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GENETICAL RESEARCH AS APPLIED TO PLANT BREEDING IN POST-WAR INDIA

IN any scheme of organisation of scientific research in India for national development, the study of Genetics should receive its proper attention. It is a young and rapidly growing science basic to modern plant breeding which is practised in all civilised countries for increased production of farm, forest and fruit crops. It is true that for thousands of years before the discovery of genetical methods for breeding, superior varieties of crops were produced; but these were mainly due to the efforts of individual, intuitive, clever men who applied a sort of conscious selection to the large number of variants occurring spontaneously or induced by random racial crossing. With the development of genetical knowledge during the present century, however, breeding practice was rationalised and many wrong corners and pitfalls which beset early breeders were removed. The concept of the gene as the unit of inheritance and the identification of the chromosomes as a string of genes controlling development, variation and evolution in living organisms have put new tools in the hands of the breeder. Recent knowledge regarding induction and utilisation of polyploids, wide crosses, mutants and hybrid vigour, arising from genetical researches, has opened up new possibilities for increased production. In fact, the new knowledge that has accumulated from researches on chromosomes—the bearers of hereditary characters—has made it possible to make new plants to order. The advice of one of the greatest authorities in genetics to breeders who desire to be most practical—"Know

your chromosomes"—indicates the importance of the study of Genetics.

It may not be out of place here to briefly mention how genetic research is being applied to secure increased production in some of the more progressive countries.

GENETIC RESEARCH ABROAD

Taking the case of Sweden, since the last War (1914-18) she has made tremendous progress in the matter of production of food and other crops as a result of the application of genetic research to plant-breeding. The annual yields of wheat and sugar-beet have been raised to a level at which the country is self-sufficient. This has been done by the application of new techniques such as by the use of twin seedlings, heat, colchicine, etc., for producing tetraploids and other suitable synthetic types. Tetraploid forms of clover, lucerne, herbage grasses, barley, rye, potatoes, flax and other crops have also been produced and some of them have already been found to be of practical use. Amphidiploid wheat-rye hybrids, first raised in the U.S.S.R., are now regularly produced by doubling of chromosomes in crosses between suitable parents for different conditions and purposes. A new grain crop, viz., Triticale, of special value for Sweden and other countries has been synthesised—"the first such invention for the last three thousand years". Higher yielding barley strains have also been obtained from X-rayed progenies; thus dispelling the misgivings of geneticists

regarding the value of X-ray mutants for breeding purposes.

The nutritional aspect in breeding was not lost sight of. Triploid apples with richer vitamin and better keeping quality have been obtained and potato varieties with higher ascorbic acid content are being bred.

Realizing the importance of breeding to forest trees, researches were initiated and within a short period significant results have been obtained. A survey of the forest resources in the country was made and triploid aspens and other trees with twice the growth-rates of the neighbouring diploid trees have been obtained. Polyploidy is being induced artificially in other trees for production of superior forms. Newer methods of propagation and grafting are also under investigation. Fundamental researches in genetics and cytology carried out at the cytogenetic laboratory in Svalöf are discovering new principles and techniques of paramount importance to breeding.

In the U.S.S.R. new and peculiar problems of production are being solved by the application of genetic research. Heavy frost and drought are constant enemies to successful crop production in that country. New synthetic crops are being produced from wide crosses which heretofore were considered useless because of the sterility involved in them, to suit different conditions and purposes. The amphidiploid hybrids of wheat with rye, *Agropyron* and *Aegilops* are a few instances in point. Extensive interspecific and intergeneric hybridisations have been undertaken in that country for the production of desirable types in rye, potato and other crops. This has been made possible by the wonderful wealth of wild genes the Russian geneticists have built up in their living collections of less well-known economic plants by surveying their own country and by sending out expeditions to other countries of origin of cultivated plants. A remarkable instance of this type of work concerns the potato. The potato introduced into Europe three and a half centuries ago set seed readily and gave rise to a number of varieties by segregation in the course of a number of years. The genes present in these varieties were utilized and all the desirable combinations of them were obtained and ultimately a position of stalemate was reached when no further improvement appeared possible although several problems such as those of Late Blight and virus diseases were unsolved. The necessity for importing fresh genes for disease-resistance was felt and a search for these genes in the original home of the potato was undertaken. Expeditions were sent to Central America and Mexico between the years 1926 and 1932 by the Russian geneticists and a large number of hitherto unknown tuber-bearing *Solanums* was discovered. As a result of this, a revolution in our ideas as to the origin and botanic status of the potato has occurred and possibilities of breeding potato to all the desired requirements of industrialised man are in sight. Another very important discovery of a Russian geneticist concerning the chimeral

nature of many of our domestic potatoes has proved to be of great significance to breeding.

The extensive collection of living plants has also helped in bringing into cultivation new and substitute crops whenever found necessary. The new investigations of the Russian geneticists on the breeding of rubber plants from *Taraxacum koksaghyz* and other *Compositae* are examples.

In America, the conquest of stem rust and other diseases of wheat and the production of hybrid corn, which has literally revolutionised corn production in that country, are eloquent testimonies to the successful application of genetic principles to increased crop production.

In England, continued cytogenetic researches on fruit trees, particularly those belonging to the genera *Fragaria*, *Rubus* and *Prunus*, have thrown light on the origin of many of these cultivated fruits and the mechanism of reproduction in them and has helped in the evolution of new and superior varieties.

With this background of research activities abroad it may be worthwhile to examine the status of genetic research in India and the possibilities of its extension in the future for national development.

PRESENT POSITION OF GENETIC RESEARCH IN INDIA

The application of genetic research to increased crop production may be said to have started in India with the opening of the Imperial Agricultural Research Institute and the Provincial Departments of Agriculture about the year 1905. The establishment of the Indian Central Cotton Committee and the Imperial Council of Agricultural Research later on, also supplemented activities in this direction. So far, the plant breeders and geneticists have produced many superior yielding crop varieties, mainly by the application of the time-honoured method of selection to naturally varying populations or to the segregates of inter-racial hybrids. Considerable success has been obtained with self-fertilized crops like the cereals and with the vegetatively propagated sugarcane. Breeding for special attributes such as disease- and pest-resistance, better quality and adaptability to regions of drought and frost have not made much progress. Suitable techniques for breeding cross-fertilized crops like mustards and maize have not been thoroughly worked out. Fundamental genetic research such as would lead to the discovery of new principles and techniques has not been taken up on a large scale. No doubt the inheritance of several morphological characters in a number of crop plants has been studied but these characters are of very limited application to breeding compared to the more complicated physiological characters which control yield and quality and which have received very little attention in India. The extensive use of the new weapons of genetic research such as polyploidy, hybrid vigour, mutations, chimeras, etc., in breeding has not

come into vogue in this country. Researches on modern lines have, however, been taken up only recently at the Imperial Agricultural Research Institute and already results of promise are indicated. Isolated experiments in productive genetics are also being made in a few other centres but much more remains to be done. If we are to advance in the future with regard to the solution of our varied problems in crop production, we have to bring into being a vastly expanded and co-ordinated plan of active research in pure and applied plant genetics whereby the breeding material and methods at our disposal could be enriched for exploitation by the breeder. The following are a few suggestions for the organisation of genetic research in India.

SOME SUGGESTIONS FOR THE FUTURE ORGANISATION OF GENETIC RESEARCH IN INDIA

The entire programme of work in connection with the improvement of crops in so far as it relates to breeding by genetical methods, may be divided into (1) Long-range research for discovering material, principles and techniques for breeding; and for training geneticists, (2) breeding for yield and other qualities in crops and (3) testing, multiplication, certification and distribution of bred varieties.

1. *Long-range Research.*—The long-range research should be located in the Central Research Institute, whose functions will be roughly as follows:—

(i) The survey and collection of the economic plant material including allied species of cultivated plants in the country and their systematic analysis with regard to their inherent useful qualities, their capacity to transmit them when crossed and the working out of techniques for obtaining such crosses for utilization in breeding. The work of the survey may be vested in a Bureau of Plant Introduction such as was pointed out by Dr. Pal in the Soils Wing Meeting of the Board of Agriculture, 1942, which will function as a wing of the Institute with a well-trained staff of geneticists and taxonomists. The universities may be called in to help in collecting information and material during tours of their staff and students in their respective provinces. The testing of the entire material could not, of course, be done in the main Central Institute owing to different climatic requirements of the plants and, therefore, a number of sub-stations in the different climatic zones will be needed for the purpose. The Bureau will also undertake introduction of plants from outside whenever possible. The materials accumulated and the experience gained with them will prove of

great use to breeders of different crops situated in different localities.

(ii) Fundamental genetic research for discovering the best techniques connected with breeding of the different types of crops such as self-fertilized, cross-fertilized and vegetatively propagated ones and evolution of new principles and methods discovered elsewhere for application to Indian conditions and crops.

(iii) Breeding of special crops and for special requirements for which the Central Research Institute is best fitted by virtue of its well-equipped laboratories and staff, as for instance, the breeding of potatoes and disease-resistant wheats.

(iv) Training post-graduate students in genetics and plant breeding. The Central Research Institute should be the best place for giving such training as it will be in touch with high-class fundamental research. For the training to be effective, it is necessary for the universities to devote more attention to the teaching of genetics, which unfortunately at present, is not receiving the attention it should. It is indeed a sad state of affairs that none of the many universities in India has a chair of genetics.

2. *Breeding Stations.*—For breeding superior strains of crops with required qualities, one or more breeding stations for each commodity may be set up in the areas typical for those crops. Each station, besides the other agricultural specialists, should have on its staff a well-trained geneticist who will help in the formulation and conduct of the breeding experiments. The breeding stations will work in collaboration with the Central Research Institute and will derive help from the latter both in regard to breeding material and techniques.

3. *Testing Stations.*—Small testing stations attached to each of the commodity breeding stations may be set up with a limited staff of agronomists and breeders to test out the bred varieties for their suitability to the different areas. At the testing stations, the potentiality of the different strains to respond to cultural and manurial treatments will also be tested. Multiplication, certification and distribution of approved seeds may also be supervised by the staff which may include a pathologist and an entomologist.

The above are only a few suggestions which may provide some basis for the organization of genetic research for improving crop production in this country. The question as to how the entire organisation should be secured and controlled is a matter for administrative authorities to decide.

S. RAMANUJAM.