imported milk is subsidized in different forms by the governments of the exporting countries. This situation could be counteracted by raising import duties, a measure that governments are usually reluctant to take because of the political implications of raising the price of a product considered to be vitally important. Despite this, such measures have been taken by some of the Central American countries. Costa Rica, for example, has limited the importation of powdered milk, both commercially and for free distribution; as a result, we have seen the development of the most successful dairy industry of the region. The excess of locally processed powdered milk that the market cannot absorb, particularly skimmed milk, is now purchased by the government for use in supplementary feeding programs, especially for needy preschool children.

The nonanimal sources of protein probably offer the most immediate possibilities for dietary improvement in the underdeveloped countries. We have had a continuing interest for many years in the possibility of lysine and tryptophan enrichment of the corn consumed in Central America, either with synthetic or natural amino acids. In fact, studies oriented toward this possibility started in the middle 1950s. This would undoubtedly be of great nutritional value through the consumption of enriched tortillas, the basic food for the populations now suffering from protein deficiency in Guatemala. We have found, however, that even if the economic problem could be solved, which is not yet easy, we would still be faced with the logistics of how to apply such measures.

The populations who need the supplement frequently produce their own corn. Even when they have to buy it, it is prepared at home every day and may be milled either in the home, or more frequently today, in the small village mills. Where and how in this system could the enrichment be done? At home, by every family? In the small mills? Will they accept an addition to a process to which they have been accustomed for centuries if they cannot see the immediate advantage for doing so? There is no simple answer to any of these questions. We are now studying various possibilities for solving these problems in the hope of finding a way to implement the enrichment for at least some segments of the population.

Another question arises within this context. How can international organizations and bilateral foreign aid programs be of practical assistance? The easiest and most humanitarian way would seem to be to provide foods produced in excess in the developed countries for free distribution to the needy populations. This approach has, in fact, been extensively used for 2 decades and is still continuing. Is this a real help? This type of international collaboration is without question needed in emergency situations, or in a well-planned, restricted manner in support of suitable local development programs. Frequently, however, the simple donation of foods may not only be insufficient, it may be utilized too inadequately to have any significant impact. Actually, such donations may even interfere with the development and implementation of the measures needed to solve basic, long-range food production problems.

Too frequently governments have not faced up to their basic nutritional problems because they have been lulled into complacency by the presence of donated food supplies. The restriction that Costa Rica

applied to milk supplies from abroad certainly was a major factor in stimulating the development of its dairy industry. The same principle will apply with respect to development of other protein sources, including vegetable proteins. In addition, the internal distribution of such donated foods has frequently drained off governmental resources that could have been better utilized in applying more permanent and practical solutions.

What is really needed is to help the countries to develop their own resources, providing them with technical and other assistance to build up their local human and material capabilities so that they have a better understanding of their problems and can find and apply measures to solve them. Only with enough capable local personnel and facilities to make better use of present science and technology will the developing countries find their way out of their current situation.

There is no one solution to the protein problem. An adequate intake of total calories and of all other essential nutrients must first be ensured for an efficient utilization of proteins. In this regard, total food availability in relation to the population must be taken into consideration. More specifically, in regard to proteins, the several possibilities now being considered to increase the local production of adequate dietary sources can be classified in the following categories:

1. More efficient methods of production, preservation, and distribution of the conventional protein sources;
2. Improvement of inadequate conventional sources by enrichment procedures, by genetic modifications, or by other changes in their production or processing;
3. Utilization of nonconventional sources, possible with the present scientific and technological developments;
4. Development of new sources.

This conference analyzes all these alternatives, with special emphasis on amino acid fortification. The problem is so great, pressing, and complex that we should make all possible efforts to implement whatever measures are practical in any given country or region, covering all alternatives. These are not mutually exclusive; in fact, they are complementary. We face a series of problems for which there are no single clear-cut solutions. We have to use all our ingenuity in this struggle, making maximum use of scientific and technological developments, with stronger support from the social and economic sciences than has so far been the case. The problem must be attacked from all possible angles,

and in a coordinated manner. Only in this way do I see some hope for success.

The alternative will be an aggravation of human misery with the attendant social, economic, and political implications for the whole world that could invalidate the spectacular achievements of this century. If we are ready to expand our frontiers into space, I think we should start from a healthier world than the one we have so far been able to develop.

References

1. Béhar, M. Prevalence of malnutrition among preschool children of developing countries. In Malnutrition, Learning, and Behavior. N. S. Scrimshaw and J. E. Gordon (eds.). Cambridge, Massachusetts, and London, England: the M.I.T. Press, 1968, p. 30.

2. Béhar, M. Death and disease in infants and toddlers of preindustrial countries. Amer. J. Public Health 54: 1100, 1964.

3. Scrimshaw, N. S., and J. E. Gordon (eds.), Malnutrition, Learning, and Behavior. Cambridge, Massachusetts, and London, England: The M.I.T. Press, 1968.

4. Mönckeberg, F. Effect of early marasmic malnutrition on subsequent physical and psychological development. In Malnutrition, Learning, and Behavior. N. S. Scrimshaw and J. E. Gordon (eds.). Cambridge, Massachusetts, and London, England: the M.I.T. Press, 1968, p. 269.

5. Cravioto, J. Application of newer knowledge of nutrition on physical and mental growth and development. Amer. J. Public Health 53: 1803, 1963.

6. Organización de las Naciones Unidas para la Agricultura y la Alimentación. El estado mundial de la agricultura y la alimentación, 1969. Roma: FAO 1969 (C 69/2), p. 3.

7. Bressani, R., D. Wilson, M. Chung, M. Béhar, and N. S. Scrimshaw. Supplementation of cereal proteins with amino acids. V. Effect of supplementing lime-treated corn with different levels of lysine, tryptophan and isoleucine on the nitrogen retention of young children. J. Nutr. 80: 80, 1963.

8. Instituto de Nutrición de Centro América y Panamá; Oficina de Investigaciones de los Institutos Nacionales de Salud (EEUU); Ministerior de Salud Pública y Asistencia Social. Evaluación nutricional de la población de Centro América y Panama. Guatemala City: Instituto de Nutrición de Centro América y Panamá, 1969.