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PLANT BREEDING IN RELATION TO FOOD PRODUCTION

INDIA has never been a surplus country with regard to her food grains. The population has been increasing by nearly ten per cent. every ten years but the production has not kept pace with this increase in population. The normal small exports of the country are more than counterbalanced by imports from outside. It has to be remembered in this connection that the statistics of production figures available in the country, are hardly reliable and ways and means of obtaining more accurate figures for production, are still under investigation.

The chief food grains of the country are, in the order of their importance, rice, wheat and millets (including jowar). Of the above, wheat is a cold weather crop grown under irrigation in Northern India,—Sind, Punjab, U.P. and Bihar—and as a rain-fed crop chiefly in the black cotton soils of peninsular India. A large part of the area under millets is also confined to the black cotton soils of peninsular India and in several cases, the success of the crop depends upon a good and well distributed monsoon. In contrast with the above two, rice production is associated with a more plentiful supply of water either in the shape of monsoon rains or special irrigation systems. The rice area is mainly confined to East India, —Assam, Bengal, Bihar, Orissa, C.P., Madras and the narrow belt of land on the west lying between the Arabian Sea and the Western Ghats. Since rice forms the staple food of a large majority of the Indian population, it is the production of this crop that determines the deficit or surplus position of the country with regard to its food requirements. Even in years when the deficit was considerable it did not cause any anxiety so long as there was Burma nearby with a large exportable surplus of the commodity. Time there was, not at a very distant date, when with the prospect of getting rice cheaply from Burma where the cost of production is comparatively cheaper than in India, the question of actually reducing the area under rice in favour of industrial crops was even thought of. In fact, the question was seriously considered at a Crop Planning Conference held under the auspices of the Imperial Council of Agricultural Research nearly ten years back. The idea was, however, dropped due to the opposition from certain provinces where, under the system of rice cultivation practised in concentrated areas, there was not much scope to introduce alternative crops. The present war and the loss of Burma has brought home the danger of depending upon foreign imports for the most important food grain of the country. For a large country like India with an enormous and ever-increasing population and where, over a large part, the success of crop production depends upon the vicissitudes of the monsoon, it is necessary that the country should be made as self-sufficient as possible for its food requirements. It is very unlikely that after the cessation of the war the question of over-production of food crops will cause difficulties, and even if it should, the proper course would be to absorb the surplus in industrial concerns.

The immediate and pressing problem is to increase the production of food crops. To attempt this, two ways are open to us:

(*i*) Increasing the acre yields in the existing areas by (*a*) substituting ordinary varieties grown by the cultivators by the improved ones evolved by the plant breeders and (*b*) by adopting intensive manuring practices.

(*ii*) Increasing the area under food crops by (*a*) either designing new irrigation systems or making adjustments in the existing irrigation projects and (*b*) substituting areas under non-food crops with food crops.

Improved Varieties as a Means of Increasing Acre Yields

It is well recognised that successful plant breeding work by itself can improve the production by at least ten per cent. If the existing varieties are systematically replaced by improved ones by well-planned seed multiplication and distribution schemes. Growing an improved variety costs the cultivator no additional expenditure and no difficulty has been experienced anywhere about the cultivator being unwilling to take up the improved variety. It is sometimes pointed out that in spite of the fact that plant breeders have been working for several years and producing new varieties, the area in the country under such improved varieties, forms only a small fraction of the total area under the respective crops. This may partly be due to want of experimental data obtained by extensive trials in cultivators' fields to decide upon the superiority of the improved kinds for particular areas. But even where such data are available, that the area under improved varieties has not increased, is mainly due to the aversion of Provincial Governments to finance seed distribution schemes. Punjab is, however, an exception where large amounts are spent annually on seed distribution schemes, and when once the superiority of an improved variety is established, seed schemes are immediately put into operation. It may be pointed out that seed schemes are by no means a net expenditure to the Provincial Government and that well-planned schemes can actually be made self-supporting. The exigencies of war and the shortage of food, have now made the Provincial Governments realise the importance of supplying pure seed to the cultivators as a sure and easy means of augmenting production and several governments have now provided liberal grants for seed schemes. This work should be extended by every possible means wherever improved varieties found suitable to particular tracts, are already available. It might happen that some of the varieties with the breeder may require further testing out in cultivators' fields and this could be undertaken immediately. Due to differences in the intensity of breeding work carried out in the various provinces, some might be more favourably situated than others with regard to the availability of improved varieties for different tracts. For example, in Madras it should be possible to recommend improved varieties for all the major rice tracts of the province.

Intensive Manuring as a Means of Increasing Acre Yields

Apart from water being a general limiting factor for crop outturn, it has an indirect relationship to manuring practices. In crops like rain-fed wheats and millets there is probably not much scope of increasing acre yields by manuring as an emergency measure. The fertility here has to be gradually built up by a continuous application of cattle manure or composts. Irrigated wheats, however, come under a different category and increasing their acre yields by manuring should be possible. There are indications of oil cakes in C.P. and ammonium sulphate in Punjab giving profitable increases in yield. But we have no extensive experimental data to go by to make immediate recommendations. The available information about rice manuring is happily much more definite. Ammonium sulphate, oil cakes and green manuring are all known to give profitable increase in yields in several areas.

Due to war conditions ammonium sulphate is not available in quantities nor at remunerative rates. It has been suggested recently that the resolution of the United Nations Food Conference "that Governments which need fertilisers should be supplied with them subject to the exigencies of war", might be given effect to. If it is possible to import the necessary machinery to manufacture sufficient ammonium sulphate in the country, it should help in increasing rice production immediately. That acre yields of rice in other countries are much higher than in India is due to the fact that the soils there are not only more inherently fertile than in India but also receive fertilisers to the extent of 70-100 lbs. of N. per acre whereas in India, the majority of the rice lands do not get any manure at all. It has been shown that in parts of Madras, acre yields comparable to the foreign countries could be obtained with intensive manuring. With regard to oil cakes the areas where rice is cultivated extensively are not those where oil seed crops come in the cropping and making oil cakes available to the cultivators at remunerative rates appears to be a question of overcoming transport difficulties. Lastly, wherever rice is grown in India, any form of green manuring has always proved profitable. Besides green manuring other bulky manures like composts, municipal wastes, etc., are also useful for rice and the use of these should be encouraged by every possible means.

It has to be mentioned, however, that it will not be enough if the use of either improved seed or manures is simply recommended; they should actually be made available at every rural centre at reasonable prices. It may be mentioned here that the general experience has been that the improved varieties respond better to intensive manuring than unselected kinds. There is no doubt that the growing of improved varieties coupled with intensive

methods of cultivation, particularly manuring, wherever possible, should soon make the country self-sufficient with regard to the country's requirements of rice.

Increasing the Crop Area by either Designing of New Irrigation Projects or Adjusting the Present Ones

Starting of fresh irrigation projects to bring new areas under food crops though it involves capital expenditure is a sure way of increasing food production. The recent appointment of a special irrigation adviser with the Government of India, is a move in the right direction. It would probably be worth while to put an irrigation engineer on special duty in each of the provinces where irrigated rice is an important crop. The possibilities of starting new minor projects or improving such of the old ones that have gone out of use would receive adequate attention in that case. The examination of improving irrigation facilities should particularly be welcome in provinces like Bengal and Bihar where, in spite of their large areas, the acre yields are comparatively low mainly for the reason that in a greater portion of their rice areas there is scarcity of water at critical periods of plant growth though there may be a surfeit of it at other times. Minor adjustments in the existing irrigation systems might help in increasing the area under the crop. For instance, where a single crop of about five months duration is at present grown, it should be possible to grow two short-duration crops in quick succession in the same season. Similarly in tracts where both single crop and double crop areas exist, and where the latter form only a small fraction of the total area, the percentage of the double crop area could be increased by adjusting the time of opening and closing of the irrigation channels. This last suggestion is already being given effect to in parts of Madras.

While considering irrigation projects the question of the large inundated areas on the seacoast in Bengal, Orissa, parts of Madras and Bombay where rice is at present a very precarious crop may also be thought of. While breeders may be expected to recommend as a result of research, varieties that could withstand flooding or a slight salinity in the water, making the area safe for rice cultivation is essentially an engineering problem. It might mean considerable capital expenditure but still it is a problem worth investigating from the view-point of the ultimate increase in the food production of the country.

The success of either new projects or improvements in the existing ones will depend to a large extent on the right choice of the varieties to be grown. The breeder with local experience should be able to give the necessary advice, and in any case, it is necessary that the irrigation authorities should work in close collaboration with the breeder.

In the attempt to bring more area under food crops the large areas shown as uncultivated wastes in the revenue statistics of *ryotwari* provinces could be thought of. In several causes such areas may not actually be cultivable for various reasons such as, rocky or poor nature of the soil, absence of water facilities, absence of people in the locality being unhealthy spots, etc. The immediate necessity is to make a proper survey of these areas with a view to determine what portions of such areas could be brought under crops and what facilities they would need. There are also the broad strips of waste land lying on either side of railway lines. A good portion of them is capable of growing food crops and the question is to determine whereall it could be done without endangering the safety of the permanent ways.

Substituting Non-Food Crops by Food Crops

The scope for this appears to lie mainly in the rain-fed tracts. The only crop that can be replaced by food crops is the short staple cotton and while considerable progress has already been made in this direction in parts of C.P. and Hyderabad, its success would appear to depend upon the cultivator being compensated in cash for the change-over as the growing of short staple cotton still brings him a greater raturn than the food crops. In irrigated lands where the non-food crops that are chiefly grown are cotton and sugarcane, the disparity in the returns between food and non-food crops even at the present rate of food grains is greater than in the rain-fed tracts, and to induce cultivators to go in for food crops might prove impracticable unless they are going to be sufficiently compensated.

Post-War Problem of Food Production

So far we have discussed the question of increasing food production as an emergency measure. Equally, if not more important, is the question of making the country self-sufficient with regard to food requirements even in the post-war period so that we shall never again find ourselves placed in a difficult situation like the present one. It has been already stated that successful plant breeding and production of improved varieties is a sure and the least expensive method of improving the acre outturns. Any expenditure on plant breeding work should give returns several fold. It is, in fact, the results of plant breeding work that form the chief plank on which most of the activities of the provincial agricultural departments depend. We shall now examine the scope and position of plant breeding work in the country with regard to the three chief food crops.

Wheat was the first crop to receive attention at the hands of Sir Albert Howard and his improved varieties had spread all over India, particularly Northern India, and outside India as well. The breeding work in this crop is now being carried on by the Imperial Economic Botanist at the Imperial Agricultural Research Institute, New Delhi. Some of the wheats bred at Delhi are expected to be found suitable for parts of U.P. and Bihar. Punjab has its own wheat botanist and certain new varieties bred by him have completely replaced Howard's wheats in the province. The wheats grown in Sind are either those of Pusa or of the Punjab. So far as peninsular India is concerned where a different wheat (*durum*) is grown, the

problem is separate and has to be dealt with independently. Work on this wheat is going on in Bombay, C.P., Hyderabad (Dn.) and Indore. Apart from the two main divisions, the irrigated bread wheats of N. India and rain-fed *durum* wheats of peninsular India, there is a fair amount of adaptability within the two groups. Wheats bred at one centre may do equally well at another. This should not be taken to mean, however, that the breeding work could be sufficiently centralised. It is quite likely that if independent and intensive breeding schemes are carried out in U.P. or Bihar, there should become available varieties even better than either Howard's wheats or the new wheats bred at Delhi. There are always bound to be local differences and adaptations of the crop to such differences.

With regard to millets which are of comparatively greater importance to peninsular India, work has been going on in Madras, Bombay, C.P., Hyderabad, Mysore, Indore, etc., but from the results available it would appear there is considerable scope for further intensification of the work. Breeding in millets is comparatively a more difficult task as the failure or an uneven distribution of the monsoon might easily upset the whole programme of work. The importance of the work on some of the minor millets has been recognised recently and breeding schemes have now been started in several provinces and States with finance partly provided by the Imperial Council of Agricultural Research.

Coming to rice, each of the rice provinces has now got either a whole-time or part-time plant breeder and the Imperial Council of Agricultural Research has been responsible for intensifying this work in some of the provinces with liberally provided finance during the last ten years. There are several improved varieties evolved by the breeders in the chief rice provinces already available with which seed schemes are in progress. One thing that has to be emphasised in the case of rice is that it has a limited adaptability, and it is within the experience of breeders that improved varieties from another province or even from a different tract within the same province have often proved failures. Work for each tract has to be done independently and the ideal arrangement should be to have as many breeding stations as the number of individual tracts with varying conditions warrant. Madras might probably be mentioned as an example of having adopted this policy. The paucity of sufficient number of stations should make it apparent how much yet remains to be done, for example, in a predominantly rice province like Bengal.

Scope of Plant Breeding Science

There is no doubt that to carry out breeding work more thoroughly and more intensively for a country of the size of India, we shall require several more trained plant breeders and breeding stations than what we have at present. The magnitude of the work needs no emphasis. Varieties superior to what is commonly grown by the cultivators have to be evolved for millions of acres on which unselected mixed types still continue to be grown. Plant breeding involves not only production of varieties with greater yields but also varieties that could resist pests, diseases, drought, salinity in the soil or water, etc. The time is past when plant breeding was considered more an art than a science. Plant breeding science touches in its sphere of activities several branches of botanical science, like taxonomy, genetics, cytology, pathology, physiology, etc. Great advances have taken place in recent days in these branches of science and proficiency in any or all of these cannot alone make a successful plant breeder. A breeder to be successful should not only know something of these sciences but also keep abreast of the latest developments and utilise them as tools in his own sphere of work. His work consists mainly in the field, making continuous observations on the growing plant and sifting the variable material. Besides the above sciences, statistics has come to play an ever-increasing part in giving a precision and objectiveness in the technique of breeding. It has partly dispensed with the trial and error methods of earlier plant breeders and no plant breeder worth the name can afford to neglect statistics.

While it is true that the practical achievements of plant breeding research in India would compare very favourably with any of the more advanced countries of the world, it has yet to be admitted that the number of successful breeders available in the country is hardly commensurate with the immensity of the problem. In India where the work is still in its infancy it is quite an easy matter to produce an improvement from the widely variable natural material available, but it cannot be said that the technique adopted in the difficult centres is not capable of being improved upon. Faulty technique is bound to cause delay in obtaining of successful results and this, a comparatively poor country like India, cannot afford.

Training of Plant Breeders

What are the facilities available in the country of the size of India to turn out plant breeders of the required calibre? The only countries with which India can be compared in this respect are Russia and U.S.A. and such a comparison immediately brings out the very poor position of India both with regard to training centres and the personnel capable of giving the necessary training. The tremendous advance Russia had made just before the present war started with regard to increasing the production of its raw products including food grains was achieved, not by tinkering with the problem, but by creating an army of trained men and distributing them for work throughout the length and breadth of the country. In India, besides the Imperial Department of Agricultural Research at New Delhi, the provincial departments of agriculture have their own Crop Specialists or Economic Botanists to deal with the problem of improvement of crops. The staff under these experts consist of men who possess a University degree either in Botany or Agriculture and they start learning work only after they join the department; the

training thus obtained might not be all that is desired. No provincial agricultural college has got a definite post-graduate training scheme.

In U.S.A., besides the workers in individual States either on Government employment or attached to the Universities, there is the federal Government which has also a large agricultural department with a team of research workers and there are schemes directly under their control not only at federal headquarters but also scattered in the different States to supplement the work which the individual States might already be doing. The Imperial Council of Agricultural Research in India no doubt functions to a certain extent on the model of the federal department of agriculture in U.S.A. but it has not got the expert technical personnel to help or give guidance to workers in individual provinces or States. This is a matter that requires consideration from the point of view of all-India interest. Apart from other considerations, it will be well if the Imperial Council of Agricultural Research could examine at least the question of providing for the country competent personnel in sufficient numbers with sound training in plant breeding. It is quite likely that at least some of the agricultural research centres already existing in the country could be utilised as training centres with additional facilities provided wherever found necessary.

In conclusion, it may be definitely stated that plant breeding research offers the greatest scope for increasing the food production of the country not only as an emergency measure under the present conditions but also as a long-range measure in the post-war period.

PROF. H. J. BHABHA, F.R.S.

PROF. H. J. BHABHA, F.R.S., has been awarded the Adams Prize for 1941-42 by the University of Cambridge. Readers of *Current Science* will rejoice to learn that Prof. Bhabha is the first Indian to win this unique distinction.

The Adams Prize, valued at about £300, is awarded every even year for the best essay on some subject pertaining to pure mathematics, astronomy or some other branch of natural philosophy. Any person, who has at any time been admitted to a degree in the University of Cambridge, can compete for this coveted Prize, which is looked upon as one of the highest distinctions for distinguished scholarship and exceptional ability at exposition by all research workers. Quite often the award of the Prize could not be made for want of recipients as the standard set is extremely high. Between 1850 and 1913 this Prize was awarded only fifteen times! The list of Adams Prize winners includes the names of some of the greatest scientists of England, *viz.*, Maxwell, J. J. Thomson, Poynting, Larmor, Love, McLarin, Jeans and Fowler.

The subject of the essay for which Professor Bhabha was awarded the Prize was "The theory of elementary physical particles and their interactions". Prof. Bhabha is among the world's foremost workers in this field and has made many original contributions of fundamental importance to this subject during the last few years. Prof. Bhabha's presidential address to the Physics Section of the Indian Science Congress at its last session, was on the same subject and, in that address, he has indicated some of his ideas on the latest developments of the subject very clearly. This address was the subject of an excellent article by Sir Ralph Fowler, F.R.S., in the *Nature* of 5th June 1943.

Prof. Bhabha, at the moment, is engaged in writing a book on this subject, to be published by the Oxford University Press, and the Adams Prize essay forms only a part of the volume. We have no doubt this book will be most welcome as it will be the first systematic and logical development of the modern theory of the elementary particles of nature.

We offer our heartiest congratulations to Prof. Bhabha on this occasion. He is still in his early thirties and we wish him many long years of eventful research and greater distinctions to crown his scientific endeavours.

CO-ORDINATION OF RESEARCH IN UNIVERSITIES

DELIVERING the inaugural address of the Madras University Research Scholars' Association, Sir C. P. Ramaswami Ayyar, Dewan of Travancore, appealed to universities in South India to pool their resources and co-ordinate research work. The universities could sit together, confer together on their work so that there might be an interchange of students and professors and to avoid duplication and competition in the future. He would be a false prophet who forecast that, at the close of the war, there was going to be the best possible world ushered in. The post-war world would be a ruthless competitive world.

There was everywhere a great deal of talk about international gatherings and a considerable amount of research devoted to the new order of things. Whatever might result from such efforts there was no gainsaying that India would have to establish her industries and commerce not in a world of peace but in a world in which other countries, which were better able to produce and sell, would compete with her.

Unless India was abreast of the industrial nations of the world, she would be swept off by the current. It was from this point of view that they, in Travancore, had planned research schemes in their university.