

ADVANCEMENT IN WHEAT PRODUCTION THROUGH INTERNATIONAL COOPERATION

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DR. NORMAN E. BORLAUG

In 1943, several years before the establishment of the Food and Agricultural Organization (F.A.O.) of the United Nations, a cooperative agricultural research and training programme was launched in Mexico. This was a pioneer cooperative project between the Mexican Ministry of Agriculture and the Rockefeller Foundation, initiated at the request of the Mexican Government for assistance in increasing the production of maize, wheat and beans and simultaneously to train new generation of scientists in all of the disciplines relating to wheat research.

Research from the outset was production oriented and restricted to that which was relevant to increasing wheat production. Researches in pursuit of irrelevant academic butterflies were discouraged, both because of the acute shortage of scientific man-power and because of the need to have data and materials available as soon as possible for use in the production programme.

To accelerate progress in varietal development, two generations of all segregating materials were grown each year. One generation was sown close to sea level in Sonora at 28 degrees north latitude in the fall when the days were progressively shorter; the second was sown near Toluca, at 18 degrees latitude and 2,500 meters above sea level during the summer when days were progressively longer. Through the use of this technique we developed high yielding, day length insensitive

varieties with a wide range of economic adaptation and a broad spectrum of disease resistance—a new combination of uniquely valuable characters in wheat varieties.

These characters were valuable in increasing wheat production in Mexico and neighbouring countries, but were to prove even more valuable 20 years later when the Mexican varieties were introduced into Pakistan and India! Without this combination of characters the successful transplantation of the Mexican varieties into Pakistan and India would have been impossible; and the advent of the Green Revolution would almost certainly have been delayed many years. We never waited for perfection in varieties or methods but used the best available each year and modified them as further improvement came to hand. This simple principle is too often disregarded by scientific perfectionists who spend a life-time searching for the unattainable in biological perfection, and consequently during a life-time of frustration contribute nothing to increasing food production.

Farm demonstrations of new varieties and technology were made by the research scientists who had developed them. Indeed, the revolution in wheat production in Mexico was accomplished before the extension service came into being. This forced the research scientists themselves to consider the obstacles to production that confronted the farmers.

Mexico became self-sufficient in wheat production for the first time in 1956, and has remained self-sufficient since. This "Quiet Revolution" in wheat production in Mexico became the progenitor of the Green Revolution in India and Pakistan a decade later.

As the use of fertilizer increased and yields climbed to 4.5 thousand kilos per hectare, lodging (falling over of the plant) began to limit further increase in yields. A search was, therefore, made among wheats from different areas of the world to locate a suitable

source of genetic dwarfness to overcome this barrier. The dwarf Mexican wheats were first distributed in Mexico in 1961, and the best farmers began to harvest 5,6, 7 and even 8 tons or more per hectare and within seven years the national average yields doubled. It was these same dwarf Mexican wheat from the Quiet Revolution that served as catalysts to trigger off the Green Revolution in India and Pakistan.

From the outset the Mexican Agricultural Programme was watched with interest by many other countries. As progress became evident the Rockefeller Foundation was besieged by requests from many other countries for assistance in agricultural improvement programmes. India made such a request in 1963.

Although the Mexican experience indicated that one of the greatest obstacles to the improvement of agriculture in the developing countries is the scarcity of trained and experienced people; India was unique in the availability of trained scientists. In countries where no corps of trained scientists exists, as was the case in Mexico 27 years ago and remains the case in many countries of Asia, Africa and Latin America today, it requires 18 to 25 years to develop enough competent research scientists and educators to meet a country's needs. So great is the urgency of the food shortage in many under-developed and emerging countries that there is not enough time to develop an adequate corps of scientists before attacking food production problems. A short-cut and organizational change had to be invented to meet the needs. And so was born the first truly international research and training institute--The International Rice Research Institute (IRRI) at Los Banos, the Philippines, in 1960, to work exclusively on the regionally all-important but too long neglected rice crop. The Institute was jointly financed by the Ford and Rockefeller Foundations in collaboration with the Government of the Philippines.

The research activities on wheat, maize and potatoes in Mexico were informally inter-nationalized in 1959 and organized as a second international centre in 1963. This International Centre for Maize and Wheat Improvement (CIMMYT), is supported also by the Ford and Rockefeller Foundations, in collaboration with the Government of Mexico. More recently, additional financial support has been provided by the U.S. Agency for International Development (U.S.A.I.D.), United Nations Development Programmes (U.N.D.P.) and the Inter-American Development Bank (B.I.D.).

There are now four international institutes in operation or being organized. They represent a significant but modest start toward the construction of world-wide network of international, national and local research and training centres. This network will help solve problems and disseminate the benefits of science to all mankind in the shortest possible time and at minimum costs.

The impact of such integrated approach is already evident in the Green Revolution. New varieties and the new technologies that make them highly productive have been the thrust behind the Green Revolution. In the Philippines, Ceylon, Malaysia and West Pakistan it was IR8 rice, developed at the International Rice Research Institute. The dwarf Mexican wheats, partly produced by CIMMYT, have provided the thrust in India and Pakistan and this is now spreading to Turkey, Afghanistan, Iran, Morocco and Tunisia. Contributing equally, or perhaps even more, to the evolution of the Green Revolution was the talented supporting leadership that has been provided by the Centers to the national programs through temporary assignments of mature scientists skilled in organizing crop production programmes to assist in the development of the national production campaigns.

The international centers were developed to supplement national agricultural research, production, and training programmes, not to replace them. The centers are but one link in the world-wide network of organizations attacking basic food-crop production problems on a world-wide, regional, national and local level. The back-bone of this network is now and must continue to be the national programmes. They must be given greater financial support and strengthened staff-wise to meet the challenge of rapidly expanding food needs for the future.

The international centres, however, are in a unique position to assist the national programmes. They are independent, non-political international organizations, which, although originally funded by private foundations, now receive support from many diverse sources. Their scientific staffs are also international and comprise outstanding scientists representing the various scientific disciplines affecting crop production. Included on their staff are a number of crop production experts who have the scientific competence and broad experience to assist national agencies in organizing and launching crop production programs.

The centers collaborate not only with the national agencies from many different countries but also with other international organizations such as the Food and Agricultural Organization (FAO) of the United Nations, the United Nations Development Program (UNDP), and international development banks. Each year the Centers have been collaborating with an increasing number of countries of all political spectra.

I am convinced that the international agricultural research institutes are developing a bond of understanding among nations, based upon the common needs for increasing food production. We must all strive to strengthen this bond.

The international centers are uniquely equipped to do fundamental, long-time researches of world-wide importance. For example, the opportunity for plant breeders, pathologists and entomologists to operate on a world-wide basis permits them to develop well conceived, diverse gene pools of the important crop species. The final crop varieties are not currently generally selected at the centers but sent to collaborators in national programmes in many parts of the world who, in turn, make the selections that best suit their needs and many eventually become commercial varieties. Similarly, the centers prepares a series of international crop yield tests, which include representatives of the best commercial varieties from the world and a few of the most promising experimental lines from collaborators. These are sent to collaborators in 35 countries for growing at 80 locations. The data from collaborators are returned to CIMMYT for summarizing and for subsequent distribution to scientists in all parts of the world. The data obtained on yield, adaptation, disease and insect resistance in one year in such tests are often more meaningful and valuable to scientists engaged in crop research and production programmes than data obtained by independent testing at one location for a period of 10 or 15 years.

The International Centers also are in unique position to contribute to practical or internship type of training in all of the scientific disciplines affecting crop production. This type of training is particularly valuable for young scientists from the developing countries because it prepares them for initiating research work upon return to their native country and will also be of value if they subsequently continue their education at the graduate level.

In summarizing the accomplishments of the Green Revolution during the past three years, I wish to restate that the increase in cereal production, rice, maize and wheat, and especially in wheat, has been spectacular and highly significant to the welfare of millions of human beings. It is still modest in terms of total needs. Recalling that 50 percent of the present world population is undernourished and that an even larger percentage, perhaps 65 percent, is malnourished, no room is left for complacency. It is not enough to prevent the currently bad situation from getting worse as population increases. Our aim must be to produce enough food to eradicate all present hunger while at the same time striving to correct malnutrition. To eliminate hunger now in the developing nations, we would need to expand world cereal production by 30 percent. If it were, however, as simple as increasing the total world production by 30 percent, regardless where the production is to be expanded, it could be accomplished rather rapidly by expanding it in the United States, Canada, Australia, Argentina, and Russia. But this would not necessarily solve the hunger problem of the developing world, because their weak economics will not permit them to expand their food imports by 30 percent. Worse still even if present production would be expanded rapidly by 30 per cent in the developing countries--which I believe is possible based on recent progress of the Green Revolution--so as theoretically to eliminate hunger, the hunger problem as it now exists still would not be solved. There remains the unsolved social, economic problem of effective ways to distribute the needed additional food to the vast under-privileged masses who have little or no purchasing power. This is still the great unsolved problem with which the economists, sociologists, and political leaders must now come to grips.

I am convinced that if all policy makers would take sufficient interest in population control and in aggressively employing and exploiting agricultural development as a potent instrument of agrarian prosperity and economic advancement, many of the social ills of the present day could soon become problems of the past. The tropics and sub-tropics have abundant sunlight and other great biological assets and it will be criminal to delay further the conversion of these assets into wealth meaningful to the poor and hungry.

Some critics have said that the Green Revolution has created more problems than it has solved. This I cannot accept for, I believe, it is far better for mankind to be struggling with new problems caused by abundance rather than with the old problem of famine. Certainly, loyalty to the status quo in food production when being pressured by population growth cannot break the chains that have bound the peasant to poverty and hunger. One must ask: Is it just to criticize the Green Revolution, with its recognized accomplishments, for failure to correct all the social-economic ills of the world that have accumulated from the days of Adam and Eve up to the present? Change we must, or we will perish as a species, just as did the dinosaurs in the late Cretaceous.

The Green Revolution is a change in the right direction, but it has not transformed the world into Utopia. None are more keenly aware of its limitations than those who started it and fought for its success. But there has been solid accomplishment, as I have already shown by concrete examples. I have also tried to indicate the various opportunities for capitalizing more fully on the new materials that were produced and the new methods that were devised. And, above all, I cannot emphasize too strongly the fact that further progress depends on

intelligent, integrated and persistent effort by Government leaders, statesmen, tradesmen, scientists and communication agencies, including the press, radio and television.

But progress is continuous, and we can and must make continuous progress. Better varieties of wheat and other cereals with not only higher yield potential, but also with higher content of protein are already in the process of creation.

We need also to explore more fully the feasibility of producing new man-made cereal species with greater production potential and better nutritional quality than those now in existence. Triticale, a man-made species, derived from a cross between wheat and rye, now shows promise of becoming such a crop.

I propose, therefore, that a bold programme of wide crosses be initiated to improve both cereals and legumes (pulses). It should include attempts to make numerous inter-genetic crosses among cereals, employing all of the modern techniques to consummate fertilization, and propagate the hybrids. If a series of new combinations can be made and doubled, such as, for example, between maize and sorghum, wheat and barley, or wheat and rice, it would open the door to the possibilities for vast subsequent improvement by conventional methods.

The Green Revolution has won a temporary success in man's war against hunger and deprivation; it has given man a breathing space. It has produced a model wherein both coordinated national and collaborative international cooperation have played a vital role in the genesis of the Green Revolution. If fully implemented, the Revolution can provide sufficient food for sustenance during the next three decades. But the frightening power of human reproduction must also be curbed; otherwise the success of the Green Revolution will be ephemeral only.

Most people still fail to comprehend the magnitude and menace of the "Population Monster". In the beginning there were but two, Adam and Eve; when they appeared on this earth is still questionable. By the time of Christ world population had probably reached 250 million. But between then and now population has grown to 3.5 billion. Growth has been especially fast since the advent of modern medicine. If it continues to increase at the estimated present rate of two percent a year the world population will reach 6.5 billion by the year 2000. Currently, with each second, or tick of the clock, about 2.2 additional people are added to the world population. The rhythm of increase will accelerate to 2.7, 3.3 and 4.0 for each tick of the clock by 1980, 1990 and 2000 respectively, unless man becomes more realistic and pre-occupied about this impending doom. The tic-tic of the clock will continually grow louder and more menacing each decade. Where will it all end?

Malthus signalled the danger a century and a half ago. But he emphasized principally the danger that population would increase faster than food supplies. In his time he could foresee the tremendous increase in man's food production potential. Nor could he have foreseen the disturbing and destructing physical and mental consequences of the grotesque concentration of human beings into the ~~poisoned~~ poisoned and clangorous environment of pathological hypertrophied megapoles. Can human being endure the strain? Abnormal stresses and strains tend to accentuate man's animal instincts and provoke irrational and socially disruptive ~~herald~~ behaviour among the less stable individuals in the maddenning crowd.

We must recognize the fact that adequate food is only the first requisite for life. For a decent and humane life we must also provide an opportunity for good clothing, and effective and compassionate

medical care. Unless we can do this, man may degenerate sooner from environmental diseases than from hunger.

And yet, I am optimistic for the future of mankind; for ⁱⁿ all biological populations there are innate devices to adjust population growth to the carrying capacity of the environment. Undoubtedly, ~~some~~ such device exists in man, presumably *Homo sapiens*, but so far it has not asserted itself to bring into balance population growth and carrying capacity of the environment on a world-wide scale. It would be disastrous for the species to continue to increase our human numbers madly until such innate devices take over. It is a test of the rationality of man as to how the story ends. I am an ~~optimist~~.