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A Historical Perspective of International Programs and their Interaction with the Program at Oregon State University

A transcription of the Symposium presentation by Norman Borlaug

President Risser, Dean Dutson, and above all, Warren Kronstad, my good friend and colleague. It's a real privilege to be here today to participate in this symposium honoring Warren's undying dedication to the improvement of wheat, one of the very basic commodities, and moreover through wheat to the improvement of the standards of living of many peoples in the world.

I have tried to condense in these couple of pages the lifetime that I have seen Warren dedicate to international agricultural programs. With that, let me say, Dr. Kronstad, we owe you a great debt of appreciation and gratitude for your contributions. You're one of the greatest wheat scientists and most effective teachers in this century. You have evidence of this by the vast number of your students who now occupy or have occupied key positions in different organizations and governments around the world, including the U.S. Dr. Kronstad is a peerless teacher and this is why this broad representation around the world of leaders in agriculture exist, not just in wheat, but in the more general context. Warren brings forth a vision into all of his courses and training of young scientists that is much broader than genetics and plant breeding. As I look at the world problems, especially in the developing nations, this unique ability to bring together the various disciplines that bear on production all too often is unique among today's leaders in world agriculture.

I think the tendency has been for the past 30 to 40 years to become specialized earlier and earlier in our careers, and this makes it absolutely necessary to have a few outstanding people like Warren who can put all of these pieces together and check them under field conditions and on the basis of this, assist in transplanting the interdisciplinary knowledge across the world map where wheat is especially important.

He's a visionary; he doesn't just work with the major problems of the time, but he has the broad outlook over many years of time, which is vital for research programs to move forward rather than making an impact and then stopping and stagnating.

Above all, he's a friend to these students and colleagues around the world. Over the past 3 decades, we have had the privilege in our international program to have Dr. Kronstad visit, time and again, in Mexico. Both at the international CIMMYT wheat nursery, in Sonora, Mexico, and also in Toluca and Chapingo. On each occasion, he always speaks to the young trainees from around the world, as well as to our international staff. This spark and ignition that he brings to their attention, not only to the young, but also to the older scientists to remind them not to stagnate, nor sink into mediocrity. He is a very great catalyst to keeping research organizations viable.

I would like to say that I admire what he has done in the international program, especially the new international winter wheat shuttle program with my colleague, Dr. Rajaram. To me, that this program now is really at the payoff stage and you will see in the next 8 to 10 years a great impact of that program across Turkey, other Middle Eastern countries, and especially the eastern European countries and the former states of the Soviet Union.

Warren, I want to congratulate you for all you've accomplished in helping to make this world a little better place in which to live for millions of people in different nations around the world.

I have been asked to make some comments about the early history of the international agricultural research and training program in Mexico. The first program in the international agricultural system was the cooperative Mexican government program with the Rockefeller Foundation. This was initiated in 1943. I joined the program in '44, and in one way or another I've been involved in international agriculture in various organizations from that day up to the present time. I'll try to give you a little insight into some of the problems that you have to cope with when trying to bring improved technology to the service of people in the developing nations; however, I think the payback has been as great for developed nations, especially in the U.S. and Canada, from such collaboration. What were some of the approaches that were necessary, since the cooperative Mexican government /Rockefeller Foundation program was established some 56 years ago? At that time there was not a single graduate school in any of the countries in Latin America. All too often, especially typified by the situation in Mexico, most of the young people who came to study agricultural sciences came from urban areas, not from rural areas. Why was this so? Because the rural schools were so poor that their students could not pass the entrance exam to enter the colleges of agriculture. As that first program in Mexico began, we had young trainees from developing countries participating in the research program. This activity continues today to overcome the shortage of trained manpower. To put together a functioning research and production program, both in Mexico and in other countries, we eventually were training people on two levels, those obtaining college degrees and others at the nonprofessional level. After receiving their Bachelor of Science from the agricultural colleges in Mexico and later other developing countries, the new graduates were required to have some practical hands-on apprenticeship-type of training. The most qualified, we sent to foreign graduate schools mostly in the U.S. and Canada since there were none in Latin America. Thus, English or European language competency was important. To establish a critical mass of trained people takes time. Starting from scratch it takes 15 years to develop the scientific staff for developing nations. In such a short period of time you not only have to train people to carry on the research programs, but to establish graduate schools in developing countries to continue to train people in more or less their natural environment.

Now, at the nonprofessional level, we found young boys with very low levels of training, who often had dropped out of school, generally in fifth, sixth, or seventh grades. These young people were trained to become master technicians and they played this role, but at the same time, we encouraged them to get back into school and finish at least the equivalent of high school education. These technicians have been very active in training many Ph.D.s and people coming for postdoctoral training from the U.S., Africa, and Asia. Over the years, they showed these visiting scientists how to put the pieces of science together so they can make a meaningful impact. I've always admired these technicians, what they could do and what they have done.

Now, just briefly, some of the things that I think were important that we learned from that program.

It was obvious that we could not expect great impact from breeding alone to enhance wheat production in Mexico. We were dealing with some of the oldest, longest cultivated soils in the Western Hemisphere. The level of fertility was at such levels that when improved varieties were grown according to what we thought were the best agronomic practices, even under irrigation, the highest yields were 7 bushels per acre. That meant we had to work across disciplines from the beginning and especially if we were going to invest in fertilizer. We also had to have security of harvest and to avoid the most damaging epidemic diseases, with stem rust being the prime consideration. Now, how was this done? I think it was a stroke of luck in some ways due to a disaster in 1956, when across the U.S. and Canada, all of the commercial varieties of wheat became susceptible to the race 15B of stem rust. Before that, there was very little collaboration between nations, other than a lot of talk, but this epidemic changed things. A meeting was held in Canada, in early winter of '53, and the late Dr. H.A. Rodenhiser organized the first international stem rust wheat nursery to identify sources of resistance. At that time, unlike now, when we know there are a lot of genes that control the stem rust organism, there was a belief by many of the scientists that we were running out of genes to control this disease. There also was a reluctance of wheat breeders, and for that matter other crop breeders, to participate in any collaboration where materials from their program might be released by others without their receiving credit. We broke that logjam by putting all of our materials developed in Mexico into the international nursery to provide for greater genetic diversity. We didn't know much about the races of stem rust in Latin America. Maybe it was by luck, because I was so ignorant about wheat in general, as I had never worked on wheat a day in my life. I was trained in forestry and had my Masters in forest pathology. But in that Department of Plant Pathology at Minnesota, even if you weren't working on wheat, you soon learned a lot about the variability in the pathogens from Dr. Stakman. By force feeding, you acquired a background to respect the diversity of microorganisms that attack our crop.

The wheat improvement strategies we employed in Mexico were first to hybridize many varieties of different genetic backgrounds to enhance the genetic diversity in the program. This was followed by ruthlessly discarding progeny that were not acceptable in terms of plant type or were susceptible to the various diseases in subsequent segregating generations. Another significant factor was the use of shuttle breeding, which some people at the time we initiated this approach referred to as "disruptive breeding." I often was criticized for taking one step forward and one backward by systematically selecting materials under two extreme environments. However, the consequences of this approach changed our whole knowledge about photoperiodism and vernalization requirements, thus uncovering flexibility or adaptability like we had never seen or thought possible. The shuttle breeding approach took advantage of the mountainous country of Mexico. During the months from October through April, one generation of segregating material was grown at 28° north latitude at about 100 feet above sea level under irrigated conditions near Ciudad Obregon in the State of Sonora. Following harvest at this location, the next generation was planted at about 18° north latitude at about 8,500 feet elevation near Toluca, which is located northeast of Mexico City. North to south, these two experimental sites are approximately 700 miles apart. By employing such an approach, two generations could be obtained per year, but even more importantly it suddenly became apparent that varieties with broad adaptation emerged. Despite what the textbooks said, the shuttle breeding approach also provided varieties, that were widely adapted to many other parts of the world especially countries such as India and Pakistan.

When the Rockefeller Program on wheat in Mexico was about to be terminated, I turned the program over to the national scientists who had been trained in 1959. So I was looking for a job. I should have pointed out that that first collaborative program in agriculture by the Rockefeller Foundation was thought to have been a one-job opportunity for me in Mexico. Two foundations, Ford and Rockefeller, established the International Rice Research Institute in the Philippines, as they could foresee the emerging crisis in rice production in Asia. However, as far as wheat was concerned, it looked like the end of the road for me in Mexico. Dr. Al Moseman, who was in the New York office of the Rockefeller Foundation, was trying to discourage me from joining the United Fruit Company to breed bananas, of all things. So he sent me on this trip across North Africa with FAO, and I saw the opportunities and needs for trained people in all of those countries from Tunisia to India. With the exception of India and Egypt, there were virtually no trained scientists of any number, and all too often in the two countries I just mentioned, they were back doing research that had very little to do with filling hungry, empty stomachs. Many of those scientists were engaged in prolonging their thesis problem that they did at some foreign university, either in Europe, here in the U.S., or in Canada. So, I said that if the Rockefeller Foundation would fund apprentice scholarships for young graduates from those schools, and a capable FAO representative would select those young people and send them to Mexico, I would train them as best I could in 6 months to a year across all of the disciplines that bear on wheat production. This proposal was accepted, and the Foundation initiated this program, with the first group coming to Mexico in 1961. Some of these became famous scientists. One of them, Dr. Narvice, took over the responsibilities of that program. The result of this was that these people not only gained hands-on training, but became co operators as we set up an international spring wheat yield nursery in 15 countries in the Near and Middle East. The number of countries and locations soon grew to about 80. This was one of the largest shipments internationally of genetic materials and contributed to the so-called "Green Revolution." The cooperators collected appropriate data and sent it back to Mexico so we could see all of the broad adaptation first observed in Mexico. Such material found homes in many parts of the spring wheat areas of the world, including having the desired disease resistance. In South Asia, India, and Pakistan, starting in the middle '60s, the most promising lines from the international spring wheat yield trial were moved after 3 or 4 years of testing into small plots on many farms. In 1961, the production of India of all cereals was 87 million tons, by 1990 it was 197. In the case of wheat, it went from about 11 million tons to, at the present time, approximately 68 million tons.

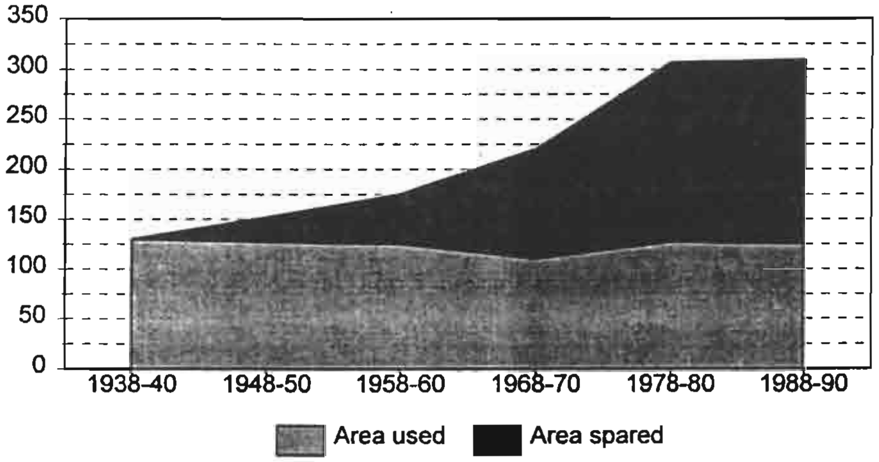
Let me say that sometimes ignorance in the beginning makes you disrespectful of things that have grown stagnant, not true, not because the original decisions were not correct, but because they were based on mini-truths and partial truths. As more research was done on microorganisms and also the genetic variations observed in crop species, it brought new insights into many complex problems. For that reason, I'm a firm believer in cross-pollination across scientific disciplines. It's truer today with all of the activists that we have in the environmental movements from the standpoint of the very special interests. One group gets overly enthusiastic about one species; others focus on another, and if you were going to legislate and try to provide for all those specific things we'd never get anything done.

A story we should have told the world would have avoided much of the misunderstanding today with many of the extremists in the environmentalist movement was the amount of land saved. In Figures 1 and 2, the impact of new technologies on reducing the amount of land necessary to produce cereals is presented for the United States, China, and India. In 1940, the production of the 17 most important food, feed, and fiber crops in the United States totaled 252 million tons grown on 129 million hectares. Compare these statistics with 1990, when American farmers harvested approximately 600 million tons from only 119 million hectares, 10 million hectares less than 50 years previously. If the United States attempted to produce the 1990 harvest with the technology that prevailed in 1946, it would have required an additional 188 million hectares of land of similar quality. This theoretically would have been achieved either by plowing up 73 percent of the nation's permanent pastures and rangelands, or by converting 61 percent of the forest and woodland area to crop land. This is a fact often overlooked by extremist environmentalists who hold that modern technology is poisoning consumers out of existence and wish to return to the good old days of "low impact" technology.

Equally impressive savings in land use can be observed in China and India as the result of high-yielding cultivars that are responsive to improved management (Fig. 2). In a recent World Bank News publication (Petrucci 1995), people in developing countries now consume half the world's wheat, and within 10 years they will consume three-fifths of all wheat produced. Since the 1960s, wheat consumption has risen almost 5 percent a year in developing countries. As standards of living increase, people tend to turn toward more convenience foods, e.g., sandwiches, especially for the noon meal. This increased interest in wheat was observed when, in 1994, Asia harvested 217 million tons of wheat, far outpacing Europe's 119 million tons and the 90 million tons produced jointly by the United States, Canada, and Mexico. During this same period, developing countries also accounted for over two-thirds of the world's total wheat imports, suggesting that demand in the developing world has risen even faster than domestic output.

Today, from that little program that was started in Mexico back in 1943, there are now 16 of these international programs scattered around the world. The budget about 3 years ago was $300 million. A lot of money, until you stop and look at it and realize that it's about the cost of seven F-18 fighter jets. Thank you.

Million Ha



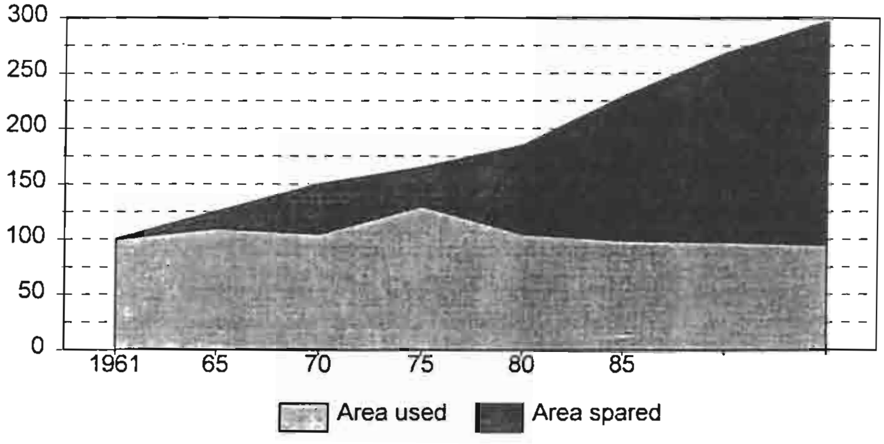
1938-40 Production: 252 million tons

1988-90 Production: 596 million tons

Fig. 1. U.S. total crop area spared by application of improved technology on 17 food, feed, and fiber crops in period 1938-40 to 1988-90 (taken from Borlaug and Dowswell 1996).

China - All Cereals

Million Ha



India -All Cereals

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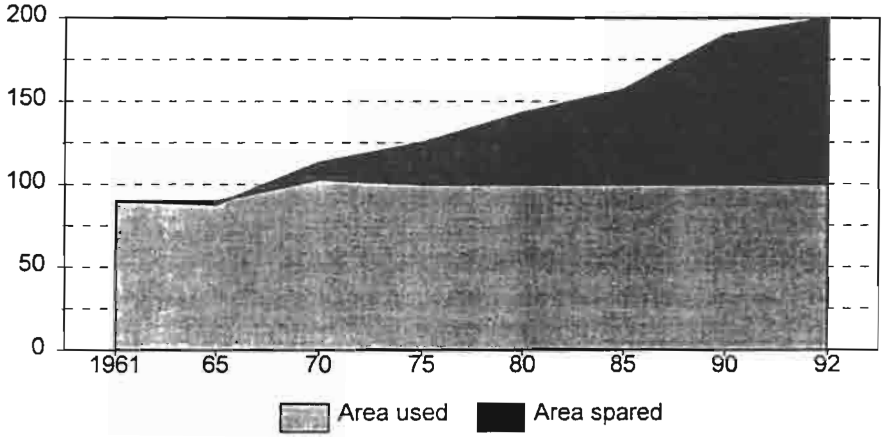

Fig. 2. The land that Chinese and Indian farmers spared through raising cereal yields* (Borlaug and Dowswell 1996).

* The upper curve shows the area that would have been needed to produce 1992 cereal production, had 1961 yields still prevailed. The lower curve shows the area that actually was harvested (Borlaug and Dowswell 1996).