GENETIC MEANS AND CULTURAL METHODS FOR IMPROVING NUTRITIONAL VALUE OF CROPS*

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ABSTRACT

Concern for refining nutritional values of food is a contemporary pre-occupation of middle- and upper-income groups of affluent societies. For the underdeveloped world, and those caught within poverty traps in advanced economies, the problem is different. Besides not having sufficient to eat, their dependence on plant products, sometimes from a single crop, signifies that essential ingredients are often below acceptable thresholds.

In accordance with a reasonable order of priorities, plant breeders have in the past concentrated on reducing disease and on improving the response of varieties to fertility and to management. Interest in food quality is recent, and the subject is considered here in respect of the amount and quality of proteins and fats, mineral composition and the elimination of anti-nutritional products.

Increased protein in cereals can be derived by nitrogen fertilisation and by using high-protein genotypes in variety production. Negative correlations between yield and protein content, and yield and lysine in protein is common but new genotypes are available in which this correlation has been broken. Protein research was stimulated by the discoveries of mutant genes in maize regulating protein fractions low in lysine. This work has generated research in other cereals, as well as the search for legumes high in sulphur amino acids. Possibilities are discussed whereby the value of proteins in some of the grain legumes may be improved.

Interest in the quantity and quality of dietary proteins has overshadowed the importance of quality of the fat content of diets. Plants can make a substantial contribution to the balance between saturated and unsaturated fatty acids. Improvements in Brassica oils through elimination of erucic acid is an outstanding example of the success of genetical techniques in enhancing nutritional value of plants.

Anti-nutritional factors such as those causing lathyrism, favism and coeliac disease are discussed with a view to their elimination by genetical means. Provided the chemical agents can be specified, genetical techniques could raise the nutritional status of varieties and eliminate the widespread suffering that is caused.

Concern for refining the nutritional value of food is a contemporary pre-occupation of middle- and upper-income groups of affluent societies. These represent probably less than 15 per cent of the World population, and their problem is to maximise satisfaction from feeding while safeguarding health by carefully selecting from the rich variety of foods that are now available.

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through the highly organised world-wide marketing and processing organisations. This novel, and happy state applies to a greater number of people than ever in history and current objectives of the food industry in advanced economies concentrate on refining the already high nutritional intake rather than correcting major deficiencies of sub-standard diet.

For the underdeveloped and developing world, and indeed those caught within the poverty traps of advanced economies, the problem is different. Besides not having sufficient to eat, their dependence on plant products, sometimes from a single crop, often signifies that essential ingredients, proteins, fats and vitamins, are below acceptable thresholds. Their need is quantity, relieved where possible by variety; marginal improvements in quality of nutrition must take second place. Deprived communities, striving frantically to correct deprivations of food supplies, can expect some technical benefits as a 'run-off' from programmes in advanced societies but, because their priorities are different, they cannot be expected to be but marginally relevant to problems in needy countries of the World.

Prior to 1964, when the amino acid composition of some maize mutants was reported (Mertz et al., 1964), crop scientists had almost exclusively concentrated on changing factors which prevent maximisation of dry matter accumulation in harvest products. This emphasis on yield of dry matter produced a succession of improved varieties, which has greatly increased the World's capacity to sustain a spectacular population expansion and simultaneously to increase the standard of nutrition.

In accordance with a reasonable order or priorities, plant breeding has concentrated on reducing the damage to crops from disease, on improving response to soil fertility and on assisting mechanisation of production. Epidemics of invertebrate pests and microbial parasites inevitably increase with the intensification of production and without genetical and chemical crop protection, their effects would have been catastrophic in the recent past.

Among the most noteworthy developments in agriculture in the modern period has been improvement in soil fertility, especially the availability of soil nitrogen. During the past thirty years nitrogen use in agriculture has increased several thousand fold, and with the new short-strawed varieties of cereals which have allowed full exploitation of nitrogen supplies, this has been a decisive factor in raising food production world wide.

Apart from assisting in the full exploitation of nitrogen supplies, modern varieties of cereals and of other grain crops possess a more economically acceptable pattern of dry matter partition to the harvest products. (see table 1.)

Although plant breeders and agronomists can be credited with increases in yields somewhat in excess of doubling during the past half century, on a