Civilization Will Depend More Upon Flourishing Crops Than on Flowery Rhetoric

By Dr. Norman E. Borlaug

Thank you Dr. Acker, Dr. Litz, Mr. Musil, ladies and gentlemen.

It's an honor to be here in the greatest wheat producing area of the world. American agriculture owes a great deal to this university. Michigan State and KSU were the two original land-grant colleges that came into being when President Lincoln signed the Morrill Act. Since that time, KSU has played a key role in the development of technical agriculture and has set a pattern for many others to follow.

Some of the comments I am about to make may sound very odd in context to life in the U.S.A. I've lived abroad for 35 years in food-deficit nations and consequently, my point of view is very different than it would be, had I continued to live here. I hope in trying to illustrate some points I don't provoke an overkill, in the sense of getting them completely out of focus.

Food is the first basic necessity for all of us. And yet in a country as privileged as the U.S.A., which has long been a large producer and exporter of food, it's very easy to take for granted how important food production is to social stability. We can only live a few weeks without it. The famine in the West African Sahel countries a few years ago led to the fall of the governments in power which were replaced by revolutionary governments of one kind or another. When stomachs go empty, patience wears out and anger flares. If we're going to achieve world stability, it won't be done, I assure you, on empty stomachs.

In 1975, total world food production equaled about 3.3 billion metric tons. Included in this total is a very diverse group of foods. Cereal grains, such as wheat, maize, rice, oats, barley, sorghum and millets, constituted about 42 percent of the total tonnage. Since cereals have low moisture contents compared to many of the other types of foods, their caloric contribution as food is much higher. Basic grain legumes, sugars, tuber crops, nuts, fruits, vegetables of all kinds, and animal products—meat, milk, eggs—add to the total food supply.

Some contend that when the world can no longer produce the food we need on the earth, we will harvest it from the ocean and inland waters. Yet, if we look at the production in 1975—that is of fish, mollusk and crustaceans—only two percent of the total tonnage came from the oceans and inland waters. Let's not be deceived by the potential in the ocean. After World War II, the catch of fish and shrimp, etc. went up dramatically with improved equipment for fishing. It leveled off at about 70 million tons and then dropped down, more or less maintaining a level of 65 and 70 million tons. With the technology that is now available some species already are overfished. Other species probably can be added, but the data clearly illustrate that we will have to rely primarily on the land resources to feed future world generations.

The U.S. has the most successful agricultural system in the world today. To produce this abundance of food, only about 3.6 percent of the total U.S. population is needed to work in agriculture and animal husbandry. Compare that to the situation in most of the developing nations where 75-80 percent of the total population is engaged in agriculture. On a worldwide basis, about 46 or 47 percent of the total world population is engaged in agriculture, most of them at subsistence standards of agricultural production.

Political attitudes toward agriculture wax and wane with the scarcity and abundance of food. That has been so, I would assume, from the beginning of the organization of governments, due in large part to the cyclic nature of food production. Yet, it's a curious thing. Even in a country such as the United States with its great agricultural production, there is less and less attention given to agriculture by political leaders. Although the shift to urban and suburban living was made possible, in part, by the successes of American agriculture, the vast majority of Americans today are ignorant about what is involved in producing and marketing our basic agricultural commodities. This ignorance has affected public policies and legislation related to agriculture, and jeopardizes the future availability of food in the U.S. and in the world.

Because of unemployment and population pressures on the land, most of the new nations are trying to transform their economies from agrarian to industrial very rapidly. In looking for ways to develop their nations, agriculture is often neglected, except when a food crisis threatens. Agriculture enjoys little prestige. Many who have grown up on small farms see little opportunity and want out. Those with the ability and chance to obtain an education, opt for a career in medicine, engineering or law. They want to be anything but agricultural scientists.

I mentioned that only two percent of the food that we harvest comes from the ocean. The other 98 percent comes from the land. Perhaps to many, there is still much to be brought under the plow. Most of us think of the earth as a tremendous planet. But remember that more than three-quarters of it is water. On the part of it that is land, there is a lot of bad real estate. Of the 8.4 billion acres of land area, only about 11 percent is arable. Of this, 22 percent is classified as pasture or rangeland used for livestock production, but most of it has a low carrying capacity. Thirty percent is classified as forests and woodlands, and again much of that is covered with worthless sagebrush and a few jack pines or junipers.

Some of what remains was farm land at one time until it was covered with pavement for cities and industries. The loss of agricultural land to urban uses is going on around the world at the rate of several million acres a year and nearly always on the best land. It seems that everybody wants to build on relatively flat land. They want to avoid the cost of building on sloping land. Today, the amout of land for agriculture is being reduced faster that we are adding to it, for example, by irrigation or by clearing land in tropical areas where there is still good land available.

In the past, when there was population growth, and usually after a famine, food problems were solved by opening new lands. In this way agriculture production was increased. This approach continued until after World War II. Today, the major emphasis is on producing more food on the land that already is under cultivation. This becomes particularly important in many countries that are densely populated and have very little opportunity to bring more land under the plow.

If we look back just a short period we can see the cyclic changes in food production. After World War II there was over production, from the standpoint of the U.S. farmer, from the period 1950 to 1971. In 1971, we had about the right balance and a reasonable amount of food grains held in stock. Then suddenly four years of bad world harvest began in 1972, made more severe by OPEC adjustments in petroleum prices and the related shortages of fertilizers. Prices of food soared, here in the U.S.A. as well as in other parts of the world. In many countries, where even in good times the masses had to spend 80 percent of their income on food, the situation was truly desperate. In many cases, when prices shot up, all the disposable income of families went for food, and it still wasn't enough.

At the 1974 World Food Conference held during the worst of the crisis, flowery speeches were made that could never hopefully be fulfilled, such as; no child will go hungry by the year 1985, by the year 2000 hunger will be banished from the face of the earth. These are completely irresponsible kinds of declarations when you see how the world really exists.

The conference participants ended up setting three objectives. One was to create an international grain reserve that would presumably be financed by all nations according to their ability to contribute. Not much has come from that—nothing except lots of talk. The second was to increase food aid for certain countries that were in grave crisis at that time—this was carried out. The third objective was to create an

international fund for agricultural development—this has been accomplished. About a billion dollars has been accumulated in this fund to be spent for development programs. The first projects are now under way. This I hope will have some impact on development. The task ahead is immense.

If we look at our agricultural production in the U.S.A. and contrast it to other countries, great differences are obvious. First of all, the United States is blessed with a lot of good land and favorable climatic conditions, especially rainfall and temperatures. We have good farmers and those farmers have the backstopping of our land grant universities and a well-developed agri-business sector. Substantial investments have been made in machinery, structures, roads and storage facilities. All of the things make the production we enjoy possible. The markets have been developed in a fairly orderly way, and this too has helped. In the third world nations, all of these elements are in short supply.

The first attempt at foreign technical agriculture assistance was established in Mexico in 1943 as a joint undertaking by the government of Mexico and the Rockefeller Foundation. The objectives were two-fold: to train a corp of Mexican agricultural scientists as rapidly as possible to take over the responsibilities for developing their own agriculture; and to establish a network of agricultural experiment stations to do research on all important aspects that impinge on food production.

This program was an out-growth of a visit by U.S. Vice President Henry Wallace who went to Mexico for a presidential inauguration. He was invited to accompany the incoming minister of agriculture and the outgoing president, who was instrumental in carrying out agricultural reforms after the revolutionary war in Mexico in 1920, on a trip throughout Mexico. At the end of this trip they made a request for assistance in developing Mexico's agricultural research capabilities.

When he came back to the U.S., Vice President Wallace called the president of the Rockefeller Foundation to discuss this request. By then the war had begun. "The government can't do anything about staffing this now," he said, "and you probably can't either. But the Rockefeller Foundation has 25 years in working with 26 different governments around the world in public health. You have stationed medical and public health specialists and you've learned how to work with the governments of developing nations. The U.S. government has much less experience. Besides, these issues become political when done on a government to government basis. You're not political, your institution is not. Do you think you can help?"

The Rockefeller Foundation formed a team to study the feasibility of this project. The team was composed of E. C. Stakman, a plant pathologist and my former professor from the University of Minnesota who recently past away, Dr. Richard Bradfield, an agronomist from Cornell University and Dr. Paul Mangelsdorf, a maize geneticist originally from Texas A&M, and later Harvard. At the end of the study, the team made a positive recommendation that the Rockefeller Foundation accept the challenge and send a small group of agricultural scientists to Mexico to see what could be done. The program began in 1943 with Dr. J. G. Harrar, who subsequently became president of the Rockefeller Foundation, as leader. The second man was Dr. E. J. Wellhausen, a corn geneticist. I was the third man on the team.

What happened? Between 1943 and 1960 we trained, at one level or another, about 1250 scientists. The best always were selected to train others. They were sent first for master's degrees here to Kansas State University and to other universities. They came back and worked again in Mexico to help train other young people. Many of the best went on to complete their doctorates at American, Canadian, Australian or western European institutions.

When these scientists came back, they took over the program and in 1960 we were out of a job. By then, most of the Rockefeller staff had been transferred to similar programs in Colombia, India and Chile. Others had returned to the U.S.A. The number of requests were mounting at this time to the Rockefeller Foundation and to the Ford Foundation for similar types of assistance programs in other third-world countries. In 1960, these foundations decided to establish the first international agricultural research institute, The International Rice Research Institute (IRRI) in Los Banos, Philippines, in collaboration with the Philippine government. In 1962, this institute had just opened its doors.

A few months later, President Lopez Mateos of Mexico was making a swing through southeast Asia and had occasion to visit IRRI. Upon returning, at the farewell banquet for the Rockefeller Foundation staff left in Mexico, President Lopez Mateos rose to speak and said, "I'm completely confused by this departure. When I visited Southeast Asia, the president of the Philippines invited me to see this new international rice research institute and it was fabulous—beautifully equipped, with scientists going about their work with enthusiasm. I was told that this institute was modeled after the Mexican wheat and maize program, the program we are saying goodbye to here. If this is so, I insist and I will strongly support the establishment of an international wheat and maize center in Mexico to help other third-world nations with their agricultural problems." Two to three years later, The International Maize and Wheat Improvement Center, known by its spanish acronym, CIMMYT, was organized.

Today there are eleven of these international centers in operation around the world. Ten work on agricultural crops and animal production and one on food policies. The two animal programs, located in Africa, are working mainly on trypanosomaiasis, a sleeping sickness transmitted by the teste fly. If this disease can be controlled, it could open vast tracts of well-watered jungle land in central Africa.

The elements of technology developed by the international centers

include improved seed; and knowledge on the use of fertilizers, cultural practices, the ways to overcome the problems of weeds, diseases and insects. In the case of wheat, the high yielding varieties combined with other improved production practices, have led to fantastic increases in wheat yields in the developing world.

Perhaps the greatest success has occurred in the Indian subcontinent. By the middle 1960s, India and Pakistan were in a grave crisis due to food shortages. We began exploring the possibilities of transferring some of the elements of higher yielding technologies that we had developed in Mexico to these countries. We sent in experimental lots of seeds, and worked with their scientists to test the Mexican varieties under a number of conditions. The prospects looked promising enough for about 350 tons of the improved Mexican semi-dwarf wheat seed to be exported to each country. Everything went wrong in the process.

First, we couldn't get it loaded on ships at Mexican ports. It had to be trucked to ports in California. Then, it got tangled up in the traffic jams outside of Los Angeles where the Watts riots were going on. Finally, we reached the freighters and got the seed abroad. The check I held to pay for the shipment had a couple of misspelled names and nobody wanted to cash it. I told them "load it and send it off, and I'll get the check cashed on Monday morning." On Sunday, the war between India and Pakistan broke out. The seed finally arrived in Singapore and was separated, part going to India and part going to Pakistan. It arrived so late we didn't have time to check the germination so we started planting.

My Mexican colleague, Dr. Narvaez, was in Pakistan, and Dr. Anderson, my Canadian colleague who is my deputy at the present time, was on the Indian side. We soon saw the imported seed had miserable germination and we had no choice but to convince ministry of agriculture personnel to double all the seeding rates. It was already very expensive seed and it didn't make us look very good. We produced about a third of a normal Mexican stand.

If I had been back home in Mexico, I would have started seeding over again. But we didn't have the seed available. We put on more fertilizer and more water and eventually it turned out to be a respectable crop. People had never seen such a crop of wheat. Farmers were convinced; they wanted more seed. What came to be called the Green Revolution hung on these thin threads.

When we backtracked what had happened, somebody had fumigated that seed back in Mexico at three times the recommended rate, killing much of the seed before it ever left Mexico.

Eventually, despite all of the problems, the introduction of these semi-dwarf wheats was a success. The next year there were thousands of tons imported which were put out on half acre plots next to the local farmers' crops. We fertilized all of our plots, many of the farmers didn't. The yield difference between our plots and their plots was not 30 percent, not 100 percent, but three or four times what they were getting.

The next job was to convince the politicians. We had a stroke of good luck on this one. While enroute with Dr. Anderson from northern India to New Delhi, we visited most of the demonstration plots. We encountered tremendously enthusiastic farmers. Upon arriving in Delhi, we were invited to have lunch at the largest tractor factory in India, just outside Delhi. It so happened that the Polish ambassador was there that day because the tractor differentials were sold by Poland. The rest of the tractor was made in India. The patio was full of tractors which had not been sold. The ambassador spoke and asked me to say a few words. I took advantage of this opportunity and said, "if we can just get some fertilizer, all of these small tractors you have here will disappear inside of a few months. The whole critical factor is now fertilizer. And if I were a member of the parliament, I would stand up and say what India needs now is more fertilizer."

My statement appeared the next day on the front page of all the newspaper in Delhi. We went to see the minister of agriculture and he was convinced. But he had lost his seat in parliament in the recent election. He said, "I can't help you. I didn't tend to my politicking and I lost my seat, and now I'm out. But I want you to talk with Minister Shokimeta," who was the second most powerful man in the government at that time, after Prime Minister Indira Ghandi. The appointment was set up.

As I was leaving the minister's office, he said, "Listen Dr. Borlaug, you talk to him just as bluntly as you have to me. You've never met him, but the time is right to treat him bluntly." I'd never met the man but I walked in and said, "Look the whole stage is set now, but there is no fertilizer. And you, Mr. Minister, if there is no fertilizer coming out the spouts next September, you'll join the rest of your party members, who have lost their seats because the farmers now know what can be done if there is fertilizer. Move or they'll move you."

That perhaps wasn't the best way to start. There were lots of sparks flying around and I kept talking as fast as I could so that he couldn't interrupt me. He was talking too, but eventually we both quieted down and we left good friends. I departed that night for Mexico. About a week or ten days later I got a bunch of clippings out of the Delhi newspaper published the morning after this meeting. The government of India had modified its stand on fertilizer. Additional plants were to be constructed, more fertilizer was to be made available.

Since then, the production of wheat in India has increased from 10.5 million tons in 1965-66 to 34 million metric tons in 1979—more than a 300 percent increase. Today, they've got wheat piled up all over. Their warehouses are running over, but there are still lots of empty stomachs. It's a different ball game now. Now the challenge is to get

the grain out of the warehouses and into the stomachs of the unemployed and underemployed people. I've been prodding and pushing that point for a long time. And finally they've got some public works programs such as existed in the U.S.A. in the 1930s.

Indian government sponsored "food-for-work" programs are building, mostly by hand, farm-to-market roads, country school houses, drainage ditches, and irrigation canals. They are replanting trees on eroded slopes. This is one way to use the surpluses. I hope economists can find other ways to improve food distribution. I've been blistered now for many years by the charge that we've made the rich, richer and the poor, poorer, because we were never able to develop the technology that would produce four times as much on a small plot of land than can be produced on a hundred acres, with the same technology. The wheat plant is pretty apolitical. It doesn't care whether it is growing on a big farm or a small farm. Some social scientists fail to realize this point.

The green revolution has been attacked for causing economic injustices because of these equity problems. But it seems to me that you can't distribute food until you produce it. I think the ball is now in the court of the economist and politician. Let's see what happens.

When your production changes, you not only have to develop the technology—improved seed, proper fertilization, the right cultural practices—and fit it into the cropping systems, but you've got to try to influence policies related to input availability and prices, credit, markets for the increased production, etc.

Many problems still exist with agricultural research and extension programs in developing countries. Many agricultural officers, when they receive university degrees, want to stay in the office or on the experiment station. They try to avoid going out to the fields to see the problems faced by the farmer. This situation is common. At CIMMYT, we bring about 140 young students who have received their first degree to work beside us each year. They get dirty and sweaty or muddy and wet, depending on the weather. They learn to work with their hands and to put some of that university knowledge to practical use. It's a long slow process. Those KSU professors who are engaged in teaching graduate students from developing nations must remember that many of these students have never lived a day of their life on the farm. They only have theoretical knowledge.

Another serious problem is that after U.S. graduate school training, many will never go back and use their knowledge in a practical way to really tackle the production challenges restricting agricultural development in their home countries. Many have received too specialized a training and suffer from scientific tunnel vision.

There are great dangers ahead if we let up on the food production front. The International Food Policy Research Institute (IFPRI) recently made an analysis of world food demand and supply to 1990. Their projections, using trend lines based on production changes between 1960-75, painted a dismal picture. Thirteen countries, including India, Nigeria, Bangladesh, and about ten others, have a projected food deficit in 1990 of about 80 million tons. This assumes no improvement in nutrition, only maintaining 1975 per capita consumption levels. After correcting for new trends that change the magnitude of these deficits, the potential food shortage is less, but still great.

In recent years there has been a big surge of environmentalists concerned about all the chemicals used in today's agriculture. To these environmentalists it's simple—we don't need the chemicals. I've spent a lifetime trying to increase the genetic resistance of crops to diseases. But we need other forms of protection. Biological controls, when they'll work, are part of the solution. But look at what happened with the tussuck moth in Oregon, Washington and Idaho. Because of the insistence by environmentalists that we shouldn't use chemical control, we ended up with about a million acres of dead timber before the biological control began to work.

Let's look at biological control in the most outstanding cases, for example, using miximitosis to control the millions of rabbits that were devasting the land in Australia. After it was introduced in the 1950s, 99.9 percent of all the rabbits in the problem areas were killed off in the first year. Then what happened? Soon, the rabbits started to come back. The viruses were unstable and mutated to produce a strain that was not highly damaging, benign, and the rabbits would get this and produce antibodies and recover. They built up resistance and drove the virulent strains out of existence. Scientists put them back in and the same thing has been repeated time and time again. And so what are they doing now? They continue to use the miximitosis virus as one arm in the battle against the rabbits, but they are back to poisoning and shooting and digging up the burrows. Nature has lots of abilities and devices for protecting herself.

The male sterilization technique that's been used to control the screw worm of cattle in the southern U.S. has done a magnificant job in cleaning out that pest. Hundreds of millions of these flys have been reared, made sterile with cobalt bombs and turned loose. The female mates only once, and when she mates with one of these sterile males, the embryos in the eggs she lays die before hatching. That's a nasty trick to play on that particular insect. But now they have started to come back again as more macho males become resistant to the sterilization techniques.

What I'm saying is that we have to use many methods to control pests. Chemicals have a role to play. Remember, chemicals are like medicine. When you're sick you go to the doctor. He diagnoses your illness, and if you take the medicine he prescribes properly, you'll probably be cured. But if you take it improperly, it'll probably kill you. So it is with agricultural chemicals.

Although I have been primarily concerned with agriculture and food production, I have by necessity, developed an interest in the broad fields of land use or misuse and demography. If one is involved in food production it naturally follows that one must be concerned with the land base upon which we depend for food production and the number of people that land base is capable of feeding. Anyone engaged in attempting to increase world food production soon comes to realize that the human misery resulting from world food shortages and world population growth are part of the same problem. In effect, they are two sides of the same coin. Unless these interrelated problems are brought into better balance within the next several decades, the world will become increasingly more chaotic. There is also the likelihood that the standard of living in many of the affluent nations will stagnate or even retrogress. My question, are we tough enough as a nation to give up some of our nice and wasteful ways?

In particular, we must come to grips with our energy problem. The situation on petroleum imports will get worse before it gets better. We are going to have to develop other energy sources—and we can, if we get to work. Meanwhile, we must cut down on our wasteful consumption of gasoline and other petroleum products so supplies will be available for our really important needs. Agriculture must be given a high priority to assure supplies of fertilizers and other inputs needed to keep our production high. We don't have viable alternatives to our current, energy-based production technologies. We can perhaps develop new ways, such as nitrogen fixation, to help provide plants with needed fertilizer nutrients. But this will take time. Until then, natural gas is the most efficient way to produce nitrogenous fertilizers and its supply to agriculture must be assured. Cultural practices, like minimum tillage, can also reduce our demand for fuel in agriculture. Still, sufficent fuel must be available to run the machinery needed to produce our abundant food supply.

In the next forty years, food and fiber production must be increased more than it was increased in the 12,000 year period from the discovery of agriculture up to 1975. In other words, we must increase our food production from 3.3 billion metric tons to 6.6 metric tons just to maintain current (and often miserable) per capita food consumption levels.

Can the production of food and fiber be doubled in the next forty years? I believe it can, providing the world governments give high enough priority and continuing support to food production. We must expand our scientific knowledge and improve and apply better technology if we are to make our finite land and water resources more productive. This must be done promptly and in an orderly way if we are to meet the growing needs without, at the same time, unnecessarily degrading the environment and crowding many species into extinction.

Today we hear a great deal about human rights. It's a noble goal to work toward, but it can never be achieved as long as hundreds of millions of poverty-stricken people in the world lack the basic necessities of life. The right to dissent? For whom: the elitist, the educated, the privileged? It doesn't mean much to the person with an empty stomach, a shirtless back, a roofless dwelling, the frustrations and fears of unemployment and poverty, the lack of education and opportunity and the pain, misery and loneliness of sickness without medical care.

My work has brought me in close contact with such people. I believe that all who are born into the world have a moral right to the basic ingredients for a decent and humane life. How many should be born, and how fast they should come on the stage is another matter. This latter question requires the best thinking of all of us. In my opinion, if we are to survive as a world in which our children and their children will want to live, and more important, be able to live, scientists and educators can no longer remain aloof from these problems. **We must influence political and religious leaders to face up to the population monster or lose the game by default. It's later than most of us are willing to think.**

Thank you.

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