OLD AND NEW IN FARMING

By

M.S. Swaminathan,
Indian Agricultural Research Institute,
New Delhi.

It is rightly said that civilisation began when agriculture commenced. Before man took to the conscious cultivation of plants, there was hardly any distinction between wild and cultivated plants. These two categories of plants differ from each other largely in mechanisms relating to self-propagation and protection, in addition to characters of economic importance. A wild plant has to fend for itself for survival, while a crop plant is protected and propagated by man. Therefore, when we compare the characters of wild rice or wild wheat or wild cotton with the cultivated ones, we see certain remarkable changes. The wild rice or wild wheat has a tendency to shatter and to possess grains with hard and tough envelopes. Likewise, the wild cottons possess hardly any lint fibre and are hence of no value for the production of textiles. It is a tribute to the acuteness of the observational power of the early agriculturists that whenever they saw a new plant with some characters of value to man, they picked it up and propagated it. In fact, almost all the plants which we now grow are the products of selection from the very early days of agriculture and man in the 5000 years of recorded history has not added a single major crop to the list of plants grown by our ancestors. The only types of plants which we might claim as being entirely new examples of domestication are fungi and bacteria with anti-biotic properties.

Evolution in agriculture progresses with an increase in the degree of protection afforded to the plant by man and with the steps taken by him to create an environment in which the plants can flourish and give their best. Coincident with man's efforts to improve the environment in which plants grow, there has been such an effective alteration in the characteristics - both morphological and physiological - of crop plants that in a plant like potato the differences between the present-day varieties and wild potatoes can be compared with the changes existing between a modern race horse and a tiny pony of neolithic times. While a type of agriculture in which man tended only partially to the needs of plants was adequate when the population pressure on land was not great and also human wants were not many, the needs of today with reference to the productive capacity of our farms, are entirely different. We have to produce more not only for the immediate purpose of bridging the gap between demand and supply but also for the more important purpose of enhancing the standard of living of our people. In a country where nearly 70 per cent of the population is dependent upon agriculture for its income, there will be no possibility of raising the standard of living if agriculture does not become more remunerative. If this is to happen we have to adopt certain new practices in farming.

Taking wheat as an example, I shall try to indicate certain basic differences between the old and new in farming. The average yield of wheat in India ranges from 800 to 900 Kgs per hectare and out of nearly 14 million hectares under this crop, about four million hectares have irrigation facilities. In areas where there

is no assured water supply, the production possibilities will be limited unless there is assured rainfall. Even where there is adequate water supply, the methods of wheat cultivation we generally adopt now would permit a maximum yield of about 3 tonnes per hectare, in contrast to about 6 tonnes which can be obtained by taking to the new in farming. There are two principal reasons for this situation. First, the varieties we have cultivated for a long time have a tall straw which leads to their falling down (lodging) when grown with water and adequate quantities of manure. This drawback does not express itself when the crop is grown in soils of low fertility without the application of fertilizers. Secondly, our older varieties cannot be irrigated during the latter part of the growing season (i.e. from the first week of March or even earlier), again because of fear of lodging. In most of our wheat belt, the temperature may rise rather fast from the middle of February and hot dry winds prevail during March. Under such conditions it is difficult for the plant to maintain a surplus energy budget when expense through respiration is matched against income through photosynthesis. This is the reason why wheat yields in India often become a gamble in temperature. If it is possible to irrigate the crop when the temperature rises, the crop will benefit immensely. Such pre-harvest irrigations are seldom given in our "irrigated" wheat fields.

If we wish to obtain wheat yields over 3 tonnes per hectare, we have to use a variety with a morphological architecture that would permit the application of large quantities of fertilizers as well as water during the later stages of plant development. In other words the

plant should possess a dwarf stature and a stiff straw so that it will not be lodged when fed properly. Secondly, the efficiency of utilisation of sunlight for the synthesis of carbohydrates would be greatly improved if the plant has a type of leaf habit which permits the maximum leaf surface to be exposed to the sun. Thirdly, for the efficient utilization of fertilizers, the variety should not produce many tillers but only a moderate number (about 12) of synchronously developing tillers. A non-synchronous tillering habit is one of the means of assuring survival in nature but is very undesirable under conditions of intensive agriculture.

Fourthly, when the soil is rich and water supply adequate, the micro-climate in the immediate vicinity of the plant changes in a direction which is favourable not only for plant growth but also for the spread of pests and diseases. Hence, either a high degree of built-in resistance to such enemies or the adoption of suitable chemical control measures is necessary to get the maximum benefit from investiment in manure and water. Thus, the morphology and physiology of the variety have to be altered simultaneously with changes in the cultural conditions for opening a new dimension in yield.

Over ten years ago, factors which induced hereditary dwarfing in wheat ("dwarfing genes") were discovered in Japan. These have been transferred to wheat varieties in the United States and Japan. The present world record for wheat yield is held by the dwarf wheat variety, Gaines, developed by Dr. O.A. Vogel of Washington State, United States. With this variety, Elmer Yoshino and his brother of Washington State produced in 1965 169.9 bushels (about 10,500 lb) of wheat per acre from a 27-acre plot. Higher yields have since been reported from the

Washington State.

In 1963, seeds of some of the dwarf wheats developed in Mexico under a joint research programme of the Rockefeller Foundation and the Mexican Government were introduced into India by the Indian Agricultural Research Institute. These varieties have performed very well in many of our wheat areas and yield exceeding 6 tonnes per hectare have been obtained by several farmers during 1964-65 with the varieties Lerma Rojo and Sonora 64. I shall describe briefly some of the basic changes which have to be introduced in our farm practices to get yields of this order.

(a) Land preparation and sowing: Normally the farmer sows wheat in repeatedly ploughed soils with moisture retained from the kharif rainfall. Because the supper surface of the soil contains little moisture, the seeds are placed at a depth of 4 to 6 inches from the surface. The tall varieties germinate normally when sown in this way. The first irrigation is given 4 weeks after the emergence of seedlings from the soil. In the case of the dwarf wheats, the seedings find it difficult to emerge from the soil if sown in this manner but grow very well if the seeds are sown at about two inches below the surface. A pre-requisite for suchshallow sowing is the availability of adequate moisture and a suitable seed drill. Thus, a pre sowing irrigation is a must for getting a good plant population when dwarf wheats are sown. Also, the use of a fertilizer-cum-seed drill greatly enables uniform germination and a good plant population.

(b) Irrigation: When an irrigation is given a month after sowing, the plant starts developing tillers. After a second irrigation, more tillers develop. This pattern of periodic development of tillers is extremely undesirable from the point of view of obtaining high

Table 1

Yield obtained in large plots at the Indian Agricultural Research Institute

Rabi 1964-65		Kharif 1965		Total grain yield Q/Ha.
Wheat variety	Yield Q/Ha.	Crop	Yield Q/Ha.	Q/Ha.
Sonora 64	65.6	Maize-Ganga 3	57.4	123.0
Sonora 63	60.0	Maize-Composite	50.5	110.5
Lerma Rojo	55.3	Jowar-CSH-1	50.0	105.3
N.P. 876	48.8	Jowar-CSH-2	55.0	103.8
N.P. 880	45.9	Bajra-H.B.1	48.3	94.2

yields. Giving an irrigation at the time of crown root development (i.e., about 16-20 days after sowing), enables the development of tillers right from the beginning and consequently almost all the tillers produce as much grain as the main stem. The dwarf wheats can also be irrigated frequently without fear of lodging and what is most important they can and should be irrigated when temperature rises during February-March.

(c) Fertilizer application: By giving an irrigation before sowing and by applying adequate quantities of fertilizers (60 to 100 kg. of nitrogen, 60 kg. phosphorus and 30 kg. potash per hectare depending upon the initial soil fertility) it would be possible to get a very high return from the fertilizer applied. The placement of fertilizers with a drill gives the optimum distribution and utilisation.

New vistas in crop yields: In recent years, hybrids of maize, jowar and bajra capable of giving very high yields have been developed and in these cases the seeds of the hybrids have to be purchased by the farmer year after year. If he takes seeds from the plants he had grown, the yield will get reduced considerably, since the maximum expression of hybrid vigour occurs only in the first generation after crossing. Many of these hybrids are capable of being fitted into new rotational systems and the yields obtained in the farm of the Indian Agricultural Research Institute during 1965 are given in Table I. The production potential of Indian agriculture is thus immense. We have abundant sinlight, extensive tapped and untapped resources of water and a good choice of high yielding varieties of and hybrids. To sustain and to improve further the yielding ability of our crop plants, we should strive to strike

fresh paths in altering the architecture and adaptability of our plants in directions that would enable us to take advantage of progress in fertilizer technology and soil and water management. Elegant tools such as the use of atomic radiations for the production of new variation are now available and consequently rapid progress is possible. For example, the red colour of the grains of Sonora 64 and Lerma Rojo, two Mexican dwarf wheats released for cultivation in India were changed within a year into white colour by exposing the seeds to radiations. Thus, the variety Sharbati Sonora was developed.

The new high yielding varieties have provided the motivation necessary for farmers to desire a change fram a static to a scientific agriculture. If this desire is to be capitalised in the form of an enduring agricultural advance, it would be necessary to pay attention to all aspects of input production and information transfer. One of the essential inputs is increased farm power and better implements. For example, a seed drill and a buck-scraper would make a great difference in the density of plant population and thereby to the return from the investment on seeds, water and fertilizer. If the seeds of the agricultural revolution now sown by our scientists are to grow into trees and bear fruits, immediate attention to such problems is vital.