BREEDING FOR QUALITY CHARACTERS

Rice:

Several aspects of rice kernel are taken into consideration for determining quality. These include appearance of endosperm, length and shape of kernel, milling quality, cooking quality, aroma, protein content, etc. Generally, a transparent type of endosperm is preferred to opaque (chalky, white belly, white chore) ones. The opaque character is due to loose packing of starch grains and affects the appearance and milling quality. Opaqueness disappears after cooking and does not affect palatability. The heritability of this character is low and agronomic practices and pre-harvest handling influence this character. The waxy type of endosperm also gives a chalky appearance but is not common in Indian cultivars (except in traditional and few released cultivars of north-east India). Waxy endosperm is governed by a single pair of recessive genes.

Preference for grain length and shape (length / breadth) varies from country to country, region and even within the economic classes of a region. In India, rice varieties are classified into five categories (long bold, long slender, medium slender, short bold, short slender) based on length / breadth ratio of the kernel.

In India, Pakistan and West Asia, long slender grains fetch a premium price in the market. Grain length and shape are quantitatively inherited characters, are independent of each other and can be combined desired except probably the long and bold characters. These characters can, however, be fixed in early generations in a breeding programme and little segregation takes place in later generations (Jennings *et al.,* 1979)

The total rice recovery varies from 70.4 to 79.2 per cent and head rice recovery 23.8 to 74.5 per cent. Both the characters are influenced by environmental factors and are independent of each other. The latter is, however, of great concern to millers and, at the same time, more influenced by environmental factors.

Cooking quality : The amylose content and gelatinisation temperature of starch determine the cooking quality of rice. The gelatinisation temperature indicates the temperature at which the starch grains swell irreversibly when boiled in water. The proportion of amylose and amylopectin - two kinds of starch grains present in rice endosperm - is associated with stickiness of cooked rice, glutinous (Waxy) rice has up to 2 percent amylose. When cooked, water absorption and volume expansion of glutinous rice is low and the grains remain sticky. In India, glutinous types are used only in north-east India in preparation of cakes, sweets, etc. The starchy types can be grouped into low amylose (20 per cent) types. The varieties with high amylose types cook dry and fluffy but become hard on cooling. The Indian varieties have generally high amylose types. The high and low amylose types are governed by a single gene pair through modified by environmental factors. The gelatinisation temperature varies from 56 to 79^0C. Rice with high gelatinisation temperature requires more water and time to cook than those with low gelatinisation temperature. The gelatinisation temperature thus reflects the hardness of the starch granules. The Indian Varieties are generally intermediate in gelatinisation temperature and amylose content. Dominance gene effect was highly significant for grain length and amylose content.

Wheat :

The quality criteria of wheat is milling quality, baking quality for bread making, biscut making which again depends upon loaf volume, doughing, expansion of dough, loaf volume, degree of kernel hardness, colour etc. The quality is mainly dependtant on the protein content of the flour: The simultaneous improvement in grain yield and grain protein content through breeding is considered difficult because of negative association between these traits (Jennes *et al* 1991). This suggested that selecting the genotype with both high yield and high protein content fro breeding purposes. It as been proposed tat wild relatives are a useful source of genetic variation for increasing grain protein percentage. (*T.turgidum* var. *dicoccoides*). Cox *et al* 1990 reported that direct introgression of genes from diploid Aegilops squarrosa into bread wheat conferred an improvement in protein percentage. Similarly high grain protein percentage of a tetraploid (wild) emmer wheat (*T.dicoccoides*) has been transferred into bread wheat (Grammer *et al*. 1984).

Pearl millet :

High heritability and significant correlation have been observed in selected genotype for protein, calcium, phosphate and total minerals of the grain. The genetic analysis reveled that high heritable differences exist for total lipids, free fatty acids, total carbohydrates and total soluble sugars. The protein content and the total lipids were negatively correlated to carbohydrates but positively influenced by sugar content and longer duration. The additive gene effects were higher than non additive effects for the quality traits of protein, lipids and free fatty acids.

Maize :

Flint varieties are preferred compared to dent. The biological value of protein in normal maize is limited for monogastric animals and human because of its unfavorable amino acids composition. Dudley (1997) reported that theoretical limit to selection occurred between grain yield and protein content in the grains of IHP strains. These IHP lines are used in breeding programmes to improve protein lines always accompanied for high oil content. The first major break through was the discovery of the effects of Opaque - 2 and Floury - 2 mutants on lysine and tryptophan content in maize endosperm protein. Backcross programme helped very much to transfer these characters to cultivated maize. Special hybrids are also produced for Hi-starch content for specific industrial purpose. These characters are controlled by major genes with high heritability.

Small millets :

The grain quality parameters namely, colour, grain hardiness and water absorption in small millets.

Pulses :

In pulses breeding for quality improvement mainly based on improvement of protein content and quality of protein and then reducing the concentration of toxio antinutritional factors. Improving the content of amino acids such as albumin, glutamin, metheonine and high vitamins like thiamine, Riboflavin and Niacin along with minerals such as Ca, Mg and Fe. Reducing of protein and amylase inhibitors oligo saccharides, polyphenols, phytolectine, cynogenic glucocide, mycotoxins.

The heritability estimates are very low for these characters indicated polygenic in nature. Therefore, the success in the improvement is very limited.

Soybean :

The higher nutritive value of soybean is largely dependant on acid component of protein and content of antinutritional factors. Sebern and Lambert (1984) suggested the early generation selection for protein followed by selection for yield in later generation will be successful if non additive effects are important selection for protein content should be in later generation. All types of breeding methods such as pedigree - mass selection for low oil, recurrent selection are being adopted Wehrmann *et al* (1987). The studies revealed that the protein content controlled by two major genes.

Sunflower :

Sunflower seed has a hard weedy pericarp, the kernel constituting of the whole seed. The oil content of the seed ranges from 22 to 36 percent, the kernel contains 45-55 percent. The component of fatty acid of the oil are saturated acids 10% (Myristic, 0.38 Palmitic 4.27 and steric 5.46%) Oleic acid 35% and Linoleic acid 57% Regarding the fatty acid profile the oil contains lesser amount of saturated fatty acids, appreciably hig amounts of essential fatty acids, linoleic. In addition that the oil contains vitamins A, D and E, sterols, squalene and other aliphatic hydrocarbons, terpene and methyl ketones. The Phosphatids (0.1 - 0.2%) present in the oil are lecithin (38.5%) and cephaline (61.5%). They occur in combination with protein and carbohydrates. Antinutrients such as haemoglutinin activity ranged from 50.6 to 132.8 units / mg of protein. The phenol content ranged from 2.6 to 3.8 per cent. The ration of linoleic to oleic acid content is affected by environment variation in oil content and quality depends on the shape and size of sunflower head. The oil from dehulled seeds could be stored for longer period.

Oleic acid content showed significant correlation with linolic acid and linolenic acid and has positive correlation. Oil content is negatively correlated with seed yield per plant. Negative correlation between oil and protein content (Mendal and Single, 1993). It is suggested that the increase in oil level could probably be achieved through selection for thin hull, more seed weight, and high oil percentage in the kernel.

High heritability value for oil content indicated that significant improvement could be made in increasing oil content through individual plant selection in early generation.

The improvement in oil yield and its desirable constitutions would be possible by restarting simple recurrent selection (Miller *et al,* 1977). Pustovoit suggested the important stage in sunflower improvement as head to row remnant seed method.

Safflower :

Carthamus tinctorius **:** The oil content and quality of oil can be influenced by environment (Patel and Jaisani, 1962). Generally the kernel contributed some 98 per cent of the oil content. The percentage of oil in hulls decreased with increase in seed weight, whereas the oil in the kernels increased. There was negative correlation between oil content and seed weight (El seed, 1996).

The safflower oil has got high amount of unsaturated essential fatty acids. There is considerable difference in the characteristics of oil of the various species of *carthamus*. The correlation between spineless and oil content has been observed (Weins, 1971). The oil composition also varies in having a linoleic acid content averaging 48 per cent and an oleic acid 43 percent and these characters are governed by gene. OL/ol. In breeding programmes oil content and oil yield **per se** must always be considered.

Rape and Mustered oil :

In rape seed and mustard oil, the presence of erucic acid is an important characteristic feature. Genotypes in B.juncea. where the erucic acid content is 60 to 65% of the total fatty acids are available and considered as industrially important. The poly unsaturated fatty acids namely linaleic and linolenic acids are also present in significant amount (20 to 25%) and confer liquidity on the oil. Among saturated fatty acids, palmetic acid and steric acid are present in very low quantities totaling about 5%. They are found to be involved in increasing the thrombic tendency in blood platelets. The main path way of the fatty acid biosynthesis (Johnson, 19977) is as follows.

Palmetic acid → Steric acid

↙

Oleic acid   Eicosenoic acid - Erucic acid

↓

Linoleic acid

↓

Linolenic acid

The undesirable acid viz., erucic acid and linolenic acid are the end produced and reduction / elimination of these fatty acid is possible if the genetic block is achieved in the steps controlling the synthesis of erucic acid from oleic acid; linolenic acid from linoleic acid. The oleic acid has negative correlation with linoleic and linolenic acid on the one hand and erucic acid and eicosenic acid on the other (Ahiya *et al* 1978). Because of the interdependence in the progenetic substrate, the zero-erucic acid is reflected in increase oleic acid, linoleic acid and linolenic acid contents.

Genetic studies in rape seed has been found to be controlled by multiple alleles. Anand and Downey (1981) identified five genes in *B.napus*. They found to act in additive manner resulting in erucic acid leves of >1,10,15,30 and 35% respectively. Later occurrence of a single gene controlling high erucic acid content was reported by Chen *et al* (1988).

Use of double haploid lines have been attempted for *Brassica* improvement (Lichter *et al* 1988). Repeated back crossing of double low segregants to superior variety is also advocated. Triple low types can be produced by hybridizing double low types with yellow seeded donors. Directional selection for high linolenic acid is found very effective (Laakso *et al* 1986) Reciprocal recurrent selection is also suggested for simultaneous improvement of the traits. (Ahuja and Banga, 1992.)

Castor :

The castor seeds differ from other oil containing seeds in respect of specific content. Such as toxic protein, ricin and the alkaloid ricinine. In castor oil there is greater quantity of trigly-cerides of ricinolic acid. The unsaturated fatty acid in castor oil (Olieic and linoleic) are synthesised in the seeds in much greater quantities. The oil and hull content is in polygenic inheritance.

Cotton :

Since fabric quality is mostly governed by that of yarn from which it is woven and the quality of the yarn inturn depends upon the properties of fibre from which it is spun. The quality of cotton is judged on the physical properties of the fibre.

Fibre length and its distribution is an important character of the fibre. The staple length of cotton is highly associated with the strength fineness of the yarn and with its appearance. The mean length of fibre of world cotton varied form 12 to 63m.m. The fibre fineness ie weight per unit length of fibre is generally taken as a measure of fineness, it is closely related to the fibre maturitey i.e. depends upon perimeters and wall tickness of hthefibre. The fibre strength is very great, the range being 2.5 to 3.0 grams weight per unit length. The tensile strength of fibres varies form 50,000 to 1,25,0001b / squae inch. The long fine cottons tend to have greater tensile strength than the short anc coarse cotton. The bundle strength of fibre depends upon its area of cross section, test length, type of test instrument, the rate of loading etc. also depends upon relative humidity of the atmosphere.

Fibre maturity indicates the degree of thickenning of the cell wall relation to its diameter. The deposition of cellulose inside the fibre is not uniform in all fibres. Generally in medium and long staple cottons,have high fibre maturity gives a better spinning performance.

The genetic variability is higher in *G.hirsutum* for fibre length, uniformity ratio and *G.barbadense* for fibre fineness heritability values upto 80 percent is observed in span length, bundle strength and elongation in percent in the *G.hirsutum*. High heritability combined with high genetic advance will be more useful than heritability alone in predicting and performance of the progenies of the selected lines (Johanson *et al* 1955). A combination of high heritability and high genetic advance observed for the fibre length and bundle strength indicated the importance of additive gene action (Parse 1957) would respond well for further improvement through pedigree breeding and simple selection procedures. The study of heterosis, hybrids reveals that low positive relative heterosis for2.5% span length, uniformity ratio, and elongation percent and heterosis for fibre fineness and 2.5% span length. The intra *hirsustum* hybrids showed relative and standard heterosis for uniformity ration and low positive heterobeltiosis for maturity co-officient.

Forage crops:

In forage crops apart from nutritive value of green fodders, physical quality parameters like stem thickness, length of leaf and width, softness of stem and leaves etc. are important from the point of view of palatability to cattle. The breeding strategies adopted to improve the fodder cereals depends on the crops.

Temperature: Indirect methods of estimating amylose content and gelatinisation temperature are available for the benefit of those in research stations where facilities for regular analysis are not available.

The elongation of kernels on cooking is a special feature of ‘Basmati’ rices and needs experimental measurements for breeding such types.

Protein content : The protein content of rice varieties ranges from 6 to 18 per cent. The application of nitrogenous fertilisers, irrigation, etc. influences this character. Variation is noticed even among the kernels of the same panicle. The inheritance of this character seems to be complex and difficult to study because of several factors influencing this trait. The amino acid balance of rice is, however, quite good. The lysine content of rice protein is 3.8 to 4.0 per cent. The distribution of protein in rice grains differs among genotypes (Siddiq 1985). Deep diffused network of protein is retained much better after polishing and hence is a desirable breeding objective.

Aroma : Presence of fragrance in rice kernels is liked in India and hence scented types fetch a premium price irrespective of size and shape of kernels. Scented types are available in almost all States in India. The inheritance of this character has not been fully understood. Efforts have been made to breed scented types with partial success.