

# THE "GREEN REVOLUTION" AND AFTER

An interview with Norman E. Borlaug

In 1970 the Nobel Peace Prize went for the first time not to a statesman or prominent public figure, but to an agricultural plant scientist conducting research in rural Mexico. A native of Iowa, in the U.S. mid-West, Dr. Norman E. Borlaug has been working in Mexico since 1944 to improve that country's wheat crop. The high-yield wheat varieties that he developed have converted Mexico's wheat shortage into an exportable surplus, have brought Pakistan from near-famine to self-sufficiency, and promise to do the same for India. Today more than 25 million acres are planted to this hardy, dis-

ease-resistant grain in Latin America, the Middle East, Asia and Africa, feeding an estimated 500 million people. This remarkable transformation of wheat farming — along with parallel advances elsewhere in rice strains — has been labelled the "green revolution."

*Dialogue* asked Diane Stanley to interview Dr. Borlaug about his past work, his present concerns and his thoughts about the future. Miss Stanley, a graduate of the University of Missouri, has worked in cultural and information programs in Chile, Brazil and Mexico.

*The arid, hot plains of the Yaqui Valley in northwestern Mexico seem an unlikely setting for a Nobel Peace Prize winner. Entering the experimental farm where Dr. Borlaug works, one sees agricultural trainees from four continents working waist high in green fields of wheat or stooping low over small corn plants. In three long one-story buildings, technicians study production charts, conduct soil analyses, and painstakingly cross different varieties of crops.*

*Despite his present fame, Dr. Borlaug continues to spend much of his time at the experimental station in Ciudad Obregon. When I visited him in the spring of 1971 his current projects included development of triple dwarf varieties of wheat and the crossing of wheat and rye. Apart from the direct, unassuming manner, which I expected, what struck me most about Dr. Borlaug was his combination of intense involvement in technical research with a deeply humane concern about the larger issues of world hunger and overpopulation.*

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*Dr. Borlaug, when you came to this area of Mexico 27 years ago, the average yield of wheat per acre was about 15 bushels. Now it is at least three times that figure. In your opinion, what were the most significant developments or breakthroughs that brought about these enormous increases in yields?*

I think the yields now really are closer to four times what they were when I came here. In other words, the yields are closer to 60 bushels an acre in this particular part of Mexico.

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## Dialogue

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The increase in yield is the composite effect of the varieties which have been bred and adapted for their high productivity, when properly grown. An important part of this total picture is the proper use of fertilizer — heavy dosages of the right kind applied in the right way — and then manipulation of the irrigation water, which also has to be handled in the right way. And when you put all of these together — assuming, of course, that you've built in the right resistance to diseases, which is always a problem — you can see tremendous changes.

*How many countries are now raising Mexican strains of wheat and what kinds of results have been obtained elsewhere?*

Well, I haven't added up exactly how many countries are actually growing them at the present time, but it's a rather large number. I suppose the ones that are growing them in the largest acreages would be India and West Pakistan, but there are also sizeable acreages in Turkey, Afghanistan, Iran, Iraq, and more recently in Tunisia, Algeria and Morocco. This is in addition, of course, to here in Latin America where there are Mexican types of wheat being grown in Guatemala, Colombia and Ecuador, as well as the southwestern United States. It now seems likely that there will be increasing quantities grown in Brazil and perhaps in Argentina before too long. In parts of Africa they are also grown in commercial acreages, for example, in Kenya, Ethiopia, South Africa and Rhodesia. So these wheats have found their way around the world.

*And are they obtaining the same high yields of close to 60 bushels an acre that are being obtained here in Sonora?*

In some cases. Certainly this is now true of India and Pakistan, and yields are being increased in many of the other countries. I should like to point out also that, although these varieties were developed originally for irrigated areas, such as here in Mexico, they are also grown successfully in rain-fed areas — Tunisia, Algeria, Morocco, the U.S. southwest, Afghanistan, Iraq and Iran and anywhere in Latin America, other than Mexico.

Of course when you grow them under non-irrigated or rain-fed conditions the results will depend in part on the distribution of that rainfall and how fertilizer can be applied. Nevertheless, these varieties have been good enough in their yielding ability to displace or replace wheat in vast areas, even rain-fed areas.

*In a report I recently read on the corn improvement program here in Mexico, it was noted that one of the problems encountered was that of convincing farmers to use the new strains of corn. How serious a problem*

*has this sort of thing been in your work around the world and how do you go about persuading farmers to try new varieties of wheat, corn or other crops?*

I think this is always one of the problems that you're up against in trying to put across not only a new seed, but new technology in general. There is a certain reluctance to change and the poorer the people are, the greater the reluctance. Consequently the smallest of the farmers are the most resistant to change — those that are living close to just bare survival. You always have to be aware of this when you're trying to introduce new seed and the new technology that makes this productive.

You can't convince a farmer by showing him a yield difference of 10 or 15 percent and expect him to accept this. You must — assuming that you have the proper seed — know how to grow it much better than he has ever grown a crop. You have to demonstrate that it is possible to double the yields or triple or quadruple the yields that he's used to. And if you can do this, and if it can be done on his own plot of land rather than on a government experiment station, you'll find that he will be very receptive indeed.

There's always — especially on the small farmer's part — a reluctance to believe what he sees on a government experiment station.



*Dr. Borlaug*

He thinks that the government is always rich and has budget and funds and therefore can do things that he cannot do on his own tract of land. Besides, even though he doesn't say this, I'm convinced that he all too often doesn't know how much magic of one kind or another — I call it witchcraft — is involved and how much of it is science.

But when he sees it done on his own plot of land, where he has actually seen the whole operation or has participated in it, he himself becomes a very effective extension worker and will carry this to his neighbors and relatives, not only in the village where he lives, but in distant villages, where he has other relatives. This is certainly the way it has spread, in large part, in India and Pakistan.

*It has been said that the "green revolution" has not been as effective in tropical areas and that, in fact, intensive agriculture in these areas will always be limited because of the poor soil conditions that prevail. Is this*

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## Dialogue

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*an accurate observation and, if so, what hope is there for the agricultural development of huge areas of South America, Africa and the Far East?*

I have the feeling that the reason the "green revolution" hasn't spread in the same way into the tropical areas of Latin America and, for that matter, areas of Africa, is that this particular new technology hasn't been developed for those areas as of now. I'm convinced that it can and will be developed if we go at it correctly, with the right amount of research effort.

You must remember that the painfully slow, hard struggle of developing these varieties, with their broad adaptation, and learning how to grow them so that they would be highly productive, represents 15 or 20 years of work here in Mexico. Then, by checking out its validity in other parts of the world, such as India and Pakistan and now more recently in north Africa, we could see that it might be possible to make a rather dramatic transplantation of this new technology in most parts of the world — and do it fast. And that is essentially what happened. The same sort of thing is true in the case of rice, where work was begun more recently at the International Rice Research Institute in the Philippines. Those efforts have also been highly successful and have spread to other parts of the world.

But in the field of tropical agriculture there has been a shortage of research, and I think it's now high time that we get on with this. As a matter of fact, this is the reason for the two most recent international research institutes: the CIAT in Colombia, which is the Center for International Tropical Agricultural Crops, and the second one which is being established currently in Nigeria. So I'm hopeful that from these centers will come useful varieties and technology that can be applied to more tropical areas.

I'd like to say one other thing, these international research institutes are only one link in the total chain. We bring many young scientists here for practical training because we recognize that the limited number of people we have on our staff can't possibly begin to cope with all of the food and agricultural problems in the world's large number of developing nations. We can do our small part, but the vast majority of the work has to be carried on by scientists in the national programs. We can only play a helpful role in assisting in the training of some of these young people in our program here, as well as at the International Rice Center or the tropical center.

*Are these three centers also funded by the Rockefeller Foundation?*

The international centers are currently funded by a number of organizations. The original Mexican agricultural program was a cooperative venture of the Mexican government and the Rockefeller Founda-

tion. It began in 1943 and had completed its mission, I believe, by 1962.

But a second aspect of this project was to train young Mexican scientists. I would estimate that close to a thousand scientists participated in the training program. Although many of them did not receive advanced degrees, but simply a lot of know-how and a lot of practical training and research, several hundreds were provided scholarships for study in the United States and received Master of Science degrees and doctor of philosophy degrees in agricultural sciences. They became the scientists who took over the responsibilities of the Mexican agricultural program when the national program was formed in 1962. At that time the cooperative Rockefeller-Mexican program was terminated.

But shortly before that, largely based on the results that had been obtained here, a new concept came into being: that of the international agricultural research centers. The first model was the International Rice Research Institute, which is located in Los Banos, the Philippines. This was jointly funded from the outset by the Ford and Rockefeller Foundations, with the assistance of the Philippine government.

Then, as sort of a second afterthought, as it were, the International Maize and Wheat Improvement Center (CIMMYT) came into being here in Mexico. It really didn't get functioning until about 1965, but it was conceived and officially set up in 1964. Originally it was financed by the Ford and Rockefeller Foundations and the Mexican government, but at the present time it also receives funds from the United Nations, the Inter-American Development Bank, and the U.S. Agency for International Development.

There is a growing number of organizations that are supporting all four of these international research centers. The Kellogg Foundation, for example, has put money into CIAT; the Canadian government's foreign assistance program is also helping to fund this program, and some of the European government institutions are beginning to assist with funding. So from the standpoint of support, these centers are becoming truly multinational.

*What is the main focus of your current work?*

As far as my own work is concerned, which is restricted pretty largely to wheat, and more recently to triticaria — the crossing of wheat and rye — we spend most of our research effort during the winter season here. That is, our experiments are planted in November and we go through the crop season here. We also bring our young trainees here from other parts of the world to work at the CIANO experimental station. The name CIANO is derived from the Spanish title for the Center for Agricultural Research in the Northwest, set up by the Mexican government here in Ciudad Obregon.

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## Dialogue

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I also spend a large part of the year traveling and working with many of these trainees who have been here, as well as other scientists in different countries of the world. I was in India and Pakistan during the month of March and I'll be leaving within a few days for Tunisia, Algeria and Morocco where I'll spend June. I'll be in Turkey during July.

*How many trainees from other countries have you had here in Ciudad Obregon since this program was initiated?*

We have had informal training programs going back a long, long time, but these were generally two or three young people at a time, mostly from Latin America. However in 1961 we began a more vigorous training program for wheat scientists, and I suppose since then we have had about 200 who have spent anywhere from nine months to a year with us. There are many more who have come for one, two or three weeks. This would again run into several hundreds. And then in recent years we have also provided an orientation program to show many government officials from different parts of the world how research is organized and how farmers participate.

I think that the CIANO's method of collaboration with the farming community in the state of Sonora is a progressive and unique arrangement that may be worth emulating elsewhere. A large share of the funding to pay for the research comes directly from contributions by local farmers taken from sales of their own produce. It's not a government tax; they collect it themselves and they administer it through a set of elected officers who work directly with the director of research at the CIANO. For this reason it is a very unique and vigorous organization that is becoming a model, we hope, for many other areas of the world.

*It has been said that the "green revolution" is likely to affect more people in a short time than any other technological change in history. Would you agree with this statement?*

I think that it has the built-in potential to do so if governments don't become complacent; if they keep allocating their resources right, keep pushing ahead with aggressive research and continue to train enough young scientists. But it's not enough to do the research. They must also make it possible to have this new technology applied to solving food problems. You see, you can have the seed, the know-how and the fertilizer available in a country and nothing happens. If change is to take place, you have to have the right economic policy established at top government level and have it implemented.

This is sometimes one of the most difficult jobs of all, convincing governments that they have to support, first of all the research, and then the policy that will make it feasible for the small farmer to apply

this new know-how: credit for buying the fertilizer and seed, and stabilizing the marketing situation so that when the farmers harvest their crops the whole bottom doesn't fall out. All of these things are equally important.

We must try to spread this new technology to an ever-increasing percentage of the total population, not only in wheat but by pushing forward aggressively in all of the other crops, so that more and more small farmers can become involved. Now, in the case of wheat, for example, Indian and Pakistani farmers have money in their pockets and they are buying things, and that starts a whole rhythm and change in the little industries in the villages, and this helps to vitalize the whole national economy.

If we can keep this moving forward, to involve more and more people, we might be surprised at what it does to the overall economic development of a country. Of course in order to have this carried forward, we have to have stable governments, in other words, peace. We can't have chaos and continue to improve the lot of the average people.

*In accepting the Nobel Prize for Peace in Oslo last November, you expressed concern that increases in the world's food supply are not keeping up with increases in population. How serious a problem do you think this is for the world as a whole today?*

I'm convinced that it is a very serious problem indeed. The figures of the World Health Organization, the Food and Agricultural Organization and various other international agencies all seem to indicate that roughly half of the people in the world are still underfed or malnourished, even today. During the last four or five years, as concerns wheat, and now it's beginning to happen in rice, we have been making some good strides to increase food production in the most densely populated countries.

For example, prior to the "green revolution", the all-time high in wheat production in India was roughly 12 million metric tons. In the last four years it has climbed to 16.5 million metric tons, then to 18.6 and in 1970 to more than 20. It now looks as though it will approach 22 million tons in 1971. So this is a lot of progress. In West Pakistan the change has been equally impressive. But these are only two countries and it is only one crop. It has to be done in all of the crops, and in some crops we don't have the new technology available. So we have to push on.

Now, when you have a situation where half the people of the world are still hungry — if not every day of the week at least several times a week — it's not a very pleasant situation. And we just can't be at all complacent. We've got to work harder than ever. It looks as though there might be some hope if we can keep this population monster from swallowing us up and destroying the whole world.

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## Dialogue

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I am deeply concerned about population growth because it affects many aspects, not only food. I'm equally worried about unemployment. With so many people coming into the world, if there are no jobs, there is going to be more and more social chaos, political instability. As a matter of fact, I think there are some very densely populated areas of the world that are rapidly approaching the point where they are ungovernable.

If this is so, how can we build any lasting peace with this kind of chaos building up all around us? I'm convinced that one of the first steps toward world peace is solving the hunger problem. But right after that we have the employment problem, the educational problem, housing, medical care, transport. All these problems are interrelated, and excessive population growth is central to all of them.

Everyone talks about the environment today, but all of the tangling up of environment is really the composite effect of too many people jammed together in certain areas of the world, where we haven't done as much to save the environment as we probably should have. I'm sure we can improve on some of these uses, but nevertheless, if we improve on them now (and I think they can be improved upon in the next five to ten years), will these problems be solved 20 years from now or 30 years from now when we have twice as many people in the world? I doubt it.

*What then do you think is the solution for this problem of overpopulation?*

There isn't any simple solution. My feeling on this is that we can build a better world only by having population growth geared to our capacity to provide a decent standard of living for all of the people who are coming into the world. Until we can do this, we are going to have continued strife. First there will be increasing civic strife within a country, ending up in civil wars of one kind and other, and which all too often have ways of spreading so that other countries also become entangled. And there is an ever-growing danger of local conflicts spreading to world conflicts.

When we talk about population, when we talk about environment, all of these things are interrelated and it comes back to the question of how can we give a decent standard of living to all peoples of the world. It's complex. There is no simple answer because the population density itself is not the same in different parts of the world. But, on the other hand, that doesn't give any of the more privileged parts of the world, from my point of view, any reason to be complacent about this situation.

In the case of the United States, for example, we have roughly six percent of the total population of the world, but we probably are utilizing 40 percent of the natural resources of the world. And in some cases, as with petroleum, much more than 40 percent of the world's consump-

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## *The "Green Revolution" and After*

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tion of petroleum products takes place in the USA because of the automobiles and other uses that we put it to. So we Americans are involved in this whether we think we are or not. We can't sit complacently back and say, "Other parts of the world that are very densely populated have this problem but we don't have it back home."

We're all coming closer than we ever thought we would to being one world, and the heavier pressures we put on all of our natural resources are depleting these resources in some cases faster than we are discovering new deposits. Either we have to create substitutes or they're going to be more expensive. All of these things have a way of affecting the whole economy, first of a nation and then of the world.

So, I'm sorry, I just don't see any simple solution. We have to work at this — what I call the population monster — from all different angles: food, employment, education, housing, clothing, transport, all of these things, including the environment.

You see, there are many people who just don't comprehend this business of the environment, even as it relates to food. I started out as an ecologist, a forest ecologist. I was a forester in my early professional days and I worked in the back country of Idaho, the biggest primitive area of the USA, and I know what the balance of nature is. Things get out of balance there too. Again, people who look narrowly at the picture don't understand this. There are epidemics of insects that destroy vast areas of a forest or there are lightning storms that start endless numbers of fires — set by lightning, not by man. And things get thrown out of balance there just as when man is around. Of course man does a better job of throwing things out of balance.

There are those purists now who say that chemical fertilizers should not be used, that we should use organic farming. Well, in the first place, there is no magic in organic farming. Maybe the USA could get by with it for a few years because of the large amount of land that is still available. The rest of the world would all starve. To say that you shouldn't use chemical fertilizers is to commit half the world right now to starvation!

We should have forgotten then about the "green revolution" from the beginning, and never tried to start one because without chemical fertilizers and without the rational use of insecticides to control certain diseases, and herbicides to control certain weeds, we're doomed in this overcrowded world.

So we've got to use common sense and it seems to me that the more people we have jamming up this world, the less common sense we seem to have around. Common sense used to be fairly general; I think it's still around now, but I think everyone is so taken up with gadgetry, so over-sophisticated, that common sense all too often is left behind the door. It doesn't seem to function; it's played down. But without it we're all doomed.

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## Dialogue

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*Your comments in Oslo on overpopulation were given wide play here in Mexico where it was subsequently said that you no doubt were referring to such countries as India and Pakistan. Do you believe there are countries in this hemisphere that face a problem of overpopulation?*

I most certainly do. If unemployment and underemployment are one of the aspects of overpopulation, then we have a number of countries in the Americas already at that stage. And we're likely to have many more within the next 30 or 40 years the way things are going now. I'm not only concerned about Asia and about some parts of Africa, I'm concerned about the Americas, too.

*Some persons have pointed out that we are only now beginning to develop the potential of the ocean as a food producing area and that in time much of the world's food probably will come from the ocean. Do you believe this is a valid observation?*

No, I think this is a great oversimplification. I think there are certain parts of the ocean where we can probably increase our food production capacity, but there are also vast areas of the ocean, like vast areas of the land, that are probably deserts or near deserts from the standpoint of fish and marine food production.

So I don't think we want to look for a lot of magic from the ocean. We want to try to develop its resources, improve on our techniques for exploiting it, but let's not think that there's going to be a simple solution forthcoming that will vastly expand food production from the ocean.

But the problem goes beyond just food. It's all of the other factors I've mentioned earlier as well: employment, housing, health, transport, and so on. There's no simple answer. We have to look at all aspects of the problem and ask: "How can we provide the kind of decent life that all people should have?"

