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WHEAT AND ROSES*

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I consider it a high privilege to have this opportunity of addressing the Fellows of the Academy and other scientists today. Some previous Presidential Addresses have been concerned with a presentation of the author's own research work while others, specially of those who were no longer actively engaged in research, have dealt with aspects of science policy or other matters of general interest to scientists. In my case, I have decided to give an Address which does make some reference on my own work but also deals with some issues which are vital to agricultural productivity in the country. The combination of wheat and roses is perhaps a little unusual but what I had in mind when I chose the title, was the thought so beautifully expressed by Muslih-uddin Sādi in his '*Gulistan*' where he has said :

"If of thy mortal goods
thou art bereft,
And from thy slender store two
loaves alone to thee are left,
Sell one, and with the dole
Buy hyacinths to feed thy soul."

Sadi has referred to hyacinths which were well known to him, but, if we take the whole world, it is the rose which symbolises for man — beauty, love and the finer things of life. Although rice feeds a larger number of people in the world, wheat is usually referred to as the "staff of life", and its importance is well brought out in the following extract from the preface of a book on wheat by K.S. Quisenberry and L.P. Reitz :

"Wheat is many things. To a botanist, wheat is grass. To a chemist it is organic compounds, and to a geneticist, a challenging organism. To a farmer, it means a cash crop, and to a hauler, freight. To a labourer it means employment; to a merchant it is produce. To a miller, it is grist, and to a baker, flour. The banker sees it as chattel and the politician as a problem. Animals browse and feed on it and it sustains parasites. The conservationist uses it as ground cover. In religion, it is used as a symbol. The artist and photographer see it as a model. To millions it provides a livelihood, and to millions more a life-giving food.

Wheat has been all of these things and many more for a very long time. Man has used wheat as a food since prehistoric times. There is some evidence that it was

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first used in a parched form. Wheat was apparently grown in the Middle East as early as 10,000 to 15,000 B.C., and it appears in writings from as early as 550 B.C. Many of the plant's characteristics were probably well-known to man 2,000 years ago, when it evidently was grown for food.... The important fact is that man has depended upon the wheat plant for himself and his beasts for thousands of years and hundreds of generations.

The experience of history and the weight of modern knowledge of nutrition, however, indicate that mankind will not, should not, and, indeed, dare not abandon wheat. A global wheat failure would be catastrophic, a disaster few nations could survive even one year." It is because of these considerations that I decided to give an address about wheat and roses. Let us take wheat first !

We know from the well known researches of Vavilov that the bread wheats i.e., the wheats which are most predominantly used for providing bread, originated in the northwestern corner of the Indian Subcontinent including also the area of Afghanistan. Wheat has therefore been associated with the ancient civilization of India from times immemorial. There is reason to believe that the great civilizations of Babylonia, Crete, Egypt, Greece and Rome were also based on wheat as one of the principal food crops, and it is reported that the Chinese grew this cereal as far back as 2,700 B.C. Men of ancient times attributed the origin of wheat to supernatural agencies. Thus, the Chinese regarded wheat as a direct gift from heaven, while the Egyptians believed that it was introduced to the earth by the Goddess Demeter and Tryptolemus. Samples of wheat have been found in pre-historic human habitats, for instance, in the rubbish heaps of lake dwellings in both Italy and Switzerland.

In more recent times the wheats of the world have been studied quite thoroughly. More than 15 species are recognised, some of them growing wild, while the others are cultivated. The wheats fall into three natural groups based on their chromosome number and some other attributes. The wheats belonging to the first group i.e., the diploid group with 14 chromosomes, are unimportant but in the tetraploid group *Triticum durum*, the macaroni wheat, is still important in some areas, particularly for the preparation of certain types of wheat products. It is the hexaploid group of wheats, however, which is most important, and in this group, the species *T. aestivum* is the bread wheat *par excellence*. Wheat is usually made into flour, though from the flour it may be consumed in many forms such as loaves, chapattis, etc. Wheat is considered to be one of the best of the cereals, and in addition to starch it supplies proteins, minerals and important vitamins.

Let us now consider briefly the position of wheat in India. India was a great producer of wheat long before the famous wheat-growing areas of the United States, Canada and Australia were developed or even discovered. Investigations by Marshall and others have provided evidence that wheat of a cultivated species was being grown about 5,000 years ago in the Mohenjodaro region. Although the area under wheat in India is less than that under rice or sorghum, it is the staple food of a large section of the population of the Indian Subcontinent. It was natural therefore that when scientific research on modern lines began in India in the early years of the current century that wheat should be one of the crops which received maximum attention.

In this early period, A. Howard and G. L. C. Howard, assisted by A. R. Khan, conducted work on the improvement of wheat. From the wide range of wheat varieties existing in the country they were able by simple selection to identify the variety '*Pusa 4*' which became world famous for its grain quality. A number of other wheats followed all of which were of reasonable, high-yielding capacity, considering the level of farming which was then practised, and most of them had good grain quality. The phase of simple selection was followed by that of simple hybridization between varieties, to provide new combinations of characters. One of the important varieties thus produced was '*Pusa 52*' which achieved a wide distribution in the country. Wheat breeding work was done not only by the Imperial (now Indian) Agricultural Research Institute but also by the research centres in some of the States in India.

I was associated with another phase of wheat improvement which immediately followed the first phase. Although, as already mentioned, wheat varieties were now available which combined fairly good yielding capacity with good grain qualities, the problem of diseases had not received adequate attention. Fortunately the wheat crop in India is not attacked severely by any insect pests, but the rust diseases caused by the different species of a fungus, loose smut and some other diseases exacted considerable toll of the produce. The rust diseases have been particularly difficult to deal with since in the case of the blank and the brown rust, hybridisation can take place on their respective alternate hosts, while in case of all three of them, frequent mutations take place resulting in new races, some of which may be more virulent than the existing ones. Races of the rust fungus may also be carried from one country to another by wind currents. The number of such races (which are morphologically indistinguishable but differ in their power to infect different varieties of wheat) is very large, and this constitutes a most difficult problem for the plant breeder, especially as new races keep this coming up and attacking wheat varieties which previously were considered to be resistant.

A programme of breeding was accordingly initiated by me with the co-operation of Prof. K. C. Mehta of Agra. In the beginning, this consisted in first making crosses between Indian varieties with good agronomic characters and exotic varieties which had the desired rust resistance, though in other respect they were not suitable for Indian conditions, and testing the resultant progenies. Three sets of crosses were made, and, in due course varieties resistant separately to the black rust, the brown rust and the yellow rust, were obtained. Multiple crosses were then made on a large scale to bring together resistance to all the three rusts, combining it with suitable agronomic attributes and adaptability to conditions in India. As a result of 18 years' work, the variety '*NP 809*', was evolved, this being the first wheat to be obtained as a result of a planned plant breeding programme, which was resistant in a large measure to all the races of the rusts then reported in India. It had another very useful asset in that it was also immune to the widespread loose smut disease. Besides '*NP-809*', a large number of other varieties were produced both at the IARI and by the State Departments of Agriculture, which were substantial improvements on the older varieties.

Yet another phase of wheat improvement began when in 1963 a large variety of wheat material containing the dwarfing genes from Mexico (these genes were originally

identified in the Japanese variety '*Norin-10*' which was subsequently brought to the United States, in 1948, and from there introduced into new varieties in Mexico by Dr N. E. Borlaug, the famous wheat breeder) through the courtesy of the Rockefeller Foundation and the Mexican Ministry of Agriculture. Out of this material two varieties, namely, '*Sonora 64*' and '*Lerma-Rojo*' proved to be successful when tested under a wide range of conditions, under the All-India Wheat Improvement Project. These short-strawed wheats responded well to high fertility conditions and were readily accepted by the farmers in spite of their relatively poor grain quality compared to that of the best Indian varieties. The wheat material from Mexico was soon crossed by the Indian wheat breeders with Indian varieties to produce new types some of which are proving very useful. It was the new varieties of wheat plus the appropriate agronomic technology which was responsible for the breakthrough in wheat production in India, and which more than doubled the output of wheat, in a short period of only five years. This breakthrough in wheat production has been the backbone of what has been called the Green Revolution.

In the case of the Punjab, one of the important wheat-growing States, the yield per hectare increased from 901 kg in 1950-51 to 2243 in 1969-70 (M. S. Randhawa, 1974). Individual farmers competing for the Krishi Pandit awards have reported very high yields indeed; for instance a farmer from the Khandwa block in Madhya Pradesh reported a yield of 55.16 quintals per acre. But while there has been a substantial overall increase in wheat productivity especially in the northwestern States, and while individual farmers in certain areas have also set up records of high wheat production, the level of wheat production in the country is nowhere near the maximum which could theoretically be achieved.

In the Table below which I have taken from S. H. Wittwer (1974), the average; the top, and the record crop yields in the USA which is one of the most agriculturally advanced countries of the world, in 1973 are given. The figures are in bushels per acre.

TABLE

Average, top, and record crop yields in the USA
(bushels per acre)

Crop	1973 Average	Top	Record
Corn	94	230	306
Wheat	32	135	216
Soyabeans	28	30	110
Sorghum	63	200	320
Rice	28	130	350*
Potatoes	385	1000	1400
Sweet potatoes	130	600	900
Barley	41	150	212
Oats	49	150	296
Sugar beets	20**	40**	54**

*Obtained at the International Rice Research Institute, Los Banos, Philippines, in 1970 from a total of crops grown in one year.

**Tons per acre.

It will be seen that even in that country there is a big gap between the record yields and those obtained by the generality of the farmers. In view of the great need for maximizing crop production, and particularly food production, from the available land on this earth, to feed the huge population which is increasing at an alarming rate in many parts of the world, what is it that scientists can do? Before we try to attempt to answer this, let us now turn for a moment to the world of roses.

India is one of the ancestral homes of the modern garden roses and *Rosa moschata* has been growing wild in the Himalayas from ancient times. But there has been no clear evidence of the growing of roses in gardens in India until we come to the Mughal times. After that, roses have been popular in India and there has also been an industry producing roses for rose oil and water. After Independence, there has been a tremendous increase in interest in the garden roses. There appear to be good potentialities for the export of cut roses to Europe in the winter months when because of climatic conditions, the industrialised countries of Western Europe cannot have fresh roses, whereas the cool weather period is the best for this purpose in India and roses can be grown out of doors all the year round. An attempt which was made just there or four years back to export roses to some Western European countries had only partial success but there were several reasons for that and the conclusion, in my opinion, should not be drawn that there is no scope for capturing a part of the European market. Israel, for instance, has a flourishing export trade of cut flowers to Western Europe. There appears to be no good reason why India which is only three hours further away by jet plane should not also be able to participate in this trade if appropriate steps are taken after a careful study of the market requirements.

Some of the countries in South and South-Eastern Asia like Indonesia, Thailand, Malaysia, Singapore and Sri Lanka have a valueable export trade to Europe of flowers such as orchids. It is a great pity that India, with its wide range of climatic conditions and a large number of technically trained people is not able to do what these countries have done. Perhaps one reason is that floriculture has not received the recognition which it deserves in this country. Flowers tend to be regarded as a luxury for the well-to-do classes. That is not correct. The culture and trade in flowers can provide employment to many persons, besides the aesthetic pleasure which flowers afford to people in all walks of life, especially the children. After man has been able to obtain the material wants of food and other vital necessities, he surely needs the finer things which inspire him to live a better life. So while we must concentrate primarily on producing food and economic materials, we can surely by proper planning afford to allocate the relatively small areas required for beautifying our country and our homes with ornamental plants.

Let us now go back to the problem of making a spectacular breakthrough in wheat and other essential food plants.

At a recent Symposium on '*Basic Sciences and Agriculture*', organised by the Indian National Science Academy, attention was drawn to the fact that a great deal of basic reasearch is necessary if the agriculture of the future is to be safeguarded. The possibilities, for example, of producing entirely new economic plants; of increasing the photosynthetic efficiency of plants; of test-tube pollination and fertilisation as a new method for raising inter-specific and intergeneric hybrids; of new methods of rodent

and pest control; and of new techniques of using biological nitrogen, and many other problems and possibilities were highlighted.

I do not propose to discuss here the details of the many problems which will require the attention of scientists, nor go into the question of how and where the researches should be undertaken. My main purpose today is to draw pointed attention to the fact that the recent advances in agriculture have given us a little breathing space in which to plan and implement really far-reaching endeavours in the fields of sciences and technology, to meet the future requirements of the human race. It is absolutely necessary that the agriculture tomorrow should be very highly productive, and characterised by stability of production and qualitative adequacy. It should provide productive employment and lead to agrarian prosperity but in such a way that it ensures "*harmonious co-existence of plants, animals and man in a mutually symbiotic and prominently productive bio-system*". This is a great challenge and demands a great response.

If we are to rise to the occasion and achieve the desired objectives, we will have to act very quickly and in a different way from what we have been doing so far.

In war time, as everyone knows, if something is required very urgently, say, a new war machine be it a new type of aircraft or submarine or tank, the Government assembles immediately the persons with the required scientific and technical expertise, and gives them a direction to produce a blue print of the required machine in the shortest possible time. This is followed up by appropriate executive action so that all the materials and components required are made available without hitch or delay and work proceeds apace. Under the stress of war a great deal of work is done, involving high level team work, which does not usually happen during normal times. When the problem of maximising food production is so overwhelming and so urgent, when we know that millions of people are hungry and under-nourished, should not something like what is achieved in war time be organised, to ensure that this gravest of problems facing the human race is properly solved? Should not the authorities bring togethor the appropriate persons in the field of agriculture and related sciences and charge them with the duty of planning and initiating a research programme which will within a period of, say, 10 years, give us wheat varieties and also rice varieties (these two being the major food crops) which can give yields of 20 tonnes of grain per hectare year after year, under an agronomic technology which is feasible and economic? From the possibilities which have been enumerated by plant physiologists and others such a target does not seem to be impossible but the will to do it must be there and the resources required must be forthcoming.

Besides the cereals, we must also similarly plan for huge increases in the productivity of the root crops which have, according to experts, a far higher potential than grain crops. When we succeed in evolving these super types of high-yielding crops with good nutritive quality, than the agronomists will have to devise new multiple and intensive relay cropping systems. But while planning for all this let us make a start on breeding the 20-tonnes-per hectare wheat varieties.

In my opinion the Indian National Science Academy should take the lead, with the co-operation of the Indian Council of Agricultural Research and other scientific

organisations, in organising a symposium in the near future at which this problem will really be thoroughly discussed and illuminated.

Such a conference obviously will not be in a position to draw up a blue print but it could furnish an expert description of the food problem in its totality and provide the necessary guidelines so that, if those in authority decide that *Project Wheat* (this is the tentative title I am giving to it)—must be taken up on the equivalent of a warfooting, the next steps will become clearer.

I thank you.

REFERENCE

Randhawa, M.S. (1974). *Green Revolution.* Vikas Publications, New Delhi.