

Conditions and Trends in the World Protein Economy

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ABSTRACT

Eating habits and food systems are difficult to change. Isolated and refined vegetable proteins are being used increasingly in a wide variety of food systems to improve nutritive values and functional qualities without displacing the system itself. They provide a way for people with rising affluence to move up the "food ladder" without disturbing familiar and traditional habits of eating. Worldwide commercial demand for food and feed crops from surplus-producing nations will continue to expand during the next decade. U.S. producers and those of other exporting nations will be able to expand production sufficiently to meet this rising commercial demand at reasonable prices during most of the years of the 1980 decade. But if tonnages necessary to satisfy real nutritional need (mostly in developing countries which are critically short of foreign exchange) were added to the commercial demand, the totals would be so great, there would be no way the export countries could produce enough. If malnutrition is to be stemmed or prevented, developing countries will have to learn to produce more on their own soil and provide the means of getting it to the people who need it. Contrary to some views, the U.S. livestock feeding industry should be regarded as an effective part of a world grain reserve and an aid to maximizing exports. In the short crop year of 1974, U.S. feed grain consumption was reduced to a much greater extent than exports. Livestock have the ability to act as a "surge tank" in the food line. There is urgent need in the world today for improved varieties of high protein legumes that are adapted to the tropics. An important component of success in improving food supplies in developing countries will be the emergence of enlightened and courageous political leadership. When country leaders "short term" it by giving in to urban pressures for cheap food, the result is usually counterproductive.

During the 1960s, people discussing the world food situation most commonly emphasized shortages of protein. During the 1970s, following publications of the new protein standards by the Joint WHO-U.N. Committee, the emphasis appeared to shift. For the past half dozen years, we've heard most frequently about total calories and less about protein. The real truth probably lies somewhere in between, and the situation varies widely from country to country and often within a country.

Speaking generally, total food production has been growing during the past two decades at a slightly higher rate than has population growth. But even though average per capita food production is rising, it is probable that the number of people who do not receive adequate nutrition is also rising. These statements are not contradictory. There are, indeed, serious food shortages in many parts of the world.

Yet, I am still convinced that there are sufficient food-producing resources and technology in the world today to provide for the feeding of whatever number of people may live in the world in the year 2000, better than mankind has ever been fed. This statement is not a prediction, but rather a statement of potential that can be realized if enough of the right things are done by enough of the right people.

Food is more than fat, carbohydrates, protein, vitamins, minerals and fiber. Food is palatability, taste, form, appearance and goodness. Food is also a political and economic reality in almost every country in the world. Food policies can determine the success or failure of governments. Food politics will continue to be a hot item of debate in United Nations and other international forums.

Because food is all of these things, because it is so much a part of people's daily lives, eating habits and food systems are difficult to change. But people do change their eating patterns! Yes, they do, but typically it is more a gradual evolution than a sharp shift. Generally, it is an evolution to something that is regarded as better. Generally, it is an evolution that is associated with rising affluence. But if improvement in nutrition is to be lasting, if it is to bring with it improved quality of life as viewed by the participants, it must be done with appropriate consideration of the likes, dislikes and cultures of the people involved.

But within all of the diverse patterns, habits and traditions that must be recognized and taken into account, there are some valid generalizations that can be made. As individual incomes begin to rise, there is an almost automatic and immediate demand for more and better foods from those who have the money – whether they live in developed or developing countries, and whether they live in Europe, Africa or Asia. As income levels increase, people start climbing what has been termed the "food ladder." People with the lowest incomes live typically on diets that are high in starch – rice, corn, root crops. Such people crave vegetable oil in their diets, and they buy it when they can afford it. Next, they want protein—including meats. And, finally, they want some of the more luxury-type items – fruits and vegetables out of season, and many of the refined types of foods that are sold in the modern supermarkets in the Western World.

The succession of food preferences seems to exist with peoples of all ethnic and geographic backgrounds and all levels of economic development. And therein lies the special charm of the isolated or refined vegetable proteins. They can be utilized in a wide variety of food systems to improve nutritive values and functional qualities without displacing the system itself. They are being increasingly utilized as alternative food proteins in existing food systems.

Elsewhere on the program of the conference is a session on vegetable protein nutrition. I feel certain that that session will conclude that the soybean is a wholesome, fully nutritious protein source for humans, and that this will provide encouragement for still more research.

Generally, soy proteins are regarded as additions to the food supply rather than as displacers of any significant food

items. They provide a way for people to move up the "food ladder" without disturbing familiar and traditional habits of eating. Take for example, Japan — whose staple food historically was rice. As the Japanese economy has grown and Japan has become one of the industrial giants, individual incomes have increased, and the Japanese people are climbing the rungs of the food ladder in a predictable pattern. First, following World War II when they were surviving on rice, they greatly increased their consumption of vegetable oils, partly through massive imports. Then they increased their consumption of vegetable protein feed ingredients and began to develop a broiler and livestock industry. They have become the world's largest importers of soybeans and feed grains. More recently the Japanese have become interested in the use of isolated or refined soy proteins to extend their supply of fish paste products, such as kamaboko, at a time when fish supplies are reduced due to the imposition of the 200 mile fishing limits. They are also increasing their use of these soy proteins in processed meat products.

We are seeing this same rising demand for animal protein in both Western and Eastern Europe and in Russia, and this lies behind the growing import demand for soybeans and feed grains. It also explains the growing interest by the Eastern European countries in the use of soy isolates and concentrates for use in extending their supplies of sausage products. They have learned that they can increase their sausage consumption with less expenditure of their limited supplies of foreign exchange than if they imported the grain and soybeans and increased livestock numbers. Less developed countries as a group, likewise, are increasingly supplementing their food supplies with soy proteins.

But no discussion of world protein can take place without relating it to the total world food supply and total world food needs.

In recent years only a handful of countries have produced more food than their own populations have chosen to consume. Except for a few specialty crops like sugar, coffee, spices and palm oil, most food and feed products that move in international trade originate in the United States, Canada, Australia, Brazil, New Zealand and Argentina. Most of the international movement of food has been to the other developed countries who had access to sufficient foreign exchange that they could enter the world market and buy what they wanted or needed.

Over the period of 20 years that began in 1950, farm exports from the United States rose about 5% per year. In the decade of the 1970s, total world commercial demand has been growing at a more rapid rate, and it now appears that the potential exists for farm exports to make annual increases during the next decade that might average as much as 6 or 7%, calculated in constant dollars. While population growth is a factor, the major force in the growing worldwide commercial demand for food is rising affluence. Whether people live in developed or developing countries, or whether they live in Europe, Africa or Asia, if incomes rise, so does the demand for food, especially for foods that will add to the availability of proteins. Further adding strength to world markets is the apparent decision of Russia and some other countries to depart from their traditional pattern in short crop years — that of tightening their belts and toughing it out. Their pattern now seems to be to enter world markets and buy, rather than cut back heavily in consumption.

The import potential of the People's Republic of China remains generally unknown. Their leaders have indicated that they expect China to be a "full participant" in the industrial world by the year 2000. With that kind of objective vigorously pushed, China may also become a major importer of food.

We need to add to this demand the continuing purchases that will be made by the PL 480, Food for Peace Program,

the purchases for food aid by other countries and the purchases for relief feeding by the various United Nations groups.

It is my judgment that the American farmer and the farmer of other surplus food countries will be able during the 1980s to produce enough to satisfy at reasonable prices the rising worldwide commercial demand for the crops we grow for export — at least in most years. We must recognize, however, that because of the vagaries of weather, there will continue to be shortages of some crops in some years and surpluses in others.

It is possible that by the end of the 1980s, most of the agricultural exporting countries will be straining their production capabilities. Much will depend on our ability to continue to increase yields, on whether price and profit opportunities will cause additional but less productive land to be utilized, on costs of energy and other production inputs and on the general availability of water for irrigation purposes.

But, let us turn to the "Other World."

Two-thirds of the world's people live in developing countries with burgeoning populations. Malnutrition is still widespread and the gap between the "haves" and the "have nots" is still large. In fact, the gap may be widening in several countries. The United States and other developed countries simply cannot begin to produce enough food to meet both the commercial demand and the real nutritional needs in the world. They could not produce that much food even assuming some magic way could be found to finance it. If starvation and malnutrition are to be stemmed or prevented, the developing countries simply have to learn how to produce more on their own soil and provide the means of getting it to the people who need it. There is no other way.

But, wouldn't it help, really, if we in the United States were to reduce our consumption of meat and release grain for consumption in the developing world? The answer is, no! To the extent that we reduced the commercial demand for grain and lowered prices, we would be signaling to farmers to reduce output in future years.

I recall vividly in late 1971, when we still had large surpluses of grains as we do today, discussing whether any way could be found to get those surplus stocks to people who needed them — and, beyond the PL 480, Food for Peace Program, and some of the special church programs, there was no way. There still is no way unless food aid can be expanded, even though today we have large surpluses and prices are low. Hopefully, either through some of the United Nation's sponsored programs or directly, other developed countries and some of the O.P.E.C. countries will increase their financial participation in relief feeding programs to the end that, collectively, we can be more effective in responding to famines and other catastrophes on an emergency basis. Hopefully, also, we will be able to convince some of our importing customers to build storage facilities on their own shores, fill their bins in years like this one, and even out their own demands to the end that pressure on the market in short crop years will be less severe.

It is technically correct to say that more people can be fed from crops grown on an acre of land when the crops are consumed directly than when the crops are fed to livestock. Even so, I intend to demonstrate that the existence of a strong livestock industry in 1974 actually helped to alleviate the world grain shortage in that period, and that in the future, the United States' livestock feeding industry should itself be regarded appropriately as an effective part of a world grain reserve, and an aid to the maximizing of grain exports — and especially so in years of world shortage.

But, let us go back to 1974 and examine what happened.

Figure 1 shows exports of feed grains and wheat between 1970 and the crop marketing year that just ended.

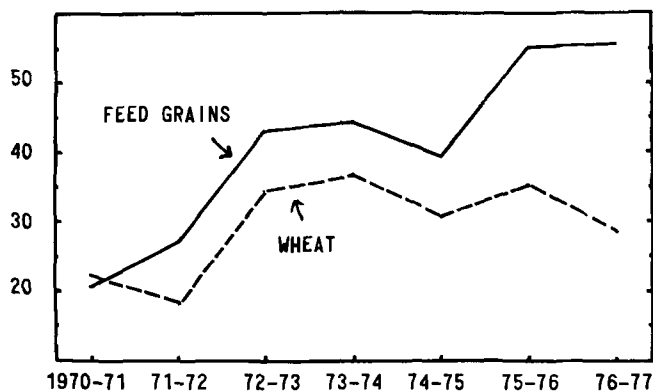


FIG. 1. U.S. exports of feed grains and wheat (marketing year - million tons).

You will note that the increase in feed grain exports has been dramatic - going from about 21 million tons in 1970-71 to 56 million tons last year. The growth in exports of wheat are not dramatic, but they are still up on a trend basis by about 5% a year. You will note also the modest drop in exports of both feed grains and wheat in the year following the short crop in 1974.

Let us look now at Table I. Total feed grain production in the United States in 1974 was down 17%. Now let us examine how the United States' livestock industry responded to this shortfall. Between December 1974 and November 1975, the pig crop was reduced by 15% from the previous year. By January 1, following the short harvest, the number of beef cattle on feed was reduced by 26% from a year earlier and by April 1, 1975, further reduced by 31% from the preceding year. Total feed grain use in this country from harvest to harvest was actually reduced by 24%. Yet exports of feed grains were down by only 10%. Clearly our feeders did adjust quickly and effectively, and because they did, the impact on the rest of the world was less severe than it otherwise would have been. Incidentally, wheat exports were cut more severely than feed grains, perhaps partly because there was little wheat being fed to livestock and there was, therefore, no livestock buffer to draw on.

"But", someone may say, "If you hadn't had all that livestock in the first place, we could have fed still less and helped the world more." Again the answer has to be, no! We expanded our grain producing base in this country in response to a growing consumer demand for meat and other animal products. In the absence of that kind of strong and continuous demand for grain to feed livestock, the acres devoted to feed grain production would have been much smaller. We would have had the same weather, fewer livestock to take grain away from, and our contribution to the world grain shortage would have been significantly less.

Moreover, without our large livestock population, especially the ruminant animals, we would not be able to convert the tremendous quantities of pasture, forage and other coarse materials that are available into human food. Also, ruminants can be shifted quickly to roughage feeds in times of grain shortages or high grain prices. In other words,

TABLE I

Grain and Livestock - Production and Exports
1974-75 as Percent Change from Year Earlier

Feed grain production, 1974	-17%
Pig crop (Dec.-Nov., 1974-75)	-15
Cattle on Feed	
January 1, 1975	-26
April 1, 1975	-31
Feed Grains fed in U.S. ^a	-24
Exports of Feed Grains ^a	-10
Exports of Wheat ^a	-16

^aMarketing year, tons.

they act as a "surge tank" in the food line.

It works the same way in a developing country. Since Biblical times, animals have been used as a buffer against crop failure. Professor Danald Paarlberg (1), writing in 1969 on this subject, states: "A big adjuster is livestock - if the food supply is reduced, we eat the livestock and then eat the crops the livestock otherwise would have eaten. The potential of this adjuster is enormous. Not all countries have this shock absorber in their food supply. The United States has it - some countries have long been so near the margin of want that the livestock population is very small and there is little cushion to avert disaster."

There is evidence that more and more of the developing countries are adding some livestock to their economies. Over the period of the 1970s, feed grain use in the United States and the other developed exporter nations has actually dropped (Table II). In the same period, there have been significant increases in feed grain usage in Japan, Western Europe, and the Central Planned Countries. The largest relative increases have occurred in the developing countries, especially in Mexico and Central America, South America, North Africa and the Middle East.

But doesn't the expansion of a local livestock industry tend to "sop up" local grain supplies and reduce the quantities of grains that would otherwise be available to the masses of people with lowest incomes? Doesn't the existence of a livestock industry cause a diversion of acres from vegetables and pulses into grains to provide feed for the livestock? Yes, these things can happen. They can happen if the pricing policies of local governments permit them to happen. But they occur generally because grains have been improved genetically through research and therefore provide higher yields and give higher incomes to the farmer than the pulses which are generally unimproved.

Actually, increasing the local supply of animal products seems always to be helpful in improving total nutritional health, and as I have pointed out already, in helping people to cope with temporary periods of bad weather and crop shortages. While meat and animal products are purchased initially by those with money, the existence of livestock in the economy seems to be a necessary step in the process of moving to a higher level of nutrition for all the people. This is a fact of economic development that often is ignored by those who approach nutrition with a strictly mathematical type of analysis.

As a further back drop for today's discussion of the future role of plant proteins, it seems appropriate to look at

TABLE II

Feed Use of Grain (2)

Country/region	1960/61-62/63	1969/70-71/72	1976/77
(Million metric tons)			
Developed countries	187.9	252.1	246.8
United States	110.8	136.5	117.0
Central planned countries	77.5	143.8	177.0
Developing Countries	17.3	29.5	41.8

TABLE III

Estimates of World Protein Production, 1976

Protein source	Million metric tons	% of total
Cereals, roots and tubers	142	52
Oilseeds	31	12
Roots and tubers	9	4
Fruits, vegetables, pulses, nuts	14	6
Total vegetables	196	79
Fish products	14	6
Meats, poultry, eggs	23	9
Milk, cheese, butter	16	6
Total animal	53	21
Grand total	249	100

the kinds of protein the peoples of the world are now eating, any shifts that may be occurring in production and consumption patterns and the total available supply of proteins in relation to the growth in population.

Table III indicates that nearly three-fourths of the protein produced in the world is in the form of grains, oilseeds and root crops; about 6% comes from fruits, vegetables, pulses and nuts, about 6% from fish, and about 15% is in animal products.

When the protein fed to livestock is removed (Table IV), we find that about 48% of the protein available for human consumption is in the form of grains and root crops. About 15% currently comes from oilseeds, fruits and vegetables, nuts and pulses; about 7% from fish and about 29% in the form of meat, poultry and other animal products.

If all four billion of us who inhabit the earth today were given allocations of protein and other food components, like rats in cages, according to our real physical needs, there would be sufficient food to supply sound nutrition for everyone and with a comfortable margin of safety. But the world does not work that way, and it will not in the future. Aggregate numbers and averages are helpful in establishing outer limits and in measuring trends; they give us little insight into the special problems of specific groups and especially those who are consuming at less than average and less than adequate levels.

For example, of the total protein consumed by Americans about 70% comes from animal sources. While worldwide, it is estimated that 70% of the protein consumed comes from plants, and in many societies it exceeds 90%.

These data suggest that if the protein content of the major cereal crops, rice, wheat and maize could be increased significantly, a major contribution to the elimination of malnutrition could be accomplished. Polished rice, for example, contains about 6% protein. If new varieties containing even 7% could be widely introduced, this by itself would add many tons of protein where it is

most needed. Varieties of rice which contain as much as 11% protein have been developed, but they are not grown generally, because there is a straight line, inverse relationship between yield and protein content. Since rice is sold by weight with no allowance for extra protein, growers stay with those varieties that produce the highest yields.

Although tremendous progress has been made in the development of high lysine corn, it is still generally lower yielding and still has some storage problems that have not been solved.

In the absence of a special bonus for high protein grains or until high protein varieties are developed that yield as well as standard varieties, little if any of the new types will be produced. If the difficulties could be overcome and the transition could be accomplished, the world would take a giant step toward eliminating protein malnutrition.

Any shifts that occur in these overall production and consumption patterns in the next two decades will be modest. They will be principally in response to demand as reflected by prices set in the free market or by prices artificially set and supported through subsidies by central governments. There is at least a basis for hoping that total calories on a per capita basis will rise. Within that pattern I would predict that during the next two decades, there will be some shift toward greater per capita consumption of both fats and proteins on the part of those with improved incomes.

In my judgment, one of the most urgent needs in the world today is for improved varieties of high protein legumes that are adapted to the tropics.

Dr. Lewis M. Roberts (2), of the Rockefeller Foundation, states, "A look at world acreage, production, and yield figures for all the major food crops reveals that the legumes are far behind in yield per hectare, although the total acreage devoted to them is relatively high, reflecting their importance. With the exception of such crops as beans (*Phaseolus vulgaris*), peas (*Pisum spp.*), peanuts (*Arachis hypogaea*), and soybeans (*Glycine max*), which are of importance in the developed world, the majority of the food legumes are of importance only to the people of developing countries. They have had little economic value as cash crops or as exports, because utilization has been almost solely confined to immediate home consumption, or at best to close range, farm-to-consumer marketing. As a result, these crops have not attracted attention in improvement programs, in contrast with wheat, rice, or maize, which have always had worldwide importance."

What Dr. Roberts is saying is that the food legumes of the type that are traditional and preferred in the developing countries in the tropics are losing out economically to high yielding grain crops at a time when they are urgently needed in the diets of the local people. There are at least 20 high protein leguminous crops, such as pigeon peas, cowpeas, wing beans, mung beans and chick peas which are preferred and eaten traditionally by various groups of

TABLE IV

FAO Estimates of World Average Per Capita Food Protein Supply, 1961-65 and 1974 (4)

Protein source	Grams/day ^a		% of total	
	1961-65	1974	1961-65	1974
Cereals, roots and tubers	32.7	33.4	50	48
Fruits, vegetables, nuts, oilseeds and pulses	10.6	10.2	16	15
Fish	3.6	4.5	5	7
Meat, milk, poultry, eggs and other animal	18.3	19.9	28	29
Other	0.9	0.9	1	1
Total	65.9	69.0	100	100

^aTotals may not add due to rounding.

people in the tropics.

The solution, of course, is the generation of an aggressive program of plant breeding designed to increase yields of the legumes so that they can be grown and sold for consumption in the rapidly expanding urban centers. Such a program, accompanied by enlightened government pricing programs, holds the potential for significant improvement in protein availability.

Recently, some sound genetics work on high protein crops for the tropics has been started. For example, both the Rockefeller and Ford Foundations are sponsoring research on selected crops, and work is also underway at several of the international tropical research centers. Soybeans are grown in a few areas in the tropics, but the yields are extremely low because the soybean is sensitive to daylength and has not been adapted for areas near the equator.

There are many things that can be done to improve the food supply for that part of the world that needs it most. I have mentioned increasing the protein levels in cereals, improving the yields of the food legumes and developing a balanced livestock sector. I should also mention the need to improve yields of existing crops, through greater and more efficient use of fertilizer, more effective control of pests, improved storage, processing and distribution systems, and the greater and more efficient use of irrigation.

Perhaps the most important single component of success will be national leadership. What is needed is a degree of enlightenment and political courage that has not always been in evidence. The Green Revolution, contrary to some reports, has been highly successful in every country where local leaders have given it a chance. But too often, country leaders "short term" it by giving in to urban pressures for cheap food. If this happens, and farm incomes drop so farmers can no longer afford to buy fertilizer, seed and water, food production may actually decline.

As programs such as I have listed or discussed begin to take hold in country after country, the isolated or refined vegetable proteins, in their special role as international food proteins, will be used widely throughout the world as critical ingredients in existing food systems. This will happen because these proteins are of high nutritional quality, because they are low cost in relation to other

protein sources, because of their functional characteristics, because of their great versatility and adaptability, their use supplements, and because they do not displace or disrupt existing systems.

The enlightened, expanded use of soy protein as a food ingredient is timely. The technology is developed and in use. Its expanded use will be an economic stimulus for innovation in food production food processing, food marketing, and food regulatory approaches. It will provide the base for turning the "potential" into the reality of expanding total food supplies and thereby helping to meet growing world need and demand.

It is vital that the food industry throughout the world continue to develop and utilize new technology for providing nutritional and wholesome economic foods. It is also important that we improve the methodology for measuring the nutritional responses of people to the new foods.

Research activity of the type that is being reported at this meeting becomes critical. People who are considering the use of new foods need assurances from competent sources concerning nutritional quality, safety, and efficacy.

Scientific interaction and peer judgments can and do provide the backdrop for the design of proper regulatory structures and standards. The actions of U.S. and other Western World regulatory agencies are especially significant, because they frequently become the model for regulations in other countries.

Finally, independent research evaluations provide an important basis for product improvement and further development.

There is *indeed* hope and the potential *does* exist for mankind to be fed better in the future than in all history.

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