The basic cause of famines has been social mores and economically induced, unequal food distribution, according to speakers at a seminar series on protein.

Protein to feed a hungry world

Benjamin H. Beard ▪ Milton D. Miller

Three years ago the price of red meat skyrocketed. Soybean meal, rich in protein, more than doubled in price from its previous all-time high. American consumers suddenly became aware that, if an actual world food shortage was not imminent, there at least was more competition from people elsewhere on the globe for foods we'd considered to be in endless supply. Aside from burgeoning demand for high-energy carbohydrate grains, people throughout the world wanted more protein-rich animal products.

Nutritionists began to examine more closely the place of protein in feeding humans. In particular, they investigated the possibility that protein might become a major limiting factor in our ability to feed a projected population of 7 billion by the year 2000.

Experts have since concluded that the apparent present world food deficit is, basically, the result of poor distribution of available supplies (*A Hungry World: The Challenge to Agriculture*, General Report by the University of California Food Task Force, July 1974, now out of print). And, where death by starvation or where malnutrition or undernourishment do exist, the problem is mostly a shortage of energy-yielding food—lack of calories rather than protein, or lack of total food, including protein.

Needs and supplies

What is known about protein needs and supplies?

In the spring of 1974, scientists in the Department of Agronomy and Range Science at the University of California, Davis, convened a weekly seminar series, "Opportunities to Improve Protein Quality and Quantity for Human Food." Participating in the symposium, which extended over eight months, were specialists from industry, the USDA, other universities, and three University of California campuses.

The proceedings were recently published as Special Publication 3058, *Opportunities to Improve Protein Quality and Quantity for Human Food*, by the Division of Agricultural Sciences, University of California, and is available free from Agricultural Sciences Publications, 1422 S. 10th St., Richmond, California 94804 (please order by postcard). Following is a brief summary of the key points of that report.

The speakers felt that the basic cause of famines has been social mores and economically induced, unequal, food distribution. The world's farmers, with the help of agricultural scientists, can produce sufficient protein to balance the lower supply of energy foods. During 1970 the average worldwide availability of protein was 173 percent of the established protein requirements, but the average caloric level for the world's population exceeded the minimum requirement by only 2 percent. (In more accurate perspective, the caloric deficit already is here. In economically developing countries and Asian, centrally planned economies with 72 percent of the world's population, the average caloric availability in 1970 was only 93 percent of the recommended minimum.) The major challenge ahead is to provide the energy foods needed. In meeting protein needs, there is reason for optimism. We are ahead in total supply, but there is no reason for unlimited optimism, because time is running out for us.

The presently accepted minimum standard of some 60 grams of high-quality protein per day per person is unneedfully high; something more like 45 grams probably is adequate for most people, a conclusion reached independently by separate United States and United Nations study committees. The net effect is considerably more protein availability than estimated earlier.

The protein problem, the scientists made clear, is for the people in developed countries—usually those who can be more choosy—to make an orderly transition away from almost exclusive use of animal protein and to turn more to vegetable proteins. In some countries, the protein requirements are already met with virtually an all-vegetable-protein diet.

Most people recognize the difficulty of change. People have historically established food preferences that are difficult to alter, even in famine, as witness some people starving in nations given copious amounts of wheat and other grains. Just as we may prefer steak instead of vegetable protein, those starving may find wheat and grain too alien to their established food patterns.

But the experts tell us that by 1980 we already will be unable to meet the total demand for animal protein. The time has come, perhaps, to consider and use the nutritional value of all food, and eat to live, rather than just live to eat.

We were reminded that poultry, one of our best feed converters, need the same kind of balanced amino acid proteins that humans do. But poultry, when consumed by humans, return only 23 to 27 percent as much protein compared to the amount they were fed.

One symposium scientist reported the United States has enough soybean protein to satisfy the needs of our own population. But we probably spend more energy in making this protein look and taste like something we're familiar with, or hunt for ways to hide it in more preferred foods, than we do in putting this resource to use.

Finally, the seminar speakers outlined considerable opportunity for increasing protein output with existing resources and technology.

Byproducts from grain milling and meal from some oilseeds could be useful in human diets but presently are used only as animal feedstuffs. The wheat derivatives already are high in the valuable amino acid, lysine, that we are trying hard to breed into some of our grains.

Furthermore, technology now exists to recover protein concentrate from leaves—a process capable of increasing the production per unit of land beyond that of any other plant or animal production system we now have. How valuable is it? Protein concentrate from fresh alfalfa is similar in nutritional value to animal protein, developmental scientists told us.

Proteins supply a balance of essential amino acids and enzymes that the animal organism needs to live, grow, and function. Protein quality and amino acid balance, certainly, must be understood in examining our gross supply potential. But without carbohydrates in the diet, proteins cannot be fully and efficiently used, regardless of their quality. So protein supply and quality have to be considered in relation to the overall food picture.

Scientists reported on the desirability of increasing the protein level and especially of improving the amino acid balance in cereal crops, corn, wheat, and sorghum. The reason is that people everywhere are likely to become more dependent upon these basic grain crops, not only for energy-yielding calories but also for their essential protein needs. The amino acid balance of rice and oats is good now, but increased protein content is needed. Some suitable germplasm is available to accomplish these improvements in the cereals, but increasing the protein percentage or changing the amino acid pattern in the oilseeds and large-seeded legumes may be more difficult. Also, the meal from some of the oilseed crops may contain native toxic substances. Both kinds of problems point to the need for more basic as well as applied breeding research.

The production of protein is subject to all the variables that influence the direction and rates of many biosynthetic processes. All of these convert solar energy to chemical energy.

The nitrogen cycle and man's nitrogen management will have the greatest impact on total crop protein production. For example, at current values and on the basis of an annual increase of around 70 million people, 100,000 metric tons more nitrogen fertilizer will be required annually if 60 percent of the crop nitrogen must be supplied by fertilizer nitrogen.

The scientists predict wider use of nitrogen-gathering legumes in the crop rotation systems or transfer of the ability to fix nitrogen to other plants, for example to corn, wheat, and barley.

Nitrogen utilization must be reexamined. Plant crude protein continues to increase under nitrogen fertilization, even after maximum crop yield is obtained. To conserve crop production energy inputs, breeders could try for plants that attain maximum yield and protein production at lower levels of applied nitrogen.

We obviously have room for improvement in nitrogen utilization by plants, and cultural and harvest practices that conserve fixed nitrogen must be developed. On the consumption side, we could learn to use more of the entire plant that we now grow only for its selected parts. Could we not use more leaf tissue for human food?

Animal protein

Several speakers underlined the high consumer demand for animal protein, the animal's inefficient conversion of products that already are directly usable by humans. The scientists also considered new ways to expand animal protein production.

Animals continue to have a compatible place in the protein picture. In fact, they are the only creatures capable of practically converting plants on our millions of acres of grasslands and wildlands to usable protein. A rangeland expert furnished a further fascinating projection of using our 32 million square kilometers of world shrublands for grazing animals. Proper management, growing the proper shrubs, and perhaps even breeding the type of animal suited to this resource could enhance world protein supply while protecting the environment and expanding human outdoor resources.

Animals can also help, researchers reported, in reconverting their own and other crop wastes to protein. One hundred laying hens, for example, can supply a ton of manure annually (dry basis) which, when mixed with 3.5 tons of treated straw produced annually from an acre of rice crop, can furnish a nutritionally complete diet for a beef cow for a year.

Finally, man still can look to the oceans and freshwater lakes for protein output. The capability of the world's ocean fisheries is predicted at a sustainable maximum of 1 to 2 million tons of food protein annually. Fish farming technology is at hand, of course, but we prefer such species as salmon or crustaceans and shellfish. Unlimited opportunities exist if we can expand our tastes to include carp or other fish. Many aquaculture problems need to be solved, because we have not yet been forced to look closely at the diseases of these water-borne species, or their need for quality water, or even their nutritional needs.

Programs needed

Finally, one single message of the symposium is clear. With world population increasing by 208,000 persons per day—2,000 while you drink your coffee each morning—the race for food and for survival will continue unless there are organized programs that effectively control population to fit the finite resources of this spaceship called our earth.

Topics and speakers of the protein seminar series, with abridged presentations included in the printed proceedings, were:

The (Other) Energy Crisis: J. B. Kendrick, Jr., Vice President--Agricultural Sciences, University of California, Berkeley.

Protein Requirements—Quantity and Quality: R. E. Young, Department of Plant Science, U.C., Riverside.

Protein and Energy—Nutritional Need and Demand: D. H. Calloway, Department of Nutritional Sciences, U.C., Berkeley.

Plant Protein Sources for Monogastric Food Animals: P. Vohra, Department of Avian Sciences, U.C., Davis.

Wildland Shrubs—a Source for Increasing Animal Protein: C. M. McKell, Director, Environment and Man Program, Utah State University, Logan.

Biological Limits of Domestic Animals to Produce Protein: R. J. Baldwin, Department of Animal Science, U.C., Davis.

Increasing the World Supply of Protein Through Recycling Wastes: W. N. Garrett, Department of Animal Science, U.C., Davis.

The Promise of Aquaculture: H. S. Olcott, Department of Food Science and

Technology, U.C., Davis.

Petro-Protein—Feedstuff or Dream: R. H. Lindquist, Chevron Research Co., Richmond, California.

Plant Protein Composition as Influenced by Environment and Cultural Practices: V. V. Rendig, Department of Land, Air, and Water Resources, and D. S. Mikkelsen, Department of Agronomy and Range Science, U.C., Davis.

Biochemical and Physiological Opportunities to Increase Food Protein: R. W. Breidenbach, Plant Growth Laboratory, U.C., Davis.

Nitrate Assimilation: R. C. Huffaker, Department of Agronomy and Range Science, U.C., Davis.

Green Leaves—a Potential New Source of Protein for Human Nutrition: G. O. Kohler, E. M. Bickoff, and D. de Fremery, Western Regional Research Center, USDA Agricultural Research Service, Berkeley, California.

Protein Concentrates from Cereal Byproducts and Minor Oilseeds: R. M. Saunders and A. A. Betschart, Western Regional Research Center, USDA, Agricultural Research Service, Berkeley, California.

Plant Breeding to Increase Protein from Cereal Crops: J. N. Rutger, Agricultural Research Service, USDA, U.C., Davis, and C. O. Qualset, Department of Agronomy and Range Science, U.C., Davis.

Improving Protein Supplies from Oilseed Crops and Large-seeded Legumes: B. H. Beard, Agricultural Research Service, USDA, U.C., Davis, and P. F. Knowles, Department of Agronomy and Range Science, U.C., Davis.

The Soybean Industry—How Strong Is the Giant?: D. R. Erickson, Swift and Co., Oak Brook, Illinois.

The World's Protein Needs: C. R. Burbee and Byron L. Bernston, Economic Research Service, USDA, Washington, D.C.

Summary and Conclusions: B. H. Beard and M. D. Miller, Department of Agronomy and Range Science, U.C., Davis.

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Search continues for control of almond hull rot

L. Todd Browne ▪ Joseph M. Ogawa ▪ Bashier Gashaira

Almond hull rot, caused by two genera of fungi, can result in severe dieback on vigorous, productive trees. Research is under way to find effective measures for controlling the disease.

Nonpareil almond tree showing blight of leaves and shoots caused by the bread mold fungus.