5. Extensions of servicing workshops and retail stores; with a view to establish one servicing centre for one revenue firka;

6. Extension of cheap electric power to the villages.

In the 3rd stage: of development, in addition to further extensions to the items of the above two stages.

1. Increased activities of the State Extension Service;

2. Establishmet of Factories to manufacture, dairy, poultry and other appliances of the farm;

3. Establishment of factories, to manufacture the Tractor and other machinery requirements of the small holdings;

4. Extension of the retail stores and servicing stations to form a net work and there should be one such station for every group of five villages in the State.

https://doi.org/10.29321/MAJ.10.A04402

Role of Plant Breeding in a Scheme of Maximising Production of Crops

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Introduction: The ultimate aim of all work on crop improvement is the production of the best crops, the chief test of superiority, implying, besides, the greatest return to the grower. This, in turn, is dependent upon the increased yields realised and the economics of production.

Although a good many of the crops now made use of for food and clothing for man and fodder for cattle have been in existence from very remote times, recent studies have shown that there is still a great scope for improving them by producing varieties that are more efficient in their use of plant nutrients, give the greatest return of high quality produce per unit area in relation to costs of production, besides a greater immunity against diseases, insects pests and adaptability to the needs of the grower and consumer. In achieving these ends the plant breeder has played a very large role.

Breeding—Art or Science? Whether plant breeding is a science or an art is still a subject of controversy. Many still hold the opinion that breeding is an 'art'. But that breeding is also scientific can be seen from the large number of achievements made since Mendel's principles of genetics have been applied to the improvement of plants and animals.

Nevertheless, the really successful breeder does possess a kind of 'instinct' to discover and integrate the very small and useful attributes of the crop plant which he is dealing with and a knack for getting the desired result in the quickest time. In this way the breeder may be reckoned as an 'artist'.

The plant is only one factor and a 'crop' a number of factors. The factors must be considered as a whole and the machinery must not be thrown out of gear. Hence the study must be all-round and should be a study of the plant as a living whole. Plant breeding as a science is the synthesis of many branches of study such as biology, taxonomy, physiology and cytology.

A few varieties introduced from other countries have become popular e. g., the Great Scot potato, the Uganda cotton, the saline-resistant strain of rice S. R. 26-B etc. By following the time-honoured pure line selection, it has been possible to produce some very good strains in the important crops of this State.

The third method of producing new varieties is by hybridisation. In all hybridisation work certain fundamental factors are involved, e. g., the right choice of parents, the type of crossing that has to be adopted e. g., whether it is the single, multiple or cyclic crosses that will be useful, at what stage back-crossing is to be done, all have to be decided appropriate to the crop and the specific character one is trying to improve.

Plant exploration: In order to carry out a hybridisation programme, it is necessary to have as wide a collection of as many races of the crops plant as are available from the different regions of the world where these are grown. The explorations by the Russian botanists headed by Vavilov have brought forth results of not only high scienctific interest but of immense practical value to plant breeders. From the 191 botanical varieties in wheat known to the best workers on wheat, (Percival) Soviet expeditions have increased the total to 800. Formerly there was known but one Linnæan species of potato (S. tuberosum) but during the past decade the explorers aided by the cytologists, physiologists, and botanists have discovered 18 new species of cultivated potatoes and a dozen species of wild potatoes. According to Vavilov the longer the crop plant had been established in a given area, the larger the number of allied species that are found there; in addition to these it also abounds in a wealth of forms with rare and dominant genes. He also enunciated what may be called the law of "Homologous Variation". Now we know in which regions of the world we must look for definite genotypes; we know where productive large-seeded forms are located; where to look for plants with solid straw, varieties resistant to definite fungus diseases and so on.

The collection of such breeding material in this country must be considered very fragmentary compared to the progress achieved in foreign lands. The collection in the State are limited to what are easily available, and it is high time more serious efforts are made in this direction.

Interspecific hybridisation—Genes constitute the building blocks of the breeder; the larger and more varied is the store of this material the greater are the chances of creating new forms, While agronomically useful genes associated, say with yield, quality. etc., are available in the cultivated crops, those which constitute special traits such as winter hardiness, resistance to pests and diseases etc., are usually met with only in their wild ancestors, which may belong to the same species or to allied species. It is through the use of such wild relatives that the breeder can build up varieties with new characters and no amount of intensive work with the existing cultivated types will give us the desired results.

But crossing two species is something like breaking the parts of two motor cars and reassembling them into a new car. One of the greatest difficulties in the use of species crosses has been the sterility in the succeeding generations. Besides the sterility question, the desired combinations in the F_2 generations following an interspecific cross may not be realised due to powerful restrictions to character recombination such as gametic and zygotic elimination, pleiotropy and linkage.

Even in crosses between parents with the same chromosome number, there are great difficulties as in the *Indica* and *Japonica* groups of rice. These might have been separated by long centuries of independent evolution during which the genetic constitution of each may have become so transformed that the two retain very little in common, beyond the chromosome number. Although these races cross readily, the hybrids between them are in a state of genic unbalance and the desired combinations between them are difficult to obtain and also unsatisfactory.

The main difficulty in most of these crosses is the large number of factors in which the parents differ and the difficulty of of getting the desired combination. This can be overcome by growing

(1) Suitable large populations to select from, and

(2) By repeated back-crossing of the hybrids with the parent which it is proposed to improve.

The sterility in the hybrid which is also very common may be got over by doubling the chromosomes to produce a stable amphidiploid.

Hybrid vigour: Connected with the question of quantitative characters is the phenomenon of hybrid vigour or heterosis that results when two parents are crossed. The matter of vigour may be

in respect of size, resistance to pests and diseases, greater fertility, etc. The study of hybrid vigour appears necessary in all plant breeding work to differentiate effects of Mendelian dominance from effects due to heterosis. Different workers advance different causes for this phenomenon. But whatever the explanation, hybrid vigour has been exploited by plant breeders from a very long time. Even in plants produced from seed, this phenomenon is made use of in increasing the yields as in maize, brinjal, tomato etc,, by growing the first generation hybrids on a commercial scale, Recently in Madras a scheme for the production of 'hybrid cumbu' is in operation.

There is a definite 'combining ability' between certain inbred lines that gives the maximum vigour, and this 'combining ability' has been found to be a genetic character. Among vegetables it is found that cucumber, and ladies finger show a good deal of hybrid vigour. Root crops such as sweet potato and tapioca offer possibilities for utilising hybrid vigour and work on them has been started in Madras.

Polyploidy: The enormous potentialities of utilising polyploidy for producing new types of plants superior to the existing ones, has stimulated, since the past two decades, research on polyploidy, its mode of occurrence in nature and its production by artificial means The occurrence of polyploids is now known to be a common feature in the experimental cultures of several workers.

It must not, however, be forgotten that in all breeding work there is an element of a gamble. Not all polyploids may be desirable. This is a vast field in which many workers are needed, and patient work, for a long time.

In foreign counties several methods of inducing polyploids are in vogue—alternating heat and cold, X-raying germinating seeds, use of chemicals, such colchicine, acenaphthene etc., But the most successful one has been found to be the colchicine treatment on seeds, seedlings, growing tips of twigs, or buds. Successful results have been secured by the following methods; aqueous solutions, or in weak alcohol, suitable emulsions and lanolin paste, agar solution, glycerine and water and glycerine and alcohol. The range of concentration varied from 0.0006 per cent to 1%, and the duration also varied from mere wetting to 24 hours.

In this various experiments are being made to double chromosomes by the colchicine treatment and it hoped these would prove successful in due course.

Cytogenetics: A knolewdge of the chromosome theory of heredity is essential to plant breaders. The crops are the end result of the interaction of genes carried in chromosomes. The student of plant breeding will be able to understand these phenomena and

derive logical explanations for the results obtained in the course of his breading work only where a knowledge of the chromosome mechanism for the particular plant under study is available.

Breeding for special characters: It has been shown by recent researches that the laws of inheritance of characters, are equally valid for the less obvious physiological and economical characteristics as well. This opened up a new line of work for the plant breeder, who has not only improved the yielding capacity of the cultivated varieties, but also characters like disease-resistance, winter–hardiness, drought-resistance, non-shattering of grain etc., Later on interest also increased in improving the 'quality' of crops e.g., the gluten of the wheat grain, fats in oilseeds, protein in fodder, ginning percentage and spinning value in cotton and so on.

But it has been made clear during the past four decades of genetical studies, that these economic characters are compound characters made up of several components going together and a proper balance must be maintained between them during the breeding processes. In certain crosses, the effects of minor and modifying characters cannot always be distinguished from the effects of environment. Most of the characters of economic importance cannot be readily grouped into classes as the genes may act in a cumulative manner.

But thanks to the pioneer work of Fisher, Yates, Mather and other biometricians, more definite knowledge of the extent to which these disturbing factors could be evaluated, is now being accumulated in the shape of replicated progeny-row trials from the early stages of hybridisation work, and certain statistics which are useful in the study of these characters.

Crop breeders with the collaboration of other specialists have taken up the study of some of the special problems in this State. We have evolved blast-resistant rice strains, black-arm resistant cotton, and rust-resistant tenai. Certain strains of rice are more drought-resistant than others and also higher yielding. Certain cotton types, while yielding as much as the local types possess also a higher ginning percentage and longer staple. It must, however be admitted that a very great deal is yet to be done by intensifying the work. Improved types for vast stretches of marginal lands, saline areas and habitually flooded areas have yet to be evolved. Breeding is a continuous process and with the advances of knowledge in various associated sciences the plant breeder has a wide field for work and helping the country.