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PLANT BREEDING AND NUTRITION

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Chairman's introduction

By G. D. H. BELL, *Plant Breeding Institute, Trumpington, Cambridge*

First, may I thank The Nutrition Society for inviting me to act as Chairman of the opening session of this Symposium. It would have been impracticable to have ranged over the crops of the world in a 2-day meeting, and it was decided to restrict the programme to cereals and pulses. These crops include those of the utmost significance to world agriculture and to human and animal nutrition in terms of food intake by virtue of their grain and seed characters. There is no need to emphasize, however, that other crops and other parts of plants, such as herbage and forage crops and a considerable range of tuberous crops, are of great importance as food producers in agriculture and have been the subject of a vast amount of study and research.

The history of mankind, his colonization of the world and the evolution of society, social structure and civilization have all been intimately associated with, and dependent upon, the exploitation of cultivated plants which have provided the essential staple foods. The number of species on which man has depended, and which are still his sole means of dietary intake, directly or indirectly, is extraordinarily small and none has greater impact than the cereals and pulses. Great civilizations of the world grew up on wheat and rice, and at this time in history more people, by a very large margin, rely on these two crops for their calorie intake than on any other crops. The world production of wheat in 1966 was over 308 million metric tons grown on 217 million hectares, and of rice 253 million metric tons on 126 million hectares. The total world cereal production was over 1087 million metric tons on 688 million hectares.

As sources of protein, the pulse crops are vital for stock raising under many agricultural systems, and for human consumption where meat is taboo or unobtainable: 40 million metric tons were grown in 1966 on 63 million hectares. The

balance of the accepted carbohydrate producers, principally the cereals, and the protein producers, as represented by the pulse crops, has been the basis of human and animal nutrition for as long as man has been aware of nutritional problems.

There is little need to emphasize to a gathering of this nature that there is a world food problem, which has been plainly represented as a straight struggle between human reproduction and agricultural production. As far as the former is concerned it has been calculated that from AD 1 it took 1000 years to double the world's population twice, while a similar rate of population increase will have occurred in the 20th century if the expected rate over the 35 years from 1965 to 2000 takes place, thereby raising the population from over 3 thousand millions to 6 thousand millions at a conservative estimate. Land resources are becoming a more critical consideration as increased population puts on the pressure: the twin objectives of raising total production through increased acreage and rising productivity are not innovations as far as plant breeding is concerned—they have always dominated our thinking and the effort has paid very good dividends. The expansion of the acreage of the staple cereals, considered on a world basis, owes everything to making available suitable varieties, while the increases in yield in many developed countries with an advanced and highly technological agriculture, that have characterized recent decades, are based on improved varieties and have found expression in the expert exploitation by the increasingly efficient grower. Future targets for increased food production are based very largely on the capacity of the plant breeder to provide the necessary varieties both for raising the productivity in terms of yield on land already under cultivation, and for expansion where this is economically feasible.

The breeder may thus be excused for his obsession with bulk, as measured in terms of yield, although for many years quality of the product has commanded a great deal of attention in the breeding of many crops. For the most part, however, quality in this connotation has been directed primarily to processing or industrial usage of the raw product, as exemplified in cereals by milling quality and flour quality in wheat and malting quality in barley. Again, there is justification for this in terms of the economy of these crops in the countries concerned, but in neither crop has nutritional value been a critical issue except in wartime when the loaf of bread has become a matter of national concern.

There are, however, interesting examples of the manipulation of individual chemical components of certain crops which are directly associated with some aspects of nutritional value, but most are of direct significance to processing, as in the composition of the oil fraction in maize and oilseed rapes for manufacture of foods. There are also the examples of the elimination of toxic principles from such crops as lupins and sweet clovers, but these examples are comparatively insignificant compared with the greater effort that has been put into a comprehensive study of all that is involved with the nutritional value of herbage plants.

Now, however, with improved technology for chemical analytical procedures, and the obviously more effective knowledge on nutritional value in terms of biochemistry, we are in a better position to become involved more closely with the application of plant breeding to nutritional problems. The recent interest in high-

protein wheat and barley and in the possibilities of manipulating amino acid composition have encouraged breeders to proceed more positively with biochemical problems. In many ways this resurgence has been due to the wide publicity given to the potential of the opaque-2 gene in maize, and the high-lysine story has stimulated expectancies which I consider are rather rash in some cases.

These developments have provided, we hope, a new dimension to crop breeding, and have brought together biochemists, nutritionists, geneticists and plant breeders in intimate association. New genes or genotypic associations are being feverishly sought after: world collections are being ransacked, and recourse to the exploitation of the newly available cytogenetic and breeding techniques has already started. We shall hear more of these matters in the papers to follow.

Nutritional considerations in attempts to change the chemical composition of crops

By K. J. CARPENTER, *Department of Agricultural Science and Applied Biology, University of Cambridge*

Improving the composition of crops by breeding has obvious advantages over many other ideas for raising nutritional standards in the world. Because of the long-term nature of such projects it is especially important that objectives should be thoroughly discussed before the criteria and priorities of selection are decided on.

History shows that effort can be wasted as a result of wrong assumptions about the nutritional aspects of a problem. For example, in the 1930s it was recognized that pellagra, a serious disease in countries where the poor lived on maize as their staple food, was a deficiency disease responding to the vitamin nicotinic acid. It then seemed obvious that breeders should try to develop strains of maize having a higher content of nicotinic acid. And yet the idea was unsound. It now seems that the nicotinic acid is present in all grains in a nutritionally unavailable form (Chaudhuri & Kodicek, 1960). Other grains are better than maize in preventing pellagra because they contain more of the amino acid tryptophan. In the body, tryptophan (in excess of that required for protein synthesis) can be metabolized to nicotinic acid (Krehl, 1949). As would be expected, opaque-2 maize, with its higher tryptophan content, does prevent nicotinic acid deficiency in experimental animals (Bressani, Elias & Gomez-Brenes, 1969).

This example illustrates the responsibility of nutritionists for checking as far as possible that the criteria they are suggesting for improving crops are effective ones. There seems a natural tendency for the nutrients which are newly discovered or the object of recent research to receive an undue amount of attention. Plant breeders must make definite 'yes or no' decisions about their priorities. If the nutritionists will not recommend nutritional priorities the selection will have