

Degeneration of Improved Crops in India.

By B. P. PAL,

Imperial Agricultural Research Institute, New Delhi

When an improved variety of an agricultural crop is released for general distribution among cultivators by the Agricultural Department, sooner or later a report generally follows that the improved variety has deteriorated or degenerated. Farmers, dealers and commercial seed growers complain that the acre-yield of the improved variety has gradually decreased or that the variety has deteriorated in quality, a few years after its introduction. As the cultivator's return ultimately depends upon the quantity and the quality of the crop he grows, it is of paramount importance to consider the various causes that may lead to the degeneration of an improved variety and to find out such measures as can be practised by the cultivator and the plant breeder to reduce it.

Causes of deterioration. It is well known that the behaviour of an improved variety or in fact of any variety is the function of the genetic constitution it inherits and the particular environment in which it grows. A change in either of these may result in deterioration. Thus the causes of deterioration may broadly be classified into genetic and non-genetic. The latter will be considered first.

When an improved variety is given out for distribution, it comes to be grown on areas, and under conditions which are different from those where the variety was bred. If its cultivation is extended to areas not particularly suited to its growing, then naturally it will not grow or yield so well as formerly. Unsuited soil conditions and unfavourable climatic conditions such as rainfall and length of day may profoundly influence the general performance of a variety. An interesting case of deterioration in quality of wheat grain was reported from Bengal a few years ago when two samples of wheat of the same variety were supplied by a correspondent to the Agricultural Commissioner. One sample grown in the Punjab showed well-filled hard grains, while the other sample which had been grown in Bengal from the same original seed consisted of shrivelled grains, of rather uneven texture, and was considered to have deteriorated. When these two lots of seeds were sown at the Imperial Agricultural Research Institute at New Delhi it was found that they gave rise to plants which did not differ in any observable characters. The deterioration observed when this wheat was grown in Bengal was therefore the result of growing it under very different soil and climatic conditions from those obtaining in its original home. It is the general experience that wheats grown under *barani* (rain-fed) conditions usually yield harder and more lustrous grains than those grown under conditions of irrigation even when the same varieties are used. An apparently detrimental influence of environment on the quality and the quantity of an improved variety may thus give rise to the cry of deterioration.

In crops like cotton the question of quality is specially important and it is known that the fibre qualities of this plant may be altered as a result of changes in environment. A cotton strain which spins upto 40 counts when grown in Madras under irrigated conditions hardly spins 30 counts when grown as a rain-fed crop in central India. Unsuited soil conditions also lead to a decrease in acre-yield. An improved variety, due to its high-yielding capacity, may remove comparatively a greater amount of fertility from the soil than the original poor-yielding one. Its continuous cultivation, without proper rotation, may result in the exhaustion of the soil, and the subsequent yields, therefore

are much less than the previous records. This may be another of the reasons for the general complaint that recommended varieties deteriorate. Agricultural Departments with the aid of the plant breeder should as far as possible prescribe definite tracts for improved varieties. The evils of deterioration due to unsuitable environmental conditions will then decrease to a substantial degree. The cultivator should as far as it lies in his power take adequate measures to replenish the soil so that the acre-yield will not fall due to poor soil conditions.

Attack by diseases. Sometimes an improved variety is considered to have deteriorated because it is affected by diseases to which it was supposed to be resistant during its creation or in the early days of its expansion. The causes of such deterioration are obvious. Certain improved varieties are not affected by diseases in a particular locality. In some cases they are free from the disease, not because they are resistant to it, but because the causal organism responsible for the disease is absent. When such a variety is extended to an area where the causal organism is prevalent, the variety naturally falls a victim to it. The problem of the disease resistance is further complicated by the fact that the causal organism, for example the fungus causing the rust disease of wheat consists of different varieties which are recognized by plant pathologists as physiologic races. A particular wheat may not be affected by one physiologic race, but it may be highly susceptible to another. For instance, a popular variety of the wheat of the Bombay Presidency, Bansipalli 808, is resistant to two out of the six forms of black stem rust. It is attacked heavily in the southern parts of Bombay, but it generally escapes rust in the Deccan. The so-called deterioration will, therefore, in such cases depend upon the distribution and seasonal incidence of these physiologic races. A particular variety may appear to be resistant to a disease, simply because it escapes the diseases by ripening at a time when the environmental conditions are not suitable for the vigorous growth of the fungus. It is reported that IP4 wheat, being early escapes rust attack in Bombay. If on the other hand the variety ripens some time after the appearance of the fungus, heavy infection is the outcome. It is desirable that the plant breeder should test his varieties for resistance under optimum conditions of infection to disease before releasing them for general distribution. Thus in Bombay, Jarila and Jaywant, two improved varieties of cotton, were supposed to be resistant, but succumbed entirely under optimum conditions of infection. The Sharbati wheats of the Central Provinces, A112, A113 and A115 evolved from a cross between a common wheat and *Rhapli* wheat were thought to be resistant to stem rust, but later on were found to break down in their resistance. But the resistant parent (*Rhapli*) concerned in the breeding of these wheats has been shown by later work to be not resistant to all the races of rust occurring in India. It must be pointed out, moreover, that at the time these were brought out, there was no accurate information regarding the physiologic races of the rust prevalent in the province.

Mixture with poorer types. Another potent cause of the deterioration of an improved variety is its mechanical admixture with poorer types. Proximity of threshing grounds, the use of the same yards, contaminated drills and seed-bins often cause extensive mixtures. In cotton, seeds may be mixed up in ginning factories. If the mixture of two or more varieties is perpetuated, a poorer type, due to its better adaptability to environment, may dominate the improved variety which will then be considered as having deteriorated. Since it is extremely difficult to prevent mechanical mixtures altogether, the best that can be done is to minimize the extent of contamination. The importance of thorough roguing of the off types is too obvious to need any emphasis. Extensive propaganda should be carried on regarding the advantages of roguing, so that farmers

may come to consider this operation as a normal routine in the cultivation of improved varieties of crops.

An improved variety may undergo degeneration if a change takes place in its genetic constitution. It is generally supposed that an improved variety released for distribution is pure, i. e. it breeds true to its type. When two varieties of a crop are crossed together with a view to evolving a better type, the progeny of the first few generations exhibit a wide range of variability in their characters. The plant breeder selects plants which possess the combinations of attributes he desires, in each generation, till his selected plants appear to be breeding true. They are then said to be pure. But recent advances in the science of genetics reveal that such strains are pure only for the more obvious characters and there may still exist variability in respect of physiological and other characters. Naturally, therefore, the variety will still manifest a range of genetic variability, though on a limited scale. In a few years new types would arise, among which would be a few obviously different from the bulk. These rogues, if unnoticed, will multiply and the improved variety will appear to have deteriorated. In order to check this evil, the plant breeder should assure himself that genetic variability is reduced to a reasonably low level before he certifies a new variety for general release. Secondly, the Agricultural Department must have stations responsible for maintaining genuine and pure seeds of the improved varieties. At these stations suitable systems for maintaining purity must be adopted and secondary selection carried out as found necessary. The new strain of cotton, Jarila, in Bombay is an example of secondary selection from an improved strain Verum 262 from the Central Provinces.

Natural crossing. The phenomenon known as natural crossing is one of the most important sources of deterioration in improved varieties. Although many of our important crops like rice, wheat and cotton are self-fertilized, they are liable to cross-pollination also. If different varieties of the same crop are grown in the vicinity of one another, as generally is the case in the cultivator's fields, there is every chance of the better variety being crossed with an inferior one. The segregating progeny of such a cross will naturally contaminate the population of the improved variety. Rogueing of the off-types can be suggested as the best control measure for reducing the extent of deterioration due to natural cross-pollination. In this connection, the problem of deterioration among naturally cross-fertilized crops may briefly be considered. Crops such as the oil-yielding *Brassicæ*, maize, and *bajra* are normally cross fertilized. Some of them are almost totally self-sterile, while in others a reduction in vigour occurs if self pollination is compulsorily enforced. In such plants single plant selection is impossible, and pure seed is raised by selecting a limited number of plants as closely alike as can be found and growing them in isolation. In the case of these plants, the maintenance of uniform strains is a matter of difficulty and the possibilities for rapid deterioration of a cross-fertilized crop are very great.

Then there is the case of the vegetatively propagated crops such as potatoes and sugarcane. Degeneration has been traced in these crops to be the cumulative effects of virus diseases which are handed on with the tubers, setts, etc. in the process of vegetative propagation. The damage thus caused can be extremely severe and the importance of using disease free planting material cannot be over emphasized.

The hereditary constitution of a plant may be altered by sudden change known as 'mutations'. Sometimes these changes are so minute that they may escape detection, but an accumulation of such inferior mutations may lead to deterioration of an improved variety.