Need for Improved Plant Proteins in World Nutrition

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Although estimates of total world food protein availability seem to indicate a significant excess over minimal nutritional requirements, the diets of vulnerable groups in many developing countries, and particularly those of preschool children and pregnant and lactating women, continue to suffer from both calorie and protein shortages. Per capita consumption levels of protein by low income groups will continue to be inadequate in such countries notwithstanding evidence in some cases of overall economic improvement; this is particularly true where the food-to-population ratio remains critical. It seems apparent also that such countries cannot meet these deficiencies through greater production of traditional animal proteins, since even some highly industrialized countries are presently unable to satisfy the demands of their populations for animal foods. Food-deficient developing countries will need to depend for their protein need on plant foods and particularly cereals, legumes, and oilseeds. Even the novel or unconventional protein resources currently under development will make their first impact on the *animal* feeding requirements of the *developed* countries. Only in the past ten years has the considerable potential for upgrading the productivity, nutritional quality, and consumer acceptability of plant protein food crops become clearly apparent. Reference will be made to examples of this progress and to future possibilities.

We have been reminded to our sorrow in the past few months that without the cooperation of the weather, the Green Revolution can provide only a limited miracle. The irregularity or partial failure of this past year's monsoon rains in India and Southeast Asia raises again the specter of famine in these regions. Rice crops are severely short in the Philippines, South Korea, Indonesia, Malaysia, Cambodia, Thailand, Burma, and India. Although India doubled its wheat crop between 1966 and 1971, she must import two to three million tons this year. The most publicized shortfall of all is, of course, that of the Russian cereal crops. All of these unhappy circumstances have a particularly serious impact on the food protein supplies of the developing countries. Several nominally separate but interrelated problems are discernible here. The first relates to the fact that in many developing countries, even those apparently making good economic and agricultural progress, large segments of the population have been unable to improve their nutritional status because they are too poor to participate in the money economy. We think of Mexico as a country making rapid economic strides, and certainly one that seemed well on the way to solving its food supply problem. The fact is that up to half of Mexico's population is no better off nutritionally than it was prior to 1945 when the Rockefeller-assisted wheat and maize breeding studies were started. And this situation is not improving to any extent.

In India the doubling of wheat production between 1966 and 1971 gave this Government and its people great hope that the food and population problem could be brought into balance. Yet coincident with this remarkable food achievement has occurred a worsening of the protein level in the Indian diet. This is because the emphasis on wheat and its profitability to the farmers, involving heavy market subsidies, and massive investment in fertilizer and new irrigation facilities, has led to serious neglect of production of food legumes, that is the "meat" of India, with almost a 20% decrease in availability and a sharp increase in prices of these foods.

The protein priority generating the *most* political support among governments almost everywhere is increased meat production—and here the developing countries cannot begin to compete with the insatiable demands of Japan, Western Europe, and the USSR. The United States consumer eats 70 g of *animal* protein per day and the Russian 36 g. A United States resident in fact consumes about 11,000 calories per day to maintain his animal protein habit; this includes of course the feed supplies needed to produce the animal products he eats. The Russians can spare 7200, yet their major concern is to produce more meat and other animal proteins. Having visited the USSR recently, the author would find it difficult to believe that there could occur a shortfall in basic food calorie needs, at least in terms of bread and potatoes. But for the average Russian this diet is no longer acceptable. He is demanding more animal protein, and primarily red meat, at least equal to that available to the people of Western Europe. In 1970 the Soviet Government proposed to increase meat production by 30%, poultry by 10%, and milk by 20%, all by 1975. Even had they not suffered this past year's disastrous cereal crop failure, they would have found it impossible to achieve these goals—because their grain and protein supplement production for animal feeding is simply not sufficient. The important point is, however, they will continue to make strenuous efforts to do so.

The surging demand for animal protein and the major crop resources it requires casts a somber light on the possibility that the developing countries can easily improve their protein production from animal sources to benefit their populations to any significant degree. Thailand and Indonesia export large quantities of corn to Japan to sustain that country's animal industry. Virtually none is used for animal protein production in Thailand and Indonesia. In Colombia, where the author visited recently, beef was unavailable in restaurants on Tuesdays and Fridays. Why? It was being exported to increase hard currency balances. In Guatemala beef was once available to families of modest means, but hardly any more. They cannot compete with the prices available in export markets.

Obviously the poorer countries will have to solve their protein needs by other means, primarily by increased production and use of plant foods. Belatedly, the Green Revolution concept is being applied to other food crops, particularly the food legumes, and new efforts are under way to upgrade protein quantity and quality in cereal crops. One of the more encouraging developments is that the Ford and Rockefeller Foundations have convinced the United Nations and the major donor countries to join them in achieving with other crops, by means of several

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new regional agricultural research institutes, the successful example set by the International Rice Research Institute in the Philippines and the International Maize and Wheat Research Center in Mexico. Thus, under the administration of United Nations agencies (the World Bank in Washington and FAO in Rome), there has come into existence the Consultative Group on International Agricultural Research which is a consortium of financial donors including the U. S., Canada, U. K., Western European countries, the World Bank, United Nations Development Programme, and FAO, which is financing a related group of new regional laboratories including the International Institute of Tropical Agriculture (IITA) in Nigeria, International Center for Tropical Agriculture (CIAT) in Colombia, The Potato Research Institute (CIP) in Peru, The Asian Vegetable Research and Development Center (AVRDC) in Taiwan, and the International Center for Research in the Semi-Arid Tropics (ICRISAT) in Hyderabad, India. These new institutions will be able to give much needed research attention to many crops heretofore neglected, including not only those indicated in their title, but also for example the food legumes and the soybeans and millets.

Other authors in this symposium will refer to progress with various food crops, while here remarks will be confined to only one example, the food legumes, which have a long way to go in terms of improvement in their productivity and other qualities to a point where they can make a nutritional impact comparable to that of the high yielding cereal varieties, and especially in terms of their primary contribution as protein resources.

Legumes, even under optimum conditions in developing countries, are of relatively low yield. Even in terms of protein yield per unit of land, peas and beans are behind even potatoes and corn. Plant breeders have likened the available knowledge of genetic variability of most food legumes to our primitive information of the genetic variability of weeds, and thus far behind what is known in this regard about the major cereals and what must be learned if a Green Revolution in the food legumes is to occur. Dr. M. S. Swaminathan, one of India's top agricultural scientists, makes the point that the traditional pulse varieties of his country have over the centuries become adapted to the poorest agronomic conditions, since they are usually grown on the most marginal lands. They are sensitive to virtually no agricultural input such as mineral fertilization as would be necessary to create high yielding varieties.

Nevertheless, at a meeting in Rome recently, sponsored by the Protein Advisory Group (PAG), on ways and means to stimulate improvement of nutritional qualities of food legumes, Dr. Norman Borlaug expressed the opinion that a Green Revolution could be achieved in legumes in as little as ten years if the kinds of techniques learned in developing the new cereals were fully and quickly applied. This meeting, to which the Chairman of this symposium made a profound contribution, may have been the first of its kind where legume breeders were joined in discussion not only with other agricultural scientists but also with biochemists, nutritionists, and food technologists on what has to be done to improve the nutritional and food-use characteristics of the food legumes. The meeting proceedings will be published soon.

In the meantime the PAG has just released a comprehensive statement prepared by one of its *ad hoc* working groups immediately following the symposium, titled "Upgrading Human Nutrition through the Improvement of Food Legumes." It is essentially a nutritional and food quality guideline which legume breeders should consider when developing improved lines of these crops. The following is a review of some of the highlights of the document.

The statement points out that food legumes are major sources of protein and other nutrients in the diets of many developing countries and they often have a significant role in desirable crop rotations. These important food species have been seriously neglected in terms of research necessary to increase their yield and to correct certain defects in the nutritional and food-use qualities.

The PAG recommends urgent research attention to six major species of food legumes: dry beans, pigeon peas, cow peas, chick peas, broad beans, and peas, and the two leguminous oilseeds, peanuts and soybeans. While increased yield and improved consumer-acceptance qualities are primary objectives, priorities are also proposed for genetic improvement of various nutritional factors. These include increased protein concentration, higher methionine and cystine levels (the sulfur-bearing amino acids are usually the first-limiting amino acids in legume proteins, cystine having a sparing effect on methionine), augmented lysine where feasible (legumes are primary sources of lysine in cereal-based diets), and protein digestibility.

The importance of specific nutrients and the need for careful nutritional evaluation are emphasized. Various techniques for evaluating nutritional properties in breeding programs are listed and critically compared. These include total protein, methionine, cystine, total sulfur, and other amino acids. Also listed and evaluated are methods for digestibility and for toxic constituents, which are classified under heat-labile and heat-stable types. These include trypsin inhibitor (whose effect on humans may not be significant), the hemagglutinins, antivitamins, goiterogens, cyanogens, alkaloids, lathyrogens, and factors leading to favism and flatulence. The applicability and interpretation of feeding tests for various factors, including protein efficiency ratio and digestibility, are discussed. Bioassays for growth-depressing factors are also listed. Recommendations are presented for needed nutritional and biochemical research.

The attention of legume breeders is directed to the need for solutions to storage, processing, and consumer-acceptance problems in legumes under the headings of cooking, milling quality, susceptibility to insect infestation, undesirable storage changes, and uniformity of time of maturation of legume crops.

Production problems and opportunities are reviewed under the headings of breeding objectives, study of growth processes, production and management policies, and production economics and utilization.

The statement closes with emphasis on the importance of a reinforced program of food-legume research and training and the need for greater research support and stronger international cooperation.

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