WHAT MODERN FOOD SCIENCE AND ITS APPLICATION MEANS TO DEVELOPING COUNTRIES [1]

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Preceeding speakers have described some of the remarkable progress which has been made in the processing and handling of food in the last few decades. Before closing the morning discussions, it is very appropriate to recognize that these advances which largely mean only added convenience to the highly developed countries may be a matter of life or death for very large numbers of people about whom we must also be concerned if our own way of life is to have a reasonable chance of survival.

One reason for this urgency is that modern communications and transportation have brought a knowledge of something better to even the most isolated countries and as a result, national aspirations are rising. At the same time, other technical developments such as those in medicine and public health, are resulting in populations increasing too rapidly to be fed without the application of modern food science teamed with

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agricultural and industrial technology. In other words, scientific and technological developments in other disciplines have made imperative the application of science and technology to the feeding of human populations.

Before attempting to describe what the advances in food science and technology mean to developing countries, it is desirable to review the present nutritional status of their populations. Even today, after more than ten years of direct contact with the nutritional problems of such areas, I am frequently surprised and shocked by new evidence of their seriousness.

Awareness of nutrition problems passed through the period when the major vitamin deficiency diseases were being identified —scurvy, beri-beri, rickets, pellagra and the like— and is now in an era in which protein malnutrition receives the greatest emphasis. Perhaps the full understanding of the significance of mineral deficiencies still lies ahead. This protein era began when Brock and Autret made a survey for WHO and FAO of kwashiorkor in Africa and reported to the second meeting of the joint FAO/WHO expert committee on nutrition which met in Rome in 1951. It was apparent from their report that kwashiorkor was not just an exotic disease confined to what was then known as the Gold Coast and today is Ghana, but also that it was common throughout nearly all of Africa and a direct consequence of dietary protein deficiency (1). Members of the committee recognized then that the same syndrome had been described under a variety of other names from Latin America, the Middle and Far East. It was still several years before the close correlation

between kwashiorkor prevalence and mortality in the 1 to 4 year age group was understood, but we now know that the best indicator of protein malnutrition in a country is likely to be its mortality rate for children in this age group.

Table 1 gives mortality rates for infants and for children 1 to 4 years of age, in several Latin American countries, as multiples of the corresponding U.S. rates in 1955. The high infant mortality in technically underdeveloped areas is notorious and yet it is not more than two to four times greater than the U.S. rate while that for children aged 1-4 averages 20 to 40 times the U.S. rate for each year of the four-year span. Guatemala with about 1/50 the population has almost the same absolute number of deaths in children 1-4 as the United States.

Table 1 also includes the only comparable figures which I was able to obtain for Africa and the Middle and Near East; no data of this type are available for many of the countries where nutrition problems are even more severe than suggested here.

To illustrate the significance of these figures, Guatemala can be taken as representative of technically underdeveloped areas. It is a country with one of the highest mortality rates for children 1-4 years of age in the world and yet there is nothing in the official vital statistics, as tabulated in the country or reported in Pan American Health Organization-World Health Organization publications, to indicate that malmutrition is an important causative factor. Locally it is recognized that kwashiorkor is a major cause of hospital admissions and deaths. INCAP undertook to

investigate the causes of each child death in four predominatly Indian villages with combined mortality rates which closely approximate the national average (2). The results for the 222 deaths studied are shown in Table 2. We found that nearly 40% of those 1-4 were dying with edema, skin lesions, hair changes, apathy and the other signs of acute kwaskiorkor. Equally significant was the fact that, of the remainder, nearly all died in the course of relatively brief episodes of either diarrhea of infectious origin or complications of common childhood infections, none of which would be fatal to any significant number of well-nourished children.

The conclusion is unmistakable that, even if it were impossible to take other health measures, improved nutrition alone would not only eliminate the nearly 40% of deaths from kwashiorkor, but also decrease the number of deaths apparently due primarily to infection. None of this could be deduced from the official vital statistics, and one of the reasons for the failure of health officials to realize the tremendous impact which measures to improve nutrition could have on the health of the people in technically underdeveloped regions stems from acceptance at their face value of inadequate official vital statistics as to causes of death. If the concepts of the INCAP study are applied to vital statistics from other regions, the true significance of the high mortality figures which I quoted earlier for various other countries is apparent.

Just as the results of this study were a revelation to us and lent new impetuous to efforts to improve the nutrition of children in

the INCAP area, including the development of low cost protein rich mixtures of vegetable origin, recent results of another type have given us a comparable shock and stimulus. Urinary creatinine excretion is traditionally considered to be a stable estimate of relative muscle mass. In INCAP studies of urinary creatinine excretion among lower income children in Guatemala, we expected to find confirmation of the retarded growth and development suggested by the results of measurements of height, weight, and bone maturation. We were not prepared to find the urinary creatinine excretion of preschool children in a rural Guatemalan village to be in the same range as previously obtained in children with acute kwashiorkor (3). In other words, as far as this particular estimate of protein nutriture is concerned, these children would have to be classified as cases of kwashiorkor. Of course, they do not have clinical kwashiorkor, but the underlying protein malnutrition, sometimes referred to as pre-kwashiorkor, which characterizes nearly all of the preschool children in population where kwashiorkor is prevalent and which produces the very marked retardation in height, weight and bone maturation for height in Guatemalan children. These same children averaged nearly four years retarded in bone maturation when they reached school age. The high mortality in preschool children is among those with pre-kwashiorkor who developed kwashiorkor when the added stress of infection is superimposed or who die when the infection itself proves overwhelming because of lowered resistance.

There is also evidence that the deficiencies which bring about retardation in physical growth and maturation are associated, physiologically or culturally, with retarded intellectual performance. Direct support for this has come recently from studies of the group of Gómez of the Hospital Infantil of México who found a direct correlation between low scores on the Gessell and Goodenough tests and the degree of deficiency in weight below standard values (4). The evidence that performance on intelligence tests is also affected by malnutrition, is a further indication of the urgency and purpose of efforts to improve the nutritional status of children in technically underdeveloped areas. Decreased stature due to malnutrition may conceivably have some adaptive advantage where nutrition deficiency is common, but the associated retardation in intelligence and increase mortality and morbidity are obviously extremely undesirable.

In looking at the health problems of technically underdeveloped areas from de viewpoint of the harmful effects of poor nutrition and attempting to appraise the benefits which the application of agricultural and food science can bring, we must also avoid the errors of the blind men describing an elephant only from the parts each is touching. When the parasitologist, malariologist and nutritionist look at the same child with edema and swollen abdomen and are each convinced that he has seen the consequences of intestinal parasites, malaria or malnutrition, according to his respective specialty, a situation not at all unheard of, it is time for objective evaluation by persons broadly conversant with tropical medicine and public health. On the other hand, in most

technically underdeveloped areas, the error lies in overemphasizing the role of infection and underestimating both the direct and indirect role of nutrition in producing the characteristically high morbidity and mortality rates. The true relationship is, of course, one of synergism in which the adverse consequences of both simultaneously are more serious than those of either one alone. Nevertheless, we can be certain that improved nutrition alone will help to lower morbidity and mortality due either to infection or malnutrition and that it will result in improved growth and development, both physical and mental. These can be felicitous consequences of the recent developments in agricultural and food science discussed today.

The discussions have also given at least a partial answer as to the way in which improved nutrition may be achieved in areas where proteins of animal origin are in short supply and largely beyond the present purchasing power of a large proportion of the population. I have witnessed in urban and rural health centers in such areas, the struggle of physicians and nurses to give practical instructions for improving diet of a malnourished child. They have been taught to emphasize the importance of milk as a protein source for children and time after time instruct a mother with a totally inadequate income for the purpose to give milk to her malnourished child. The net result is that the mother must either ignore the advice entirely or give her child a tiny quintity of milk in large amounts of water. In either case, the result is likely to be the development of kwashiorkor and death.

For similar economic and cultural reasons, recommending the other conventional sources of protein of good quality, eggs, meat and fish, may be equally unrealistic. The usual result is that the health worker continues to give this impractical advice because there seems to be no alternative, and concentrates on the things that he can more obviously do something about --such as treatment of acute illnesses, preventive immunizations, latrine construction and other environmental sanitation measures. Nutrition is not neglected because of lack of interest in the problems but because of frustration in attempting to cope with it. Agricultural and food science and technology can break this vicious circle of frustration and apparent apathy by providing sources of protein and other nutrients, that are both cheap and effective. Vegetable mixtures for this purpose hold great promise. For Central America, the development of INCAPARINA, a vegetable mixture containing 27.5% of protein of a quality in the range of that of animal protein and costing about 1 cent a glass, has changed almost overnight the possibilities of doing something immediately about the serious malnutrition which prevails among young children in Central America. For some areas, increased supplies of milk and eggs may be the measures of greatest importance. For others fish flour and meat meals or soya products may be useful. Certainly no single measure on food should be considered a panacea to the exclusion of others. All practical sources of quality protein and other essential nutrients will have to be exploited adequately to feed the growing population of the world. If modern food science and technology can be applied in developing areas, marasmus should virtually disappear and kwashiorkor need no longer

occur. There will not be thousands of children permanently blinded as a result of vitamin A deficiency in Indonesia and other parts of South East Asia as well as sporadically some in Africa and Latin America. Application of present knowledge of enrichment procedures would eliminate Pellagra from Yugoslavia, the Middle East and parts of Africa where it is still prevalent and beriberi from the countries of South East Asia. Infantile beriberi in which the breast-fed child dies very suddenly as the result of a deficiency of thiamine in his mother's milk is actually increasing at the present time as machine milling of rice replaces the less efficient hand pounding which leaves some thiamine with the grain. The true magnitude of the problem is seldom fully understood even by professional nutritionists. This is partly because all surveys are necessarily based on the study of relatively small numbers of individuals. It is hard to visualize the problems encountered in small groups multiplied by the hundreds of thousands or millions of persons in a similar socio-economic and nutritional situation in a given country. Picture individual cases of Marasmus, Kwashiorkor, Pellagra, Beriberi, Keratomalacia and other major deficiency diseases multiplied by a million and whether the period covered is one year or ten, they become a staggering human problem.

The food production needs are also staggering. For example, dietary surveys show that the diet in rural areas of Guatemala includes as high as 80% corn and obviously limited amounts of other foods. When national food needs in Guatemala were calculated on the basis of a minimum adequate diet as close as possible to the pattern and cost of that already consumed, the inadequacies of agricultural production of

food crops were more apparent. In Figure 1 you will note that the only item in excess was sugar, which was being consumed as empty calories directly or after being converted to alcohol. National production of corn was inadequate for human consumption even without taking into consideration the large amount of corn going into animal feeds. Furthermore, there was a need to increase production of dairy products nearly 400% , eggs 300% , fruits and legumes 200% , and meat 100%.

This is one approach to evaluating the food needs of a country but it is not entirely realistic. The market at that time already appeared saturated with milk--20 cents per quart, with chicken— at over $1.00 per pound and eggs—as high as 8 cents apiece even in rural areas. More production at the same prices would not have helped the lower socio-economic groups very much. But since this survey was made in 1957, a few large producers, adopting U.S. poultry production techniques including pure breeds, batteries of individual cages, high protein rations, hormones and antibiotics and frozen storage, lowered the price of eggs to 4 cents apiece and of poultry to as low as 39 cents per pound. The result is that a level of poultry and egg consumption only recently assumed to be completely impossible is now a reality. In contrast, although milk production has increased, prices have not fallen and producers are finding it impossible to dispose of all of their milk. The details may vary, but the principles are the same for all underdeveloped countries. Techniques are required which will make goods cheaper as well as more abundant. To rely on economic development to bring sufficiently

increased purchasing power to pay needlessly high prices, is to court disaster.

There is too much evidence in whatever continent we look to forget that malnutrition and political instability are handmaidens. The application of modern agricultural and food science to the solution of the nutritional problems of technically underdeveloped areas will most certainly give them a better chance for achieving political stability and balanced economic and social development. The greatest danger lies in the difficulty of conveying by a general statement like this, the current urgency of the situation. Time is running out in many parts of the world and each effort is important. A disaster whether natural or man-made always seems worse if it occurs in our own country and more serious still if it is in a state or town which we personally know well.

I have tried to point out the mass disasters which are occurring daily in technically underdeveloped countries and about which something can be done through application of the measures described in this symposium. I have no doubts as to the adequacy of the means available now and in the future for solving the nutrition problems of technically underdeveloped areas, but I am deeply concerned as to whether we will apply them in time.

If we are to do so effectively, we must learn to understand and take into account the view point of the people we propose to help. A few examples may help to clarify this point. When an agreement is signed which puts United States technicians in control of the entire

agricultural research and extension of a foreign country and then they and the national personnel working with them are prohibited from doing research or giving advice on crops competitive with those in surplus in the United States, locally nationals are understandably dismayed. A disposal of United States surpluses abroad in ways that sound magnanimous but which actually interfere with the development of a country's capacity to feed itself, do not really deceive local leaders. In arranging for the commercial production and distribution of the INCAP developed low cost vegetable mixture for human feeding in Guatemala, the local management of two companies under U.S. control were unable to present an acceptable offer because the margin of return expected on new foreign investments required a price which would have defeated the purpose of the product. In order to make investment in essential or important new industries in technically underdeveloped areas attractive and safe, some other way than a relatively quick return, must be found to compensate for the excessive risk and political uncertainties involved. Many of the industrial operations taken for granted in this country, are simply impossible at the present time in most technically underdeveloped areas because of the lack of long term investment capital and the very high interest rates which presently prevail.

Similar principles apply to the education and training of technical personnel. Technically underdeveloped countries are not technically underdeveloped because their people are malnourished, but rather they are technically underdeveloped and underfed because they do

not have sufficient technicians of all types. Cooperative arrangements for a foreign educational institution to receive help from a U. S. university are not likely to be successful if they are looked upon primarily as an opportunity for faculty members to gain experience and for their students to do interesting thesis work. The U. S. institute must be willing and able to understand the needs and purposes of the local institution and see that benefits of the association are mutual. Even more important in terms of the numbers of persons involved is the need to consider more seriously the real needs of foreign students who come to the U. S. It is not right to expect them to do all of the adapting to a strange educational system and a program often bearing little relationship to their needs. No U.S. institution should be encouraged to accept a foreign student in a program which is ill adapted to his needs and conversely those institutions which do accept a large number of foreign students have a strong moral obligation to attempt to provide the type of training which will be useful to them. A great deal better job needs to be done in the handling and teaching of foreign students from technically underdeveloped countries in the U. S. today.

Only if both industrial organizations and educational institutions in the more highly developed countries recognize the urgency of the problems and make more rapid progress toward understanding and helping to meet the needs of technically underdeveloped areas, will the advances in knowledge which you have heard discussed this morning have the dramatic and incalculably desirable effects which have been optimistically described.

SUMMARY

In summary, I am very pleased to have been assigned the title "Implications of Food Science and Technology for Technically Underdeveloped Areas" because they are dramatic and can be far reaching. They are much more important for the future of the world than the mere improvement of an already favorable food situation in the highly developed countries. They are of incalculable importance because they are the only means by which some countries will be able to cope with the problems caused by an increase in the national aspirations of people everywhere and by the application of advanced technology in other disciplines. Many of the advances in food science and technology of which we have heard today should, and I trust will be, part of action programs which will eliminate the prolonged period of retarded growth and development after weaning, characterizing most preschool children in technically underdeveloped countries, reduce the high mortality from marasmus, eliminate kwashiorkor, lower morbidity and mortality from infections, improve the learning and working capacity of older children and adults, and be a major factor in economic and social programs and in the preservation of freedom in those countries now classified as underdeveloped. These advances become available at a very critical juncture in the history of the world and a far greater sense of urgency and purpose is required to insure their effective applications. They can mean a brighter, safer, happier and freer world for everyone--if their significance for technically underdeveloped areas is also realized and they are applied in the proper manner--and in time.

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TABLE 1. INFANT AND CHILD MORTALITY IN UNDERDEVELOPED AREAS

(Multiples of 1955 U.S. rates)

LATIN AMERICA			AFRICA AND ASIA		
Country	Infant Mortality	Mortality 1–4 years	Country	Infant Mortality	Mortality 1–4 years
Ecuador, 1955	4	26	Egypt, 1947	8	45
Colombia, 1956	4	18	Algeria (Moslems), 1948	6	35
Guatemala, 1955	4	39	Federation of Malaya, 1947	7	22
Brazil, 1956	4	11	Singapore, 1947	5	14
Mexico, 1955	3	22	Ceylon, 1952	3	21
El Salvador, 1956	3	21	Thailand, 1947	2	16

TABLE 2. CAUSES OF DEATH OF CHILDREN UNDER 15 YEARS OF AGE IN FOUR HIGHLAND VILLAGES IN GUATEMALA, 1956 AND 1957

Cause	Official vital statistics	INCAP investigation
Congenital malformations and diseases peculiar to early infancy	43	49
Diseases of the respiratory system	35	42
Diseases of the digestive system	21	37
Infective and parasitic diseases:		
whooping cough	12	17
intestinal parasites	58	0
other	9	10
Other specified causes:		
kwashiorkor	0	40
other deficiency disease	1*	3
other	2	0
Ill-defined or unknown	41	17
Not investigated	0	7
Total.....	222	222

* Died in a hospital in Antigua, Guatemala

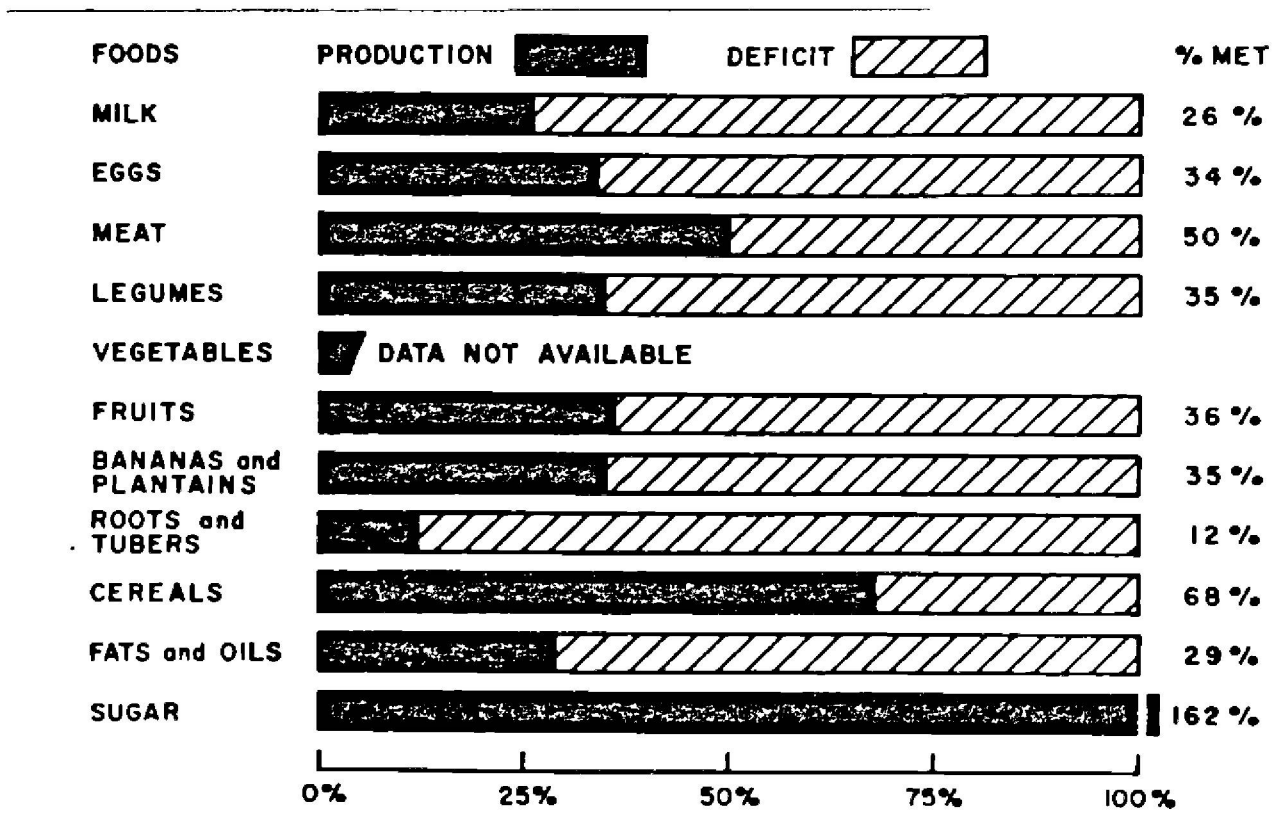

FIGURE 1. Available food production compared with actual food requirements in Guatemala in 1955. (Prepared by Klein and Saks, Washington, D.C., in collaboration with INCAP