THE GENETIC BETTERMENT OF YIELD AND QUALITY IN FOOD CROPS

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Three of the major problems now under intensive genetic investigation are: tailoring new strains of plants to the needs of dry farming, improving the efficiency of utilisation of nutrients by crops in irrigated areas and the upgrading of the quality of food grains from the nutritional and industrial standpoints. The following are some of the genetic tools employed in these studies.

Breeding varieties for better performance under conditions of moisture stress

A clear understanding of the physiology of growth and development of plants in areas characterised by chronic moisture deficit is essential, for standardising selection indices in a breeding programme. Earliness and a photoinsensitive nature are desirable attributes in varieties bred for dry areas, since these traits will enable the plant to withstand better the vagaries of the weather. Crossing strains with very divergent maturity characteristics helps to generate abundant genetic variability upon which disruptive selection can be practised. In plants like Sorghum vulgare and Pennisetum typhoides, hybridity together with earliness confer greater stability in performance and hence the development of suitable hybrids has helped to offset to some extent the effects of an adverse environment. The Sorghum hybrid, C.S.H.I, is an example of the utility of exploiting the advantage genetic heterozygosity provides in dry areas. Seeds of hybrids, however, would be more expensive and discovery of Dr. N. Ganga Prasad Rao of IARI of genetic apospory in Sorghum vulgare would, if exploited properly, provide a method of maintaining heterozygosity in a permanent manner and would render the purchase of F1, seeds every season unnecessary.

The presence of reducing conditions in the soil is important for the availability of Fe and Mn to the rice plants but creates problems of toxin accumulation. In the development of rice varieties for upland conditions it is important to get the character of rapid senscence of leaves incopporated, since this will reduce both oxygen transport to the rhizosphere and loss of energy through respiration particularly during grain development. The tiller number should be less but the grain number per panicle and grain weight should be high. Also, the root system should be well developed. These indices of selection are now being employed at the IARI in the breeding of superior rice varieties for areas where it is not possible to keep standing water all the time. In wheat, the indices of selection for unirrigated conditions are better understood, thanks to the work of Dr. R. D. Asana and his colleagues. Strains with 1 or 2 tillers having ears characterised by branching and with over 50 spikelets per spike are now under development.

Increasing the efficiency of utilisation of nutrients by crops grown with irrigation

Studies by Dr. B. Ramamoorthy at the IARI have shown that about 15 Kgs and 25 Kgs of Nitrogen have to be applied to get an yield or 1 tonne of rice and wheat respectively.

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The introduction of dwarping genes has helped in evolving a plant architecture best suited to the needs of better nutrient utilisation in rice, wheat, sorghum and Pearl Millet Forced recombination amojg distinct genotypes, the examination of a large number of biparential progenies, the screening of large F2 and F3 populations so as to enlarge the recombination spectrum and introduction of agronomic differentials in the selection programme have all helped in the selection of geno-types with the ability of utilising solar energy as well as soil nutrients better. The availability of elegant techniques for the artificial transmutation of genes has facilitated the ereation of variability for characters which represent new parmeters of human selection, such as productivity per day, fertilizer response, photoinsensitivity, suitability for mechanical harvesting and processing and quality characteristics. Thus, in castor a mutant has been isolated in by Dr. Kulkarni of IARI the progenies of the variety HC 6 irradiated with therma neutrons, which takes only 120 days from sowing to harvest in contrast to the over 240 days taken by the parent.

Genetic betterment of protein quality: Research in this field started with the studies of Mertz, Bates and Nelson whose examination of isogeme liones of maüze differing only at the opaque 2 locus showed that the endosperm of opaque 2 maize contained toice as ãuch lysime and tryphoffan, 50% more arginine, aspaitic acid and glycime and 30% less alanine and leucine. The cause of these changes is a marked reduction in the level of zein and an increase in the level of glutelin in the opaque 2 maize endosperm. When used in the human diet as the sole source of protern diet as the sole source of protern, the value of the lutant appproaches that of skin milk (bressani 2) The prolamine fraction of prtein which contains a low lysine content is 3% in rice, 12% in oats, 45% in bread wheat (Triticum aestivum) , 60% in durum wheat (T. durum), 50% in maize and 60% in Sorghum. Gnes for the suppression of prolamine synthesis will help to enhance the content of lysine content in many cereals. However the percentage of lysine in the prolamine and glutelin fractions varies in different plants and prolamine - suppression genes will be useful only in plants like maize and Sorghum where the lysine content is low in the prolamine noiety (Table). Research on exploiting both naturally occuring and induced variability for amino acid balance in the major cereales, millets and pulses is currently underway at IARI, and the Nutrition Research Laboratory, Hyderabad. Such research is of immense significance since over 66% of the protern supply in an Indian diet is contributed by cereales.

The physical properties of proterm like toughness and elasticity are very important in wheat. A strong gluten is essential for bread making while a weak one is excellent for making biscuits. Varieties with a strong gluten represented by a high Pelshenke value, also suffer less from weevil infestation during storage. The food industry should be come variety - conscious since it is possible now to match varieties to end use.

Table I

Crop	% Lysine in	
	Prolamine	/Ohitelin
Maize	0.20	5.0
Sorghum	0.20	3.0
Wheat	0.85	1.3