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Plain Talk About Nutrition

What is a "good" food? Will any single food substance supply all the essential nutrients? How many calories do you need? Some straight answers by an expert in the field of nutrition.

by Henry Borsook

One of the greatest biological discoveries of this century was the separating out of the essential from the accidental in food.

Today, as far as human nutrition is concerned, between 20 and 30 essential nutrients are recognized. The first of these is calories, which may be provided by protein, fat, or carbohydrates — the three main bulk constituents of our food. A deficiency of calories is as serious, and leads to as serious disease, as a deficiency of any other essential nutrient.

The next group of essential nutrients is in proteins. In animal protein, about half the weight consists of eight amino acids which animals are unable to make for themselves and so must get from their food. These are referred to as the indispensable amino acids in protein.

A protein may be compared to a great brick structure. It has about 20 different *kinds* of bricks, but there are hundreds of them, and they are arranged in a very special way in each protein. When this great chemical structure is eaten — by a baby, for example, whose chief source of protein is milk — the protein suffers a wrecking operation in the stomach and intestines and becomes like a pile of bricks. The bricks are then absorbed into the blood stream, and the liver, blood, hair, brain, muscle, and so on take out what bricks they need and rearrange them to make the proteins characteristic of the tissue. The chief difference, say, between skin and muscle isn't so much the kind of bricks, as their arrangement.

Of all these 20-odd kinds of bricks, there are the 8 we can't make for ourselves and which we have to get from our food. We have to get enough of them so that children will grow, and so that we will be free of nutritional disease. The nutritional quality of a protein is measured by how much of these eight amino acids is supplied by a reasonable serving.

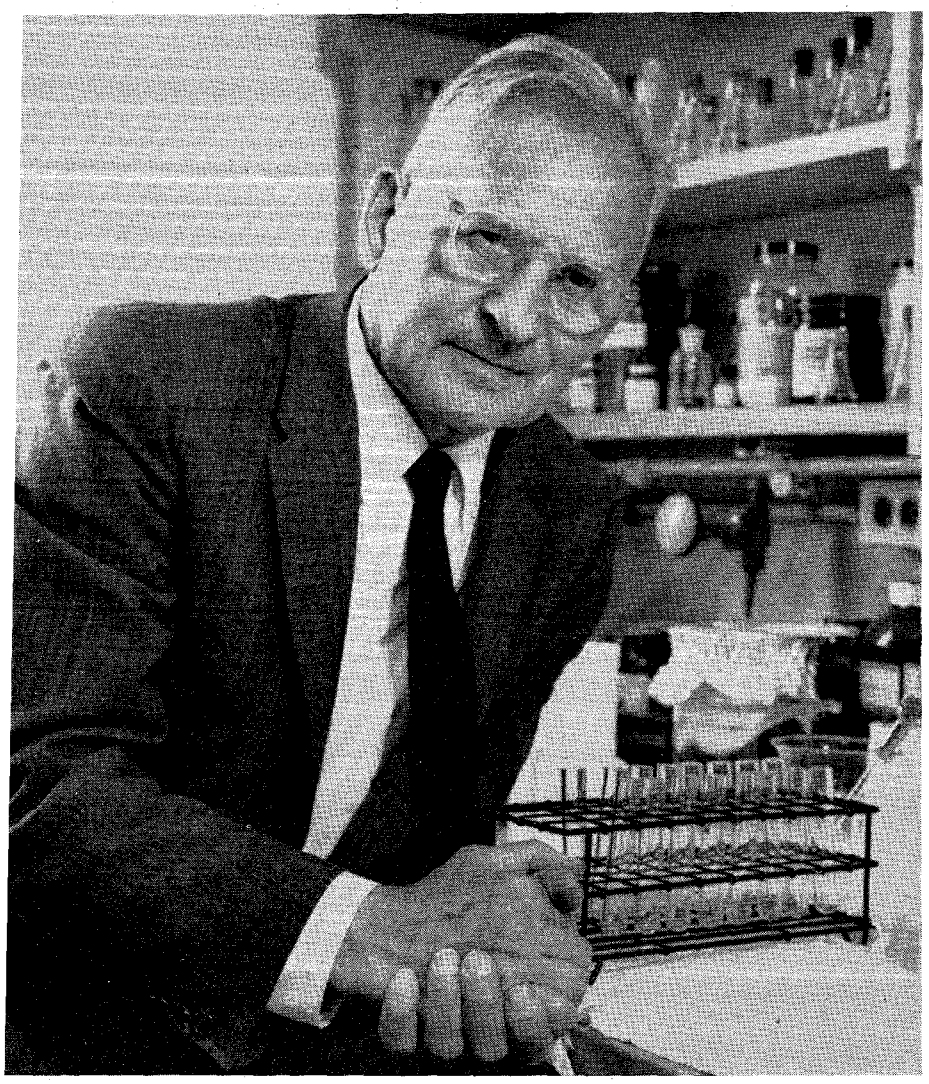
Then there are certain minerals. We probably need all the minerals that are known — most only in trace amounts — but there are really only three that we need to pay attention to: calcium, iron, and iodine. If we get enough to eat, we get all the rest.

Next there is the whole group of vitamins. They are all organic compounds; they all contain carbon, most also contain nitrogen, and two contain sulfur; we need only minute amounts of them. Ordinarily, we might eat a pound or a pound and a half of food a day — 700 grams dry weight. We need only about 1/15,000 of that amount of some vitamins, but without this minute amount there is disease. This is characteristic of vitamins in general: they are essential; we can't make them for ourselves; and though the quantity we need is actually very small, it is often hard to get this small quantity. Millions of people, in fact, don't.

Finally, in the last few years, attention has been focused on what are called poly-unsaturated fatty acids, which we can't make for ourselves and need to get from our diet.

Not all of the essential nutrients have to be provided in our food. Some animals are able to make some of them. (Vitamin C, for example, can be made by all animals except guinea pigs, monkeys, and humans — so these three species are the only ones known to be susceptible to scurvy.)

Some of the essential nutrients are provided for us by the bacteria in our intestines, such as vitamin K, which is required for the clotting of blood. Children are born without it, and during the first two or three days after birth they are more prone to cranial hemorrhages than later on. The milk that they drink, in spite of all the mother's care, is infected. The bacteria then take hold in their intestines and produce the vitamin K the children need.



Henry Borsook, professor of biochemistry at Caltech, and the man responsible for the development of Multi-Purpose Food.

Essential nutrients are all, in a platonic sense, essences. They are the realities of the diet, and, being essences, no one can replace another. A diet may be abundant in all 20-odd essential nutrients *but one,* and it is a disease-producing diet. There is one exception; the amino acid tryptophane, which we can't make for ourselves, is converted to a vitamin which we can't otherwise make for ourselves – nicotinic acid. But this is merely replacing one essential nutrient with another; the principle has not been invalidated.

This is how it comes about, for instance, that in the tropics young children are found dying with full stomachs. They get plenty to eat, but one or two essential nutrients are missing. If they are given as little as a third of an ounce a day of food containing the missing nutrients, then all the rest of the food is made good.

The next great discovery in this field, and it is *the* discovery from which all the future promise comes, was the proof that the source of an essential nutrient is immaterial. It may come from food which is grown, it may be mined, or it may come from a factory. For example, vitamins are the same whether we get them from wheat or meat or orange juice, or from Du Pont or Merck. I find a certain resistance to accepting this simple fact even among Caltech students, at first – that a substance is a substance, and it doesn't matter where it comes from.

As far as vitamins and minerals are concerned, it is easier, cheaper, and often more convenient to get them from sources *other* than food. In fact, the whole promise of coping with world food problems depends on our using industrial sources. For instance, one of the important reasons for eating milk and cheese is the calcium they contain, but the calcium of the chalk cliffs of Dover is just as good, cheaper, and easier to handle.

In southern California, if we went around without clothing most of the year we would probably pick up all the vitamin D we need from the sunlight. In England, rickets (a vitamin D-deficiency disease) used to be called "the poor man's disease," because the children of the well-to-do went to the country or the seashore in the summer, where they ran around with hardly any clothes on and the sunlight made enough vitamin D to carry them through the winter. The poor children stayed in the smoky city, where all the ultraviolet light which makes vitamin D was absorbed in the air, and so they got rickets.

We often hear talk of how some foods are good for us, and some are better than others. The definition of food is now a matter of arithmetic. It is simply this: Given a reasonable serving, a good food will supply a large measure of all the different essential nutrients that we need, and a poor food will not. No one food is perfect either; I don't know any single food substance where reasonable servings eaten

three times a day will supply all the essential nutrients.

Most of the nutritional diseases that affect whole populations are in regions and countries where the people eat very few kinds of food. Nutritional safety is in variety. This needs to be borne in mind with the growing practice in the United States of reducing diets. It is important that a reducing diet be prescribed by a doctor who knows about nutrition. It is not an easy thing to do well, and an important principle is that no matter how calories are cut down, the protein mixture needs to be adequate in quality and quantity, and it should contain enough vitamins and minerals.

Safety in variety

The safety factor here is in variety. To restrict it is to court the danger of running into a shortage of one or more essential amino acids even if multivitamin pills are taken. In terms of the amount of the essential nutrients which are supplied, a quart of milk, a pound of "enriched" white bread, and a pound of meat are about a stand-off in nutritional quality. No one of them is perfect, but a combination of any two would do pretty well. Even in a reducing diet some calories are needed. The best source of calories for a reducing diet is enriched white bread. If I had to choose which of these three I would subsist on, I think I would do best with a pound of enriched white bread.

How many calories do we need? We don't know, really, because the standards for calorie requirements were set at the turn of the century by people living in cold climates, where they did much more physical work than we do now, and at a time when they didn't know much about vitamins — so, in order to get the minimum amounts of food needed to prevent certain specific deficiency diseases, they had to eat a lot. I am quite sure, for example, that people from middle age onwards, who are living the sort of sedentary lives most of us live nowadays, do better with less than the 2500 calories required in all the books on nutrition. I suspect the figure should be below 2000.

One of the most important medical developments I can think of would be the determination within reasonable limits of the proper caloric intake for middle-aged and elderly people. No matter how low these caloric requirements might turn out to be, there are certain facts that indicate we will never be able to get along on a few pills. The calculation runs like this: Let's say we need 2000 calories, which is 20 percent below the standard. Taking only the digestible material, and considering only its dry weight, for 2000 calories we need about 400 grams. That is about 9/10 of a pound. It is impossible to get 9/10 of a pound into a couple of pills. Furthermore, a deficiency of calories is noticed in a couple of days, whereas it wouldn't hurt anyone very much to live for a couple of weeks with a deficiency of minerals or vitamins. In any food planning for emergencies or for special circumstances, the first essential is calories.

One sure way of getting the indispensable amino acids we need is to eat meat; any animal food will do, because animals don't differ very much from each other in their basic chemical composition. The trouble is that animal protein is expensive. A cow returns in food only 3 percent of the food it eats, so beef is a luxury.

Vegetable proteins are cheap, but, in general, they tend to be short in one or two indispensable amino acids. Yet we have all known vegetarians who have done well. The largest animal in the world today, the elephant, is a vegetarian; and one of the most prolific, the rabbit, is also vegetarian.

Obviously, it is possible to do all right on a vegetarian diet. How is it done? By a mixture. For example, a mixture of beans and any cereal will provide a protein mixture which is as good as meat and a lot cheaper.

One of the most common diseases in the world today is a deficiency of one or two indispensable amino acids. It goes by various names, though the one generally used now is "kwashiorkor." It is very common throughout the tropics. Yet the world produces enough protein so that, if it were used sensibly, there would be no such disease as this.

Certain crops are grown for the sake of the oil; the meal that is left from the seed, in this country, goes mainly into petfoods. In other countries it is used for fertilizer or is thrown away. Without taking into account any of the proteins in meats and fish and dairy products, the world supply of oil seed cake protein *alone* provides enough protein, if used in a sensible mixture, to prevent protein deficiency disease in the world. It is a question of knowing how much we have and using it sensibly.

How much protein do we need?

How much protein do we really need, allowing a factor of two for safety? If all of our protein were meat, the most expensive source, it would be a surprisingly small amount — about two ounces. Most of us eat more than twice that. If only a fifth of the protein in our diet was meat and the rest was in a mixture of bread or beans, we would do very well.

The one mineral which all nutrition teaching says we don't get enough of is calcium. One of the important nutritional reasons for milk and cheese is the calcium they contain. The Recommended Daily Allowance (a technical term used by the National Research Council) is 800 mgs. per day. It takes about a pint and a half of milk to provide that much calcium. For young people this is probably too much milk; for old people it may not be enough calcium.

I sometimes say to nutritionists that if I were in charge of an orphan asylum (their food budget is always limited) I wouldn't serve the children any milk. I would provide the essential nutrients of milk – the protein, calcium, and vitamins – far more cheaply from other sources such as beans, powdered chalk, and vitamin concentrates. With the money saved I would give the kids some luxuries that they would get some fun out of.

Iron deficiency (anemia is a result of iron deficiency) used to be common in the United States. Today one sees it chiefly among the very poor and among the "faddy" eaters. It is easier to supply the iron as a mineral than as meat or any such common food source.

This was proven during the war when the British government, in order to save ship tonnage, since all the wheat had to be brought in by ship, made the British people eat whole wheat bread made of 85 percent extraction flour. Children soon began to show signs of calcium and iron deficiencies. This came about because of a material in the branny layers of the wheat berry which forms insoluble salts with calcium and iron; not only are the iron and calcium in the wheat berry not usable, but the berry robs iron and calcium from the other foods that are eaten.

The British government then added powdered chalk and an iron salt to the flour to make good the deficiencies that this noxious material in the branny layers had induced. If the British government could do something as drastic as this, my prescription for the replacement of milk isn't quite so wild.

Iodine deficiency, which shows up as goiter, used to be common in this country too, but iodized salt has done away with it. The amount of iodine required is very little.

Fruit and vegetables—unnecessary

There are certain vitamin deficiency diseases which are very difficult to treat by diet alone. The advent of pure synthetic vitamins, which can be given intravenously, has made possible their expeditious cure. It is chiefly for their vitamins that we eat the fruits and vegetables that nutritionists urge us to. Of course, many people eat fruits and vegetables because they like them, and that's fine. But, as far as vitamins are concerned, a good multivitamin pill makes the eating of vegetables and fresh fruit unnecessary, and it is a lot cheaper and easier. Yet I often find resistance to this convenient fact.

In the last decade, the medical profession has become interested in a relatively new essential nutrient —poly-unsaturated fatty acids. We know that poly-unsaturated fatty acids, the cholesterol level in the blood, and certain kinds of arterial disease are related in some way. The exact mechanism isn't clear, but I think everyone who has studied the subject is convinced that there is something in it. I take the conservative position and recommend that we play it safe. For this reason, all animal fats are advised against, and vegetable fats high in poly-unsaturated fatty acids, such as safflower oil or corn oil, are recommended. Cottonseed oil or olive oil are not quite as good, but are better than animal fats – of which butter is one, of course.

The information on this subject isn't quite as precise as one would like, but the recommendation now is about two tablespoons a day of safflower oil, which is the best and richest source. But it mustn't be cooked; these unsaturated acids are unstable *because* they are unsaturated, and cooking will wreck them.

Some potential benefits

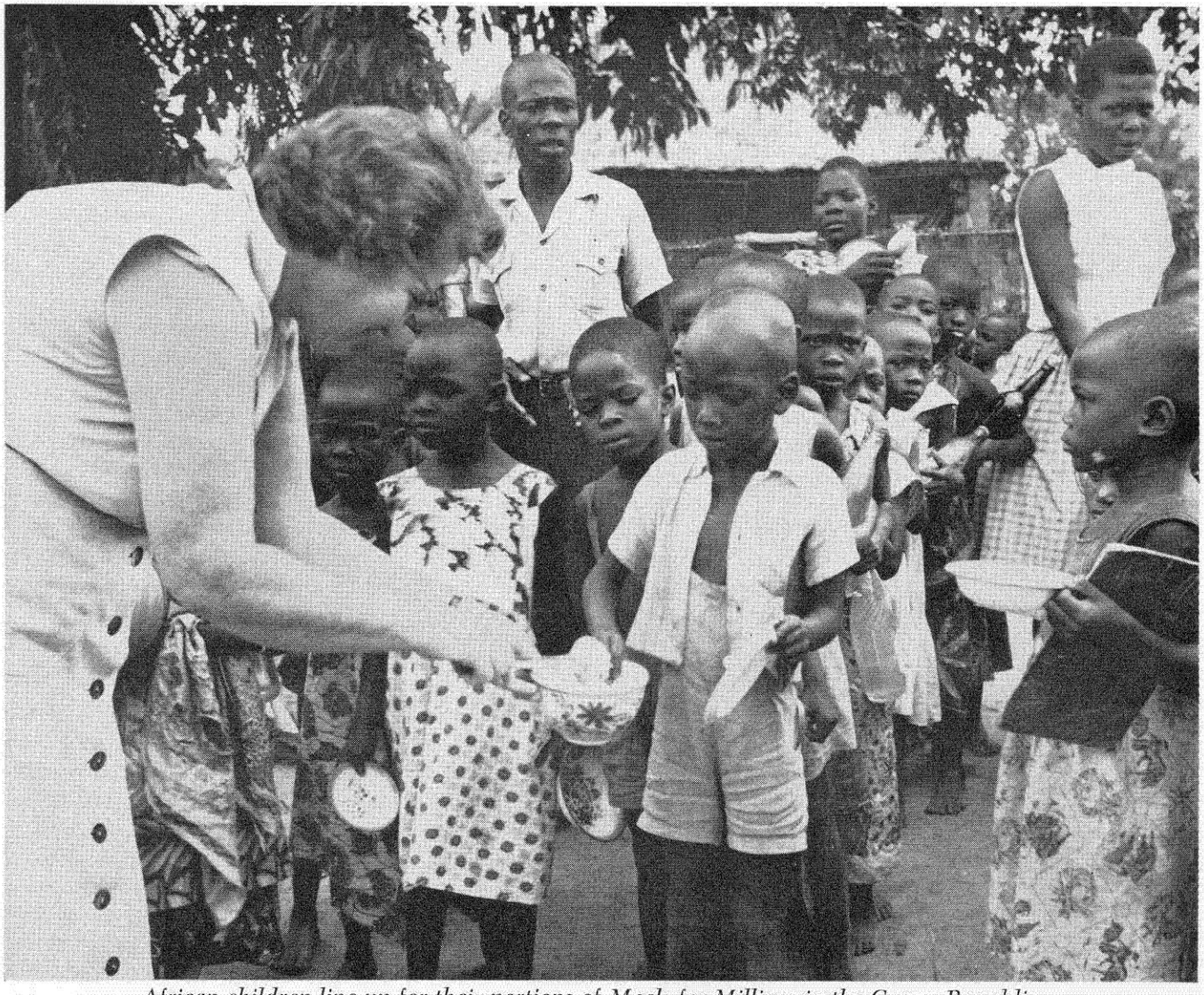
I can probably best illustrate the potential benefits from the use of our scientific knowledge of nutrition by two examples. I am told that Mr. Clifford Clinton, founder of the Clifton Cafeterias, as a boy, lived in China and saw famine. As happens so often when we are children, we make certain resolves and these resolves are the ideals that govern us all our lives. In his case, his resolution was that if he could do anything about famine, he would. It was no accident, then, that when he grew up he went into the restaurant business.

When the depression hit southern California in 1930, Mr. Clinton let it be known publicly that whoever came to his restaurant at certain hours of the day would get a meal for nothing. After awhile I think he felt that this was being abused, and so he asked people to pay five cents for the meal, and this is still being done.

During the war, with his great experience of feeding large numbers of people quickly, it was inevitable that Mr. Clinton was asked to advise the government on the feeding of troops. It was toward the end of the war that he came to me and said that he would like to have a food made with roughly these specifications: not more than two ounces would supply one-third of the Recommended Daily Allowances of all the essential nutrients; it would cost no more than three cents per meal at the then prevailing prices; we were not to draw on foods that were customary in the American diet (there wasn't much danger at that price); it must keep well – in fact, indefinitely; it mustn't offend any religious taboo; it could be eaten with other foods; and it would be satisfying.

I said at once that the calories would have to come from some other food because two ounces would not supply one-third of the day's requirements of calories. I also thought it was inadvisable to attempt to supply the vitamin C, for it wouldn't keep when the food was cooked. But it would be quite feasible to do all the rest.

How could I say this so quickly? We knew already that we needn't worry about the vitamins and minerals. They were cheap and readily available; we



African children line up for their portions of Meals for Millions in the Congo Republic.

could add them to anything and they wouldn't affect the flavor or the way things were to be cooked. So all we had to be concerned with was the protein — with the quality of two ounces of protein which had to supply one-third of the day's requirements of essential amino acids. Animal proteins were too dear and would offend some religious taboos, but all I had to do was look up a book of tables on the amino acid composition of different vegetable proteins.

It was soon clear that the best protein nutritionally was soy bean protein. We were growing soy beans for the oil, and the meal left after the oil was extracted was largely thrown away at that time. After the war (and after we got started with our new food) the soy protein began to be used, as it is today, for pet foods.

It was simple, then, to meet Mr. Clinton's specifications. We made the two ounces in weight almost entirely of soy protein. The necessary vitamins and minerals were added from inexpensive concentrates or synthetic sources; the soy meal was a pretty good source of some of the vitamins and of iron and calcium. The vitamin C, if need be, could be added as a separate little pellet. Since there was a serious shortage of calories in two ounces of this food, our recommendation was to get the calories from any cereal. Happily, cereals are rich in the one indispensable amino acid (methionine) in which the soy bean protein is low. Then it became a nutritionally good diet, as good a diet as milk, eggs, meat, and vegetables —the customary American diet. And it was not difficult to do it for three cents a meal.

Mr. Clinton made a grant to Caltech to develop this food, and in the course of a year it was done. Indeed, most of the year was spent in learning how to cook the food so that we could tell people good ways of using it.

After that, this food was sent all over the world, where it was bought by many religious and philanthropic agencies who were concerned with near-famine. The reports began to come in — and are still coming in — of how a very small amount of this food did so much good. At first, I simply refused to believe these reports; I thought that they came from

overenthusiastic users who just wanted more of the food. We know now that the reports were true and we know the reason why.

In the Pacific Islands, for example, they grow cassava because they can get the most food per acre from it, and it is easy to grow. After they are weaned, children on these islands are given little more than cassava to eat—which is little more than starch. The children get ill. Give them a very small amount of a good protein food such as Multi-Purpose Food—sometimes only one-third of an ounce, or even less — and they get well, because the indispensable amino acids they lack are supplied by the soy protein.

A foundation was then formed, under Mr. Clinton's leadership — the Meals for Millions Foundation — to raise money to make this food and give it away. After some years of operation, we thought we would like to know whether the good reports we were getting were true, so the secretary of the Foundation, Miss Florence Rose, was sent on a tour around the world. In India, she achieved an outstanding feat of statesmanship.

We had been sending American Multi-Purpose Food into India, but how could *any* quantity that we could send have any impact on the nutrition of 400 million people? Miss Rose realized that the Indians would have to learn to grow this food — or some food as good — for themselves, and they would have to make it and sell it themselves.

India doesn't have any soy beans and can't afford to buy them, so Miss Rose enlisted the support of an Indian nutritionist and food technologist and put it up to him to develop something from foodstuffs grown in India, but not used for human food, that was as nutritious as American Multi-Purpose Food. "If you need a little money to get your lab started," she said, "we can probably help you, but once you get started we will buy your whole production. Instead of sending American Multi-Purpose Food bought with American money over here, we will send you the dollars and buy your food for distribution in India."

Food from peanut meal

The scientist she enlisted, Dr. Subrahmanjan of Mysore, did a magnificent job. One of the food by-products which wasn't being used in India at that time was peanut meal. Peanuts are grown there in great quantities for oil, which is exported, while the peanut meal was being wasted. So, after some analyses and trials, Dr. Subrahmanjan found that a mixture of peanut meal and chick pea meal, with some vitamins and minerals added, was nutritionally equivalent to the American Multi-Purpose Food. The food was first tested on rats in the standard way, and when that turned out all right, it was tried in orphanages and schools with striking results.

A year ago an Indian businessman put up his own money to build a plant which is now producing ten tons a day and the whole production is being bought by the state of Madras for their school lunch program. Each child gets about half an ounce a day and the results are so satisfactory that the Indian Minister of Agriculture is now trying to get the heads of governments of all Indian states to set up similar programs.

The Indian experiment was of great importance because it showed that it is perfectly easy to get a very good diet from vegetable sources alone. Not long ago the then head of the Food and Agriculture Organization (FAO) of the United Nations wrote a book in which he said that it was impossible to have a good diet without animal protein. This is not only wrong but harmful. It may be stated as a categorical fact that the two-thirds of the world which is now malnourished would remain so if they had to depend on even small amounts of animal protein. The whole problem can easily be solved from a technical point of view if people will use the vegetable proteins which are now being produced.

Food from grass

In every country in the world where malnutrition is endemic, one usually finds that the people are really growing enough for a pretty good diet if they would only use what they raise. Probably the largest source of potential food which isn't used at all is grass, leaves, and such uncultivated vegetation. A number of us at Caltech have been talking about building a portable machine that would go around and pick up grass and leaves and extract the soluble protein and vitamins. Grass would go in one end and a nice white powder, which would be highly nutritious in proteins, vitamins, and minerals, would come out the other.

This sounds fanciful, but we were all interested and pleased to read recently that an Englishman at the University of London had actually designed such a machine and it is now being tried out in British Guiana. The problem is one of engineering — to get fuel cheap enough and accessible enough. No one would have thought this was possible had it not been established that the source of an essential nutrient is immaterial. Synthetic vitamins or minerals can be added if necessary; they are so cheap and so abundant that even the poorest can afford them.

One of America's great interests as far as farm policy is concerned is assistance to underdeveloped countries. In many of these there is malnutrition. We can help these countries very quickly, with a very small capital outlay — and much more quickly than in the usual long-range agricultural programs — by applying a few basic nutritional principles. Good nutrition is the foundation of a sound industrial development. To provide these people with an adequate diet is not only the decent thing to do; it would also be good international politics.