Wheat in Heat-Stressed Environments: Irrigated, Dry Areas and Rice-Wheat Farming Systems

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The Political, Socioeconomic, and Institutional Obstacles to Empowering the Farmer with Improved Production Technology

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Your excellencies Minister Eltayeb and Minister Geneif and distinguished delegates, it is a real privilege and a pleasure for me to be here today to participate in this Conference on Wheat in Hot, Dry, Irrigated Environments. We owe a lot of the recent advances in growing wheat in the nontraditional warm environments to the early efforts of the late Dr. Glenn Anderson. It was he who wrote the original proposal for this work and submitted it to the United Nations Development Programme (UNDP) shortly before he passed away in 1981. Twelve years later, we are gathered here in Wad Medani to discuss many of the accomplishments of this project. I am pleased to see in the audience today many scientists who have participated in training at Mexico sponsored by the UNDP project as well as other agencies.

Today, I would like to provide some insight into the various factors that have to be manipulated to provoke change in agriculture. The first of these, of course, are the biological factors that have to do with developing varieties that have good adaptation to the local climate and soil, built-in high genetic yield potential when they are properly grown, and disease resistance—at least to the major diseases that are likely to cause problems in the area under consideration. It's not just a question of developing varieties with these attributes, but there also has to be an organization that will multiply the seeds and deliver them to the farmers.

The second group of factors involve soil fertility and cultural practices. It has been my experience in many places that seedbed preparation has to be the first and foremost consideration. I remember the first times I visited Gezira here in Sudan in 1961 and 1964. I saw poor stands of plants that ultimately had to be blamed on uneven seedbeds. One has to start there, not only to assure a good plant stand, but to distribute irrigation water uniformly if it's irrigated agriculture. Now, I am not picking on Sudan; the same was true in Pakistan, in India, and even in Mexico.

With a good seedbed in place, the right date of planting is the next consideration. The correct date of planting varies with the variety and farmers have to take advantage of the lowest temperature regimes of the season—especially if they are in a high temperature area like Sudan, which is close to the upper limits of where wheat grows well. Next come proper fertilization and weed control. I've seen all too often farmers buy fertilizer and then they simply end up growing more weeds. Generally, there's not much of a market for weeds over grain and this is one of the common defects in many parts of the world. When I was here last year, I couldn't believe how much good wheat I saw compared to when I was here in 1986. In collaboration with the Sudanese

Ministry of Agriculture, the Crop Research Center, and the Extension Service, the Sudanese have done a marvellous job of putting all the pieces together.

Finally, after one has come to grips with the biological factors and agronomic practices, these components must be put together into a "production package" and then distributed to farmers. Some assumed that good research would eventually find its way to farmers' fields. Maybe so. But we in the Cooperative Mexican Wheat Program—and later CIMMYT—were never that passive. We decided that when we had something that was better than what was being used by farmers, we immediately transferred it to them. This was part of our philosophy and the results were manifest in many different ways. Indeed, good research will eventually find its way into farmers' fields, but with constant population growth, we couldn't wait for new technology to find its own way to farmers. Since there was no extension service in Mexico when we began in the 1940s, we in research were the extension people.

I would like to recognize the squadrons of "young" Mexican scientists with whom I have worked over the years. They are not young any longer—many have retired from government service. However, I had the good fortune and pleasure of bringing three Mexican scientists here to begin the program in Sudan and two—Drs. Marco Quiñones and José Antonio Valencia—are both here today. I feel very proud that these are two members of the extraordinary team that I was privileged to train in Mexico. They are not only good researchers, but they are good extension people because they understand how to put the package of production technology together, they understand the mentality of the farmers and the scientists—both in research and extension, they understand the government policymakers and the political leaders, and they are capable of dealing with all of those groups—to me, this is a very vital part of any crop production effort.

There are always psychological barriers along the road to success. However, everywhere I've ever worked in developing countries, I find that if a good package of technology is demonstrated to show its real potential on farmers' fields, the farmers are usually very receptive. When dealing with trying to provoke production change, we have to destroy the "status quo" philosophy. Fear of the change frightens many people, but if we stand still with a promising production technology, in effect, we walk backwards because every year there are more people that need to be fed.

It's my experience that when we get older, we become more conservative. I suppose I'm that way today when it comes to some of the new things in biotechnology and the use of computers because I feel that I don't have time to go back and get "up to speed", so I keep using tools I am more familiar with. I think this personifies what I've seen in senior scientists in many parts of the world and, in some cases, they have been very difficult to convince to try new tools.

And then there are the administrators. I became aware of administrative barriers during the early days in Pakistan and India. These bureaucrats, as we call them, are the people who handle the papers and put them in the right places; they become ultra-conservative because they are "protecting" the general public, but mostly they are simply afraid of change, which is what we as scientists are promoting. Then in most ministries, in both developing and developed nations, there are legions of economic planners, who know all about economics and they make very complicated plans with which we have to deal. Finally, we have to learn to deal with the political leaders because they make the final decisions that will determine 1) if there will be seed of improved varieties available to permit the package of technology to be distributed to farmers, 2) if there will be fertilizer of the right kind available and if it will it be at the village level in time for planting, 3) if there will be water six weeks before planting starts, and 4) if there will be credit so that small farmers can afford the package.

I am now in my 49th year working with these kinds of problems in agriculture. I lived continuously outside of the United States for the first 40. During the last nine, I have taught one semester each year at Texas A&M University. The rest of the time, I have continued to work out of my office at CIMMYT in Mexico.

How is it that a major research program on wheat was started in 1943 in Mexico, the home of maize? Few know that wheat was brought to Mexico in early colonial times by the Spanish. When I arrived in the country, 60% of the wheat was imported. Nine years prior to this in 1934 in the State of Sonora in northwestern Mexico, Governor Rodolfo Elías Calles was tremendously enthusiastic about agriculture and he established a modern 100-hectare farm with excellent buildings, a good set of machinery, and the best livestock that money could buy. The talented Edmundo Taboada managed the farm for the first couple of years and he was particularly interested in wheat. He had selected some 30 or 40 varieties that he brought in from other countries to make crosses. Then he was called to Mexico City to organize the whole research program for the Ministry of Agriculture. Because of Taboada's efforts, farmers in northwestern became interested in wheat. Unfortunately, inexperience in breeding for disease resistance led to disastrous stem rust epidemics in 1939-41 that essentially wiped out the whole crop. This was the environment in which I found myself when I arrived to establish a wheat breeding program.

Needless to say, the animosity of the farmers towards anyone who was involved with the agricultural sciences was pretty high. We were ignored—maybe that was the best treatment at the time as far as we were concerned. In those days, it took 10 to 11 years to develop a rust-resistant wheat variety. The dogma of the time dictated that, in order to have a variety that was adapted, a breeder had to make a cross and then make all subsequent selections in the soil and climatic conditions under which the variety was to be grown commercially—that meant one generation a year. When I had seen that there had been three successive stem rust epidemics in the main wheat growing area of Mexico, only three years before I arrived, I knew I didn't have 10 or 11 years before the next epidemic, and when it did occur I would be thrown out of the country.

To speed up the breeding process, I started what was later to be called "shuttle breeding". With this methodology, segregating populations were planted on an irrigated coastal plain in northwestern Mexico (at the 28°N latitude and 30 masl) in November when the days were getting shorter. We created artificial rust epidemics and selected the best plants for height, rust resistance, and grain type. We then "shuttled" the resulting seed back to the high elevation (2650 masl) of the Toluca Valley (18°N latitude) for planting when the days were growing longer. In four and a half years, we had the first varieties, which were very good ones. We used the same procedure for the first two seed multiplications.

All this took place before there was knowledge of photoperiodism and it's importance in cereal grains. It had been known for several years when I was in graduate school that photoperiod was important in certain kinds of horticultural crops, but it was thought that cereals were not very sensitive. However, it turned out quite differently.

How did this little wheat breeding program in Mexico have an impact in so many places around the world? Mexico itself became self-sufficient in food production in 1956. By 1959, I turned the wheat breeding program over to my young Mexican colleagues and I considered becoming a banana breeder in Central America. But the Rockefeller Foundation had other ideas. They sent me to work with the FAO to look at wheat production problems in North Africa, all of the Middle East, and India and Pakistan. As I travelled through these regions, I saw a shortage of trained people. However, in India and Egypt, I saw many young people who had fresh doctorates or masters degrees from Europe, Canada, the U.S., Australia, and many other different places. So, I made a proposal that we bring young scientists from these countries, who had just finished their university training, to Mexico for an intensive 6-month training course in plant breeding, plant pathology, agronomy, soil irrigation, and cereal technology. The idea was approved and the first trainees (an outstanding group of individuals) came to Mexico in the fall of 1961. Each year after that, a new group came.

During this early period, we organized the First International Wheat Yield Nurseries with the help of the trainees, who brought with them to Mexico about 200 g of the main wheat varieties of their home countries. The seed was disinfected and grown in seed plots. The next generation of seed was sent abroad to many parts of the Near and Middle East. I think that first year there were only 35 locations, but soon there were 75 and then 125. The data that were compiled from these nurseries began to show immediately what we hadn't known for sure before about the importance of photoperiod.

Also included in those first nurseries were the best spring wheats from Canada, North Dakota, South Dakota, Minnesota, and Wisconsin not to mention our own Mexican material and wheats from Guatemala, Ecuador, Peru, Chile, and Argentina. Soon we discovered that the commercial varieties from Canada and the northern U.S., which had good disease resistance and good milling and baking qualities, almost always ranked last in yield in every location under 48° latitude. Yet the semidwarf Mexican wheats yielded well almost everywhere since they were insensitive to day length because they were developed through the shuttle breeding methodology in Mexico.

The Mexican Program was the first foreign technical assistance program in the agricultural sciences. It preceded by five years the Marshall Plan, which assisted the Western European countries in their recovery from the disasters of World War II. It also preceded by six years President Truman's declaration that "the United States has a moral obligation to help developing nations improve their agriculture." So you see the Mexican Program was really a pioneer in this arena.

By the early 1960s, trainees returning home from Mexico always took back with them 10-g samples of any wheats in the Mexican breeding plots they liked. Through letters or through messages carried by other young trainees from the same country who came to Mexico the next year, it soon became apparent that some of these wheats were very promising. There was particular interest in Pakistan and India where food shortages were becoming all too common.

In 1963, I was invited by the Government of India to visit its wheat research program. By then, the success story of the dwarf Mexican wheat varieties had spread to many countries in the Near East by the young scientists returning from Mexico. M.S. Swaminathan at IARI had obtained seed of five of the first semidwarf Mexican lines through the USDA International Wheat Stem Rust Nursery and was intrigued by their potential for increasing Indian wheat production. He wanted my opinion on whether these lines might be useful in the Indian breeding program. Since these particular lines were obsolete, I was reluctant to voice an opinion without seeing their performance in the field.

As luck would have it, I would have this opportunity in Pakistan, which was the next stop on my itinerary. And with what transpired there we see the resistance to change that we were up against at that time. I had been invited by the Minister of Agriculture of Pakistan to review their wheat breeding nursery at Lyallpur (now Faisalabad). Now I could see how the lines I saw in India were performing elsewhere in the region. Accompanying us as we visited the experimental plots were two young Pakistani scientists who had been in training program in Mexico. I was disappointed to see the performance of the Mexican semidwarf wheats in the demonstration and breeding plots. They were inferior to the Pakistani wheats under the conditions of the tests. However, I could see that these wheats had been planted at the wrong time and had not been properly fertilized and irrigated, consequently I was sure that the methods used in growing the demonstrations were not optimum for the Mexican wheats under Pakistani conditions. When I mentioned this to the Director of Research, he responded that "this is the way wheat is planted in Pakistan."

After dinner, the two young trainees who had accompanied us to the plots that day took me aside and said that they had something to show me in the morning before I left for the airport. In the pre-dawn they awoke me with tapping on my guesthouse window. We walked to the most remote corner of the experiment station and there they were—four plots of Mexican dwarf wheats about half as wide as this auditorium and three times as long—beautiful, just as beautiful as they were back home in Mexico. I asked why they didn't grow the demonstration nurseries with the same technology? They responded that they were not allowed to do so by the experiment station administration.

This story illustrates one of the real obstacles to change. From Pakistan, I went on to Egypt and I found the same thing—some beautiful plots of the Mexican wheats hidden in a remote corner. I am not pointing a finger at Pakistan or at Egypt because I've seen the same thing in the U.S. When the Mexican wheats finally escaped from Mexico to the U.S., it was the farmers themselves and some scientists who brought it. The Mexican wheats had taken over 30% of the hard red spring wheat region of northern U.S. before the experiment stations in that part of the country produced their own varieties of high yielding dwarf wheats.

So my message to all of us here today—including myself, especially at my age—is don't be so ultraconservative. Let's try to keep our minds open to new ideas because change will come and if we are not careful, we'll be left behind.